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| **Joint Video Experts Team (JVET)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  16th Meeting: Geneva, CH, 1–11 Oct. 2019 | Document: JVET-P\_Notes\_d4 |

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| *Title:* | **Meeting Report of the 16th Meeting of the Joint Video Experts Team (JVET), Geneva, CH, 1–11 Oct. 2019** | | |
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| *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 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 of JVET | | |

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# Summary

The Joint Video Experts Team (JVET) of ITU-T WP3/16 and ISO/IEC JTC 1/ SC 29/ WG 11 held its sixteenth meeting during 1–11 October 2019 at the ITU premises in Geneva, CH. The JVET 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 2.13 of this document. It is further noted that the unabbreviated name of JVET was formerly known as “Joint Video *Exploration* Team”, but the parent bodies modified it when entering the phase of formal development of a new standard. The name Versatile Video Coding (VVC) was chosen in April 2018 as the informal nickname for the new standard.

The JVET meeting began at approximately 1400 hours on Tuesday 1 October 2019. Meeting sessions were held on all days (including weekend days) until the meeting was closed at approximately XXXX hours on Friday 11 October 2019. On the first two days of the meeting, only aspects related to high level syntax were on the agenda. Approximately XXX people attended the JVET meeting, and approximately XXX input documents, 8 CE summary reports, and 18 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 JVET. The subject matter of the JVET meeting activities consisted of developing video coding technology with a compression capability that significantly exceeds that of the current HEVC standard, or otherwise gives better support regarding the requirements of future application domains of video coding. As a primary goal, the JVET meeting reviewed the work that was performed in the interim period since the fourteenth JVET meeting in producing a fifth draft of the VVC standard and the fifth version of the associated VVC test model (VTM). Further important goals were reviewing the results of 8 Core Experiments (CE), reviewing other technical input on novel aspects of video coding technology, producing the next versions of the VVC draft text and VTM, and plan next steps for further investigation of candidate technology towards the formal standard development.

The JVET produced XX output documents from the meeting (update):

* JVET-O2001 Versatile Video Coding specification text (Draft 6), also issued as ISO/IEC CD 23090-3 Versatile Video Coding
* JVET-O2002 Algorithm description for Versatile Video Coding and Test Model 6 (VTM 6)
* JVET-O2007 Supplemental enhancement information messages for coded video bitstreams
* JVET-O2011, JVET common test conditions and software reference configurations for HDR/WCG video
* JVET-O2021 through JVET-O2028, Description of Core Experiments 1 through 8

For the organization and planning of its future work, the JVET established XX “ad hoc groups” (AHGs) to progress the work on particular subject areas. At this meeting, X Core Experiments (CE) were defined. The next four JVET meetings were planned for 8–17 January 2020 under WG 11 auspices in Brussels, BE, during 15–24 April 2020 under WG 11 auspices in Alpbach, AT, during 23 June – 01 July 2020 under ITU-T SG16 auspices in Geneva, CH, and during 7–16 October 2020 under WG 11 auspices in Rennes, FR.

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

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

# Administrative topics

## Organization

The ITU-T/ISO/IEC Joint Video Experts Team (JVET) 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 JVET are ITU-T WP3/16 and ISO/IEC JTC 1/SC 29/WG 11.

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

It is further noted that the unabbreviated name of JVET was formerly known as “Joint Video *Exploration* Team”, but the parent bodies modified it when entering the phase of formal development of a new standard. The name Versatile Video Coding (VVC) was chosen in April 2018 as the informal nickname for the new standard.

## Meeting logistics

Information regarding logistics arrangements for the meeting had been provided via the email reflector [jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de) and at <http://wftp3.itu.int/av-arch/jvet-site/2019_10_P_Geneva/>.

## Primary goals

As a primary goal, the JVET meeting reviewed the work that was performed in the interim period since the fifteenth JVET meeting in producing a sixth draft of the VVC standard and the sixth version of the associated VVC test model (VTM). Further important goals were reviewing the results of 8 Core Experiments (CE), reviewing other technical input on novel aspects of video coding technology, producing the next versions of draft text and VTM, and planning next steps for further investigation of candidate technology towards the formal standard development.

## Documents and document handling considerations

### General

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

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 practised as follows:

* Decisions made by the group that might affect the normative content of a future standard are identified in this report by prefixing the description of the decision with the string “Decision:”.
* Decisions that affect the VTM software but have no normative effect are marked by the string “Decision (SW):”.
* Decisions that fix a “bug” in the VTM description (an error, oversight, or messiness) or in the software are marked by the string “Decision (BF):”.

This meeting report is based primarily on notes taken by the JVET chairs. The preliminary notes were also circulated publicly by ftp and http during the meeting on a daily basis. 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 is not 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 Tuesday, 24 September 2019. Any documents uploaded after 1159 hours Paris/Geneva time on Wednesday 25 September were considered “officially late”, giving a grace period of 12 hours to accommodate those living in different time zones of the world. The deadline does not apply to AHG reports, and other such reports which can only be produced after the availability of other input documents.

As agreed by the fifteenth meeting as permanent rule, contributions related to CE proposals (including draft text) were to be uploaded 1 week ahead of the above mentioned deadline, such that more thourough study was possible, and in particular the CE summary reports could be provided in time by the regular deadline. Consequently, CE proposal documents which were uploaded after 1159 hours Paris/Geneva time on Wednesday 18 September were considered “officially late”.

It was suggested to have CE description documents include a description of how the results are planned to be reported – e.g., the form of the tables to be used for the results data. Complexity analysis characterizations were suggested to be a particular issue where this applies.

All contribution documents with registration numbers higher than JVET-P0618 were registered after the “officially late” deadline (and therefore were also uploaded late). Likewise, CE proposal documents with registration numbers higher than JVET-P0081 were registered late. However, some documents in the “late” range might include break-out activity reports that were generated during the meeting, and are therefore better considered as report documents rather than as late contributions. Also, all cross-check reports were uploaded late.

In many cases, contributions were also 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 availability for contributions is generally noted in the section discussing each contribution in this report.

One suggestion to assist with the issue of late submissions was to require the submitters of late contributions and late revisions to describe the characteristics of the late or revised (or missing) material at the beginning of discussion of the contribution. This was agreed to be a helpful approach to be followed at the meeting.

The following technical design proposal contributions were registered and/or uploaded late:qq

* JVET-P0XXX (a proposal on …), uploaded XX-XX.
* …

It may be observed that some of the above-listed contributions were submissions made in response to issues that arose in discussions during the meeting or from the study of other contributions, and thus could not have been submitted by the ordinary deadline. For example, some of them were proposing combinations or simplifications of other proposals.

The following other document not proposing normative technical content, but with some need for consideration, were registered and/or uploaded late:

* JVET-P0XXX (a document on …), uploaded XX-XX.
* …

All cross-verification reports at this meeting (except for JVET-P0594) were registered late and all were uploaded late. In the interest of brevity, these are not specifically identified here. Initial upload times for each document are recorded in Annex A of this report.

The following (X) contribution registrations were later cancelled, withdrawn, never provided, were cross-checks of a withdrawn contribution, or were registered in error: JVET-P0XXX (withdrawn), JVET-P0XXX (missing by the end of meeting), … .

The following crosschecks had not been uploaded yet by the end of the meeting, but were provided later (check if they become available – otherwise withdraw them):

…

“Placeholder” contribution documents that were basically empty of content, or lacking any results showing benefit for the proposed technology, and obviously uploaded with an intent to provide a more complete submission as a revision, had been agreed to be considered unacceptable and to be rejected in the document management system until a more complete version was available (which would then typically be counted as a late contribution). At the current meeting, this situation applied to the initial uploads of documents JVET-P0487, JVET-P0596, JVET-P0620, and … .

Contributions that had significant problems with uploaded versions included the following:

* JVET-P0XXX (…)
* …

As a general policy, missing documents were not to be presented, and late documents (and substantial revisions) could only be presented when there was a consensus to consider them and there was sufficient time available for their review. 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, although there was some expression of annoyance and remarks on the difficulty of dealing with late contributions and late revisions.

It was remarked that documents that are substantially revised after the initial upload can also be a problem, as this becomes confusing, interferes with study, and puts an extra burden on synchronization of the discussion. This can especially be 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 participants tend to seldom notice what is recorded there.

A few contributions may have had some problems relating to IPR declarations in the initial uploaded versions (missing declarations, declarations saying they were from the wrong companies, etc.). These issues were corrected by later uploaded versions in a reasonably timely fashion in all cases (to the extent of the awareness of the responsible coordinators).

Some other errors were noticed in other initial document uploads (wrong document numbers or meeting dates or meeting locations in headers, etc.) which were generally sorted out in a reasonably timely fashion. The document web site contains an archive of each upload.

### Outputs of the preceding meeting

All output documents of the previous meeting, particularly the meeting report JVET-O2000, the Versatile Video Coding specification text (Draft 6) JVET-O2001, the Algorithm description for Versatile Video Coding and Test Model 6 (VTM 6) JVET-O2002, the Methodology and reporting template for coding tool testing JVET-O2005, the Supplemental enhancement information messages for coded video bitstreams JVET-O2007, the JVET common test conditions and software reference configurations for HDR/WCG video JVET-N2011, and the Description of Core Experiments 1 through 8 (JVET-O2021 through JVET-O2028), had been completed and were approved. The software implementation of VTM (versions 6.0 and 6.1) was also approved.

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

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

## Attendance

The list of participants in the JVET 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 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 responsible coordinators.

## Agenda

The agenda for the meeting was as follows:

* Opening remarks and review of meeting logistics and communication practices
* IPR policy reminder and declarations
* Contribution document allocation
* Review of results of the previous meeting
* Reports of *ad hoc* group (AHG) activities
* Reports of core experiments planned at the previous meeting
* Consideration of contributions and communications on project guidance
* Consideration of additional video coding technology contributions
* Consideration of information contributions
* Coordination activities
* Approval of output documents and associated editing periods
* Future planning: Determination of next steps, discussion of working methods, communication practices, establishment of coordinated experiments, establishment of AHGs, meeting planning, other planning issues
* Other business as appropriate for consideration

On the first two days of the meeting (October 1 and 2), only aspects related to high level syntax (including AHG8, AHG12, AHG14, and AHG17 reports) were on the agenda. In the morning of October 3, the meeting was continued with general status review and administrative matters, and then proceeded with reports of ad *hoc* group activities, reports of core experiments, and other matters.

## IPR policy reminder

Participants were reminded of the IPR policy established by the parent organizations of the JVET 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 JVET 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/jvet-site> (JVET contribution templates)
* <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 responsible coordinators invited participants to make any necessary verbal reports of previously-unreported IPR in technology that might be considered as prospective candidate for inclusion in future standards, and opened the floor for such reports: No such verbal reports were made.

## Software copyright disclaimer header reminder

It was noted that the VTM software implementation package uses the same software copyright license header as the HEVC reference software, where the latter had been agreed at the 5th meeting of the JCT-VC and approved by both parent bodies at their collocated meetings at that time. This license header language is based on the BSD license with a preceding sentence declaring that other contributor or third party rights, including patent rights, are not granted by the license, as recorded in [N 10791](http://phenix.it-sudparis.eu/mpeg/doc_end_user/current_document.php?id=27881&id_meeting=16) 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 VTM software, and for evaluating proposals for technology to be potentially included in the design. This software or parts thereof might be published by ITU-T and ISO/IEC as an example implementation of a future video coding standard and for use as the basis of products to promote adoption of such technology.

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.

These considerations apply to the 360Lib video conversion software and HDRTools as well.

## Communication practices

The documents for the meeting can be found at <http://phenix.it-sudparis.eu/jvet/>.

It was reminded to send a notice to the chairs in cases of changes to document titles, authors etc.

JVET email lists are managed through the site <https://lists.rwth-aachen.de/postorius/lists/jvet.lists.rwth-aachen.de/>, and to send email to the reflector, the email address is [jvet@lists.rwth-aachen.de](mailto:jvet@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 JVET 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 to inquiries regarding the nature of their interest in the work. The current number of subscribers was 1221.

For distribution of test sequences, a password-protected ftp site had been set up at RWTH Aachen University, with a mirror site at FhG-HHI. Accredited members of JVET may contact the responsible JVET coordinators to obtain the password information (but the site is not open for use by others).

## Terminology

Some terminology used in this report is explained below:

(check for completeness with JVET-N0013, and draft text)

* **ACT**: Adaptive colour transform.
* **AFF**: Affine.
* **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.
* **AMT or MTS**: Adaptive multi-core transform, or multiple transform selection.
* **AMVR**: (Locally) adaptive motion vector resolution.
* **APS**: Adaptation parameter set.
* **ARC**: Adaptive resolution conversion (synonymous with DRC, and a form of RPR).
* **ARSS**: Adaptive reference sample smoothing.
* **ATMVP** or “subblock-based temporal merging candidates”: Alternative temporal motion vector prediction.
* **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**: See CPR or IBC.
* **BCW**: Biprediction with CU based weighting
* **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).
* **BDOF**: Bi-directional optical flow (formerly known as **BIO**).
* **BDPCM**: Block-wise DPCM.
* **BL**: Base layer.
* **BMS**: Benchmark set (no longer used), a former preliminary compilation of coding tools on top of VTM, which provide somewhat better compression performance, but are not deemed mature for standardzation.
* **BoG**: Break-out group.
* **BR**: Bit rate.
* **BV**: Block vector (used for intra BC prediction).
* **CABAC**: Context-adaptive binary arithmetic coding.
* **CBF**: Coded block flag(s).
* **CC**: May refer to context-coded, common (test) conditions, or cross-component.
* **CCLM**: Cross-component linear model.
* **CCP**: Cross-component prediction.
* **CE**: Core Experiment – a coordinated experiment conducted toward assessment of coding technology.
* **CG**: Coefficient group.
* **CGS**: Colour gamut scalability (historically, coarse-grained scalability).
* **CIIP**: Combined inter/intra prediction.
* **CL-RAS**: Cross-layer random-access skip.
* **CPMV**: Control-point motion vector.
* **CPMVP**: Control-point motion vector prediction (used in affine motion model).
* **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 called a block vector, in a manner conceptually similar to motion-compensated prediction.
* **CST**: Chroma separate tree.
* **CTC**: Common test conditions.
* **CVS**: Coded video sequence.
* **DCT**: Discrete cosine transform (sometimes used loosely to refer to other transforms with conceptually similar characteristics).
* **DCTIF**: DCT-derived interpolation filter.
* **DF**: Deblocking filter.
* **DMVR**: Decoder-side motion vector refinement.
* **DRC**: Dynamic resolution conversion (synonymous with ARC, and a form of RPR).
* **DT**: Decoding time.
* **ECS**: Entropy coding synchronization (typically synonymous with WPP).
* **EMT**: Explicit multiple-core transform.
* **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).
* **ECV**: Extended Colour Volume (up to WCG).
* **EL**: Enhancement layer.
* **ET**: Encoding time.
* **FRUC**: Frame rate up conversion (pattern matched motion vector derivation).
* **GRA**: Gradual random access
* **HDR**: High dynamic range.
* **HEVC**: High Efficiency Video Coding – the video coding standard developed and extended by the JCT-VC, formalized by ITU-T as Rec. ITU-T H.265 and by ISO/IEC as ISO/IEC 23008-2.
* **HLS**: High-level syntax.
* **HM**: HEVC Test Model – a video coding design containing selected coding tools that constitutes our draft standard design – now also used especially in reference to the (non-normative) encoder algorithms (see WD and TM).
* **HMVP**: History based motion vector prediction.
* **HRD**: Hypothetical reference decoder.
* **HyGT**: Hyper-cube Givens transform (a type of NSST).
* **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 (8 bits per sample) source video is encoded using higher bit-depth signal processing, ordinarily including higher bit-depth reference picture storage (ordinarily 12 bits per sample).
* **IBF**: Intra boundary filtering.
* **ILP**: Inter-layer prediction (in scalable coding).
* **IPCM**: Intra pulse-code modulation (similar in spirit to IPCM in AVC and HEVC).
* **ISP**: Intra subblock partitioning
* **JCCR**: Joint coding of chroma residuals
* **JEM**: Joint exploration model – the software codebase for future video coding exploration.
* **JM**: Joint model – the primary software codebase 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.
* **KLT**: Karhunen-Loève transform.
* **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.
* **LFNST**: Low-frequency non-separable transform
* **LIC**: Local illumination compensation.
* **LM**: Linear model.
* **LMCS**: Luma mapping with chroma scaling (formerly sometimes called “in-loop reshaping”)
* **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.
* **MC**: Motion compensation.
* **MCP**: Motion compensated prediction.
* **MDNSST**: Mode dependent non-separable secondary transform.
* **MIP**: Matrix-based intra prediction
* **MMLM**: Multi-model (cross component) linear mode.
* **MMVD**: Merge with MVD.
* **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 JVET).
* **MPM**: Most probable mode (in intra prediction).
* **MRL**: Multiple reference line intra prediction.
* **MV**: Motion vector.
* **MVD**: Motion vector difference.
* **NAL**: Network abstraction layer (as in AVC and HEVC).
* **NSQT**: Non-square quadtree.
* **NSST**: Non-separable secondary transform.
* **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. l,ight input to a camera) to output light (e.g., light emitted by a display).
* **operation point**: A temporal subset of an OLS.
* **PDPC**: Position dependent (intra) prediction combination.
* **PMMVD**: Pattern-matched motion vector derivation.
* **POC**: Picture order count.
* **PoR**: Plan of record.
* **PROF**: Prediction refinement with optical flow
* **PPS**: Picture parameter set (as in AVC and HEVC).
* **PTL**: Profile/tier/level combination.
* **QM**: Quantization matrix (as in AVC and HEVC).
* **QP**: Quantization parameter (as in AVC and HEVC, sometimes confused with quantization step size).
* **QT**: Quadtree.
* **BT**: Binary tree.
* **TT**: Ternary tree.
* **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.
* **RDPCM**: Residual DPCM
* **ROT**: Rotation operation for low-frequency transform coefficients.
* **RPLM**: Reference picture list modification.
* **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.
* **SBT**: Subblock transform.
* **SbTMVP**: Subblock based temporal motion vector prediction.
* **SD**: Slice data; alternatively, standard-definition.
* **SDT**: Signal-dependent transform.
* **SEI**: Supplemental enhancement information (as in AVC and HEVC).
* **SH**: Slice header.
* **SHM**: Scalable HM.
* **SHVC**: Scalable high efficiency video coding.
* **SIMD**: Single instruction, multiple data.
* **SMVD**: Symmetric MVD.
* **SPS**: Sequence parameter set (as in AVC and HEVC).
* **STMVP**: Spatial-temporal motion vector prediction.
* **TBA/TBD/TBP**: To be announced/determined/presented.
* **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.
* **TPM**: Triangular partitioning mode
* **UCBDS**: Unrestricted center-biased diamond search.
* **UWP**: Unequal weight prediction.
* **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 JVET).
* **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.
* **VTM**: VVC Test Model.
* **VVC**: Versatile Video Coding, the standardization project developed by JVET.
* **WAIP**: Wide-angle intra prediction
* **WCG**: Wide colour gamut.
* **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 in HEVC:
  + **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.
  + **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 in HEVC.
  + **PU**: Prediction unit (containing both luma and chroma), the level of the prediction control syntax 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).
* Block and unit names in VVC:
  + **CTB**: Coding tree block (luma or chroma) – there are three CTBs per CTU in a P or B slice or in an I slice that uses a single tree, and one CTB per luma CTU and two CTBs per chroma CTU in an I slice that uses separate trees.
  + **CTU**: Coding tree unit (synonymous with LCU, containing both luma and chroma in a P or B slice or in an I slice that uses a single tree, containing only luma or only chroma in an I slice that uses separate trees), with a size of 16x16, 32x32, 64x64, or 128x128 for the luma component.
  + **CB**: Coding block, a luma or chroma block in a CU.
  + **CU**: Coding unit (containing both luma and chroma in P/B slice, containing only luma or chroma in I slice), a leaf node of a QTBT. It’s the level at which the prediction process and residual transform are performed in JEM. A CU can be square or rectangle shape.
  + **PB**: Prediction block, a luma or chroma block of a PU.
  + **PU**: Prediction unit, has the same size as a CU in the VVC context.
  + **TB**: Transform block, a luma or chroma block of a TU.
  + **TU**: Transform unit, has the same size as a CU in the VVC context.

## Opening remarks

Remarks during the opening session of the meeting 1430 Tuesday 1 October (chaired by GJS) were as follows.

* The first two days are dedicated to high-level syntax
* Workshop on "The Future of Media" planned for October 8
* 0900 start time generally
* Balloting and approval timeline: "H.VVC" and ISO/IEC 23090-3
  + CD in July 2019 – Results: m49979
  + DIS as output of this meeting, with ballot period between the January and April meetings.
    - Post-meeting editing
  + FDIS and Consent in July
* The meeting logistics, agenda, working practices, policies, and document allocation were reviewed.
  + The meeting host is the ITU
  + Having text available is crucial (and not just arriving at the end of the meeting).
  + There were no objections voiced in the opening plenary to the consideration of late contributions.
* The results of the previous meeting were reviewed.
* On placeholders – there were a number of cases where there was some description of a concept but no test results (see section 2.4.2).
* The primary goals of the meeting were to review the results of CEs, identify promising technology directions, and adopt proposed technology into the VVC draft text and VTM.
* Due to the high number of input contributions, parallelization and breakout work were planned to be used at the meeting.
* Planning of viewing & equipment setup is needed
* Principles of standards development were discussed.

## Scheduling of discussions

Scheduling: Generally meeting time was scheduled during 0900–2100+ hours, with coffee and lunch breaks as convenient. 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:

* Tue. 1 Oct., 1st day
  + 1430–1530 Opening remarks, review of practices, agenda, IPR reminder
  + 1530-1600 Reports of AHGs 8, 12, 17
  + 1630 High-level functional discussion:
    - Scalability
      * 1630 OLSs – section 6.20.1.1
      * 1750 RAPs – section 6.20.1.2
      * 1830 PTL / conformance – section 6.20.1.3
      * 1910 ROI scalability – section 6.20.1.4
      * 1950 VPS and single-layer decoders – section 6.20.1.5
      * 2005 External independent layers – section 6.20.1.6
      * 2015 Layered coding and subpictures – section 6.20.1.7
      * 2120 Diagonal inter-layer referencing – section 6.20.1.8
    - Subpictures
      * 2140-2215 JVET-P0693 summarizes some categories of the HLS proposals on subpictures – section 6.19.1.1
* Wed. 2 Oct., 2nd day
  + High-level syntax
    - 0900 Cross-RAP referencing / external decoder refresh section 6.18.3 [closed]
    - Subpictures
      * 1100-1645 JVET-P0693 some categories of the HLS proposals on subpictures – section 6.19.1.1
    - Slices, tiles, bricks
      * 1720-2000 JVET-P0686 HLS proposals on slices, tiles and bricks
    - 2030-2330 JVET-P0687 HLS proposals on access unit delimiter, picture header, and slice header parameters signalling
* Thu. 3 Oct., 3rd day
  + 0900-1030 Status review, AHGs 1-3 and JCTVC-P0113 input from editors
  + 1100-1345 Track A: Review (JRO)
    - 1100 AHGs 4, 5, 6, 7, 9, 10, 11, 13, 14, 15, 16, 18
  + 1100 Track B (GJS)
    - 1100 HLS JVET-P0687 HLS proposals on access unit delimiter, picture header, and slice header parameters signalling
    - 1430 CE1 RPR
    - 1620 CE2 GDR
    - 1715 CE4 Inter prediction
  + 1430 HLS BoG Room A
  + 1445-2000 Track A:
    - Planning of viewing related to CEs (CE4, CE5)
    - Review CE3, CE6, CE7
* Fri. 4 Oct., 4th day
  + 0900-1300 JCT-VC (outside of JVET)
  + 0900-1115 BoG on CE3 related (G.v.d. Auwera)
  + 0900- Track A (JRO)
    - 1130-1300 Track A: CE8 (JRO)
    - 1400-2230 Track A: CE6 related (JRO)
  + 1430-1900 Track B (GJS) RPR filters – section 6.1
* Sat. 5 Oct., 5th day
  + 0900- Track B (GJS)
    - Misc coding tools – section 6.14
    - RPR filters (P0409 & P0592) – section 6.1
    - Partitioning – section 6.11

## Contribution topic overview

The approximate subject categories and quantity of contributions per category for the meeting were summarized as follows (note that the noted document counts do not include crosschecks, and may not be completely accurate):

* AHG reports (18) (section 3) (Plenary)
* Project development (X) (section 4) (Plenary)
  + Text and software development (1)
  + Test conditions (1)
  + Performance assessment (3)
  + Coding studies on specific use cases (0)
  + Test Material (0)
  + Conformance (6)
  + Implementation (2)
* Core Experiments (xx) (section 5) with subtopics
  + CE1: Reference picture resampling filters (4) (section 5.1) (Track B)
  + CE2: Gradual decoding refresh (3) (section 5.2) (Track B)
  + CE3: Intra prediction and mode coding (4) (section 5.3) (Track A)
  + CE4: Inter prediction (8) (section 5.4) (Track B)
  + CE5: Loop filtering (8) (section 5.5) (Track A)
  + CE6: Transforms and transform signalling (6) (section 5.6) (Track A)
  + CE7: Quantization and coefficient coding (9) (section 5.7) (Track A)
  + CE8: Screen content coding tools (6) (section 5.8) (Track A)
* Non-CE technology proposals (xx) (section 6) with subtopics
  + CE1 related – Reference picture resampling filters (9) (section 6.1) (Track B)
  + CE2 related – Gradual decoding refresh (0) (section 6.2) (Track B)
  + CE3 related – Intra prediction and mode coding (48) (section 6.3) (Track A)
  + CE4 related – Inter prediction (107) (section 6.4) (Track B)
  + CE5 related – Loop filtering (72) (section 6.5) (Track A)
  + CE6 related – Transforms and transform signalling (40) (section 6.6) (Track A)
  + CE7 related – Quantization and coefficient coding (24) (section 6.7) (Track A)
  + CE8 related – Screen content coding tools (36) (section 6.8) (Track A)
  + Quantization control (23) (section 6.9) (Track A)
  + Entropy coding 4) (section 6.10) (Track A)
  + Partitioning (14) (section 6.11) (Track B)
  + Chroma sampling and chroma formats (1) (section 6.12) (Track A)
  + Lossless and near lossless coding (24) (section 6.13) (Track A)
  + Miscellaneous coding tools (6) (section 6.14) (Track B)
  + Neural networks (1) (section 6.15) (Track A)
  + 360 degree video (2) (section 6.16) (Track B)
  + High level tool control (0) (section 6.17) (Track B)
  + AHG17: General high-level syntax (47) (section 6.18) (Track B)
  + AHG12: High-level parallelism and coded picture regions (46) (section 6.19) (Track B)
  + AHG8: Layered coding and resolution adaptation (36) (section 6.20) (Track B)
* Complexity analysis and reduction (2) (section 7) (Track X)
* Encoder optimization (1) (section 8) (Track X)
* Metrics and evaluation criteria (1) (section 9) (Track X)
* Withdrawn (13) (section 10) (Track none)
* Joint meetings, plenary discussions, BoG reports, Summary of actions (section 11)
* Project planning (section 12)
* Establishment of AHGs (section 13)
* Output documents (section 14)
* Future meeting plans and concluding remarks (section 15)

The document counts above do not include cross-checks and CE summary reports.

Track A (294) was generally chaired by JRO, and Track B (281) by GJS.

# AHG reports (18)

These reports were discussed Thursday 3 Oct. 0900–XXXX (chaired by GJS and JRO), except otherwise noted.

[JVET-P0001](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8564) JVET AHG report: Project management (AHG1) [J.-R. Ohm, G. J. Sullivan]

Discussed Thursday 0910 (GJS & JRO)

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

The work of the JVET overall had proceeded well in the interim period with a huge number of input documents submitted to the current meeting. Intense discussion had been carried out on the group email reflector, and all output documents from the preceding meeting had been produced.

Output documents from the preceding meeting had been made available at the "Phenix" site (<http://phenix.it-sudparis.eu/jvet/>) or the ITU-based JVET site ([http://wftp3.itu.int/av-arch/jvet-site/2019\_07\_ O\_Gothenburg/](http://wftp3.itu.int/av-arch/jvet-site/2019_07_%20O_Gothenburg/)), particularly including the following:

* The meeting report (JVET-O2000) [Posted 2019-09-30]
* Versatile Video Coding (Draft 6) (JVET-O2001) [Posted 2019-07-13, last update 2019-07-31]
* Algorithm description for Versatile Video Coding and Test Model 6 (VTM 6) (JVET-O2002) [Posted 2019-08-15, last update 2019-09-10]
* Methodology and reporting template for coding tool testing (JVET-O2005) [Posted 2019-08-05]
* Supplemental enhancement information messages for coded video bitstreams (Draft 1) (JVET-O2007) [Posted 2019-07-31]
* JVET common test conditions and software reference configurations for HDR/WCG video (JVET-N2011) [Posted 2019-09-27]
* Description of CE 1..8 (JVET-O2021..28) [all first posted 2019-07-11/12/13, further updates during the CE definition period of 3 weeks after the meeting]. The following CE description documents had later updates (more than 4 weeks after the meeting):
  + - JVET-O2021 [last updated 2019-09-11]
    - JVET-O2023 [last updated 2019-09-03]
    - JVET-O2024 [last updated 2019-09-19]
    - JVET-O2025 [last updated 2019-08-30]
    - JVET-O2026 [last updated 2019-09-13]
    - JVET-O2027 [last updated 2019-08-22]
    - JVET-O2028 [last updated 2019-09-16]

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

Software integration of VTM was finalized approximately according to the plan.

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. 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.

Roughly 750 input contributions to the current meeting (not counting the AHG and CE summary reports) had been registered for consideration at the meeting. Though topics of Core Experiments and related documents for the development of low-level coding tools reflect the bulk of these documents, around 140 documents were submitted on aspects of high-level syntax.

A preliminary basis for the document subject allocation and meeting notes for the 16th meeting had been made publicly available on the ITU-hosted ftp site.

[JVET-P0002](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8565) JVET AHG report: Draft text and test model algorithm description editing (AHG2) [B. Bross, J. Chen, J. Boyce, S. Kim, S. Liu, Y.-K. Wang, Y. Ye]

Discussed Thursday 0920 (GJS & JRO)

This document reports the work of the JVET ad hoc group on draft text and test model algorithm description editing (AHG2) between the 15th meeting in Gothenburg, SE, (3–12 July 2019) and the 16th meeting in Geneva, CH, (1–11 October 2019).

At the 15th JVET meeting, it was decided to include additional coding features for intra picture-prediction, inter-picture prediction, transform, CABAC engine and in-loop filter in the sixth draft of Versatile Video Coding (VVC D6) and the VVC Test Model 6 (VTM6) encoding.

The normative decoding process for Versatile Video Coding is specified in the VVC draft 6 text specification document. The VVC Test Model 6 (VTM 6) Algorithm and Encoder Description document provides an algorithm description as well as an encoder-side description of the VVC Test Model 6, which serves as a tutorial for the algorithm and encoding model implemented in the VTM6.x software.

An issue tracker (<https://jvet.hhi.fraunhofer.de/trac/vvc>) was used to facilitate the reporting of errata with the VVC documents.

Fourteen versions of JVET-O2001 were published by the Editing AHG between the 15th meeting in Gothenburg, SE (3–12 July 2019) and the 16th meeting in Geneva, CH (1–11 October 2019).

The input document JVET-P0113 has been prepared to provide integrations of a number of bug fixes reported in the bug tracking system as well as some other editorial changes made by the authors, based on the latest JVET output draft VVC text in JVET-O2001-vE.

Two versions of JVET-O2002 were published by the Editing AHG between the 15th meeting in Gothenburg, SE, (3–12 July 2019) and the 16th meeting in Geneva, CH, (1–11 October 2019).

The AHG recommends to:

* Approve the edited JVET-O2001 and JVET-O2002 documents as JVET outputs,
* Continue to edit the VVC draft and Test Model documents to ensure that all agreed elements of VVC are fully described,
* Compare the VVC documents with the VVC software and resolve any discrepancies that may exist, in collaboration with the software AHG,
* Encourage the use of the issue tracker to report issues with the text of both the VVC specification draft and the algorithm and encoder description,
* Continue to improve the editorial consistency of VVC WD and Test Model documents,
* Ensure that, when considering the addition of new feature to VVC, properly drafted text for addition to the VVC Test Model and/or the VVC Working Draft is made available in a timely manner.
* Use the the editorial input and fixes for VVC draft 6 in JVET-P0113 as the basis for integration of adoptions of the 16th JVET meeting.

[JVET-P0003](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8566) JVET AHG report: Test model software development (AHG3) [F. Bossen, X. Li, K. Sühring]

Discussed Thursday 0945 (GJS & JRO)

This report summarizes the activities of the AhG3 on Test model software development that has taken place between the 15th and 16th JVET meetings.

*VTM software development*

Development was continued on the GitLab server, which allows participants to register accounts and use a distributed development workflow based on git.

The server is located at:

https://vcgit.hhi.fraunhofer.de

The registration and development workflow is documented at:

https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware\_VTM/wikis/VVC-Software-Development-Workflow

The VTM software can be found at

https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware\_VTM/

*CTC Performance*

The following table shows **VTM 6.1** performance over **HM 16.20**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra** |  |  |
|  |  |  | **Over HM-16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -28.12% | -33.44% | -33.64% | 1627% | 174% |
| Class A2 | -27.86% | -20.72% | -13.06% | 2625% | 183% |
| Class B | -21.10% | -19.86% | -27.27% | 2927% | 190% |
| Class C | -21.81% | -19.77% | -23.98% | 4098% | 204% |
| Class E | -25.16% | -21.29% | -25.60% | 2393% | 176% |
| **Overall** | -24.23% | -22.48% | -24.96% | 2716% | 187% |
| Class D | -17.70% | -14.41% | -15.71% | 4741% | 198% |
| Class F | -38.92% | -39.43% | -41.80% | 4338% | 186% |
|  |  |  |  |  |  |
|  |  |  | **Random Access** |  |  |
|  |  |  | **Over HM-16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -37.32% | -38.56% | -44.50% | 843% | 162% |
| Class A2 | -41.64% | -38.65% | -32.64% | 932% | 174% |
| Class B | -33.98% | -41.65% | -43.13% | 902% | 160% |
| Class C | -28.65% | -32.77% | -34.87% | 1144% | 174% |
| Class E |  |  |  |  |  |
| **Overall** | -34.76% | -38.06% | -39.10% | 954% | 167% |
| Class D | -26.40% | -29.45% | -30.18% | 1231% | 178% |
| Class F | -40.66% | -45.33% | -46.77% | 640% | 142% |
|  |  |  |  |  |  |
|  |  |  | **Low Delay B** |  |  |
|  |  |  | **Over HM-16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -26.95% | -30.69% | -31.68% | 861% | 150% |
| Class C | -22.91% | -23.65% | -25.50% | 1005% | 153% |
| Class E | -25.56% | -31.33% | -33.57% | 435% | 121% |
| **Overall** | -25.25% | -28.50% | -30.09% | 764% | 143% |
| Class D | -21.34% | -19.29% | -21.28% | 1024% | 169% |
| Class F | -37.72% | -41.80% | -43.27% | 526% | 116% |
|  |  |  |  |  |  |
|  |  |  | **Low Delay P** |  |  |
|  |  |  | **Over HM-16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -31.87% | -34.39% | -35.33% | 809% | 149% |
| Class C | -25.45% | -25.00% | -26.93% | 964% | 160% |
| Class E | -29.82% | -36.00% | -37.95% | 425% | 123% |
| **Overall** | -29.22% | -31.66% | -33.18% | 730% | 145% |
| Class D | -23.47% | -21.35% | -22.26% | 987% | 171% |
| Class F | -37.62% | -41.91% | -43.00% | 575% | 122% |

The following table shows **VTM 6.0** performance compared to **VTM 5.2**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra** |  |  |
|  |  |  | **Over VTM-5.2** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -1.91% | 9.60% | 4.82% | 73% | 99% |
| Class A2 | -3.68% | 7.65% | 7.61% | 75% | 100% |
| Class B | -0.81% | 6.57% | 7.39% | 77% | 101% |
| Class C | -0.69% | 2.95% | 4.11% | 82% | 102% |
| Class E | -0.74% | 3.55% | 5.32% | 84% | 98% |
| **Overall** | -1.43% | 5.95% | 5.92% | 78% | 100% |
| Class D | -0.69% | 4.75% | 6.19% | 82% | 106% |
| Class F | -1.38% | 0.54% | 0.84% | 91% | 102% |
|  |  |  |  |  |  |
|  |  |  | **Random Access** |  |  |
|  |  |  | **Over VTM-5.2** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -3.37% | -0.93% | -5.52% | 95% | 102% |
| Class A2 | -3.85% | -4.75% | -4.40% | 97% | 103% |
| Class B | -1.77% | -8.48% | -7.39% | 92% | 102% |
| Class C | -0.99% | -8.26% | -6.28% | 92% | 101% |
| Class E |  |  |  |  |  |
| **Overall** | -2.30% | -6.16% | -6.12% | 93% | 102% |
| Class D | -0.73% | -7.13% | -4.31% | 85% | 99% |
| Class F | -1.25% | -7.69% | -6.67% | 88% | 101% |
|  |  |  |  |  |  |
|  |  |  | **Low Delay B** |  |  |
|  |  |  | **Over VTM-5.2** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -1.27% | -13.27% | -12.74% | 107% | 107% |
| Class C | -0.55% | -7.38% | -6.24% | 105% | 113% |
| Class E | -0.12% | -11.51% | -9.23% | 99% | 116% |
| **Overall** | -0.74% | -10.87% | -9.69% | 105% | 111% |
| Class D | -0.08% | -7.48% | -6.89% | 100% | 107% |
| Class F | -2.10% | -9.06% | -8.59% | 98% | 109% |
|  |  |  |  |  |  |
|  |  |  | **Low Delay P** |  |  |
|  |  |  | **Over VTM-5.2** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -2.01% | -14.22% | -14.41% | 109% | 107% |
| Class C | -1.12% | -8.10% | -7.08% | 108% | 112% |
| Class E | -1.20% | -12.64% | -10.95% | 107% | 116% |
| **Overall** | -1.51% | -11.78% | -11.10% | 108% | 111% |
| Class D | -0.65% | -8.45% | -7.17% | 100% | 106% |
| Class F | -2.09% | -9.57% | -9.29% | 102% | 110% |

The following table shows **VTM 6.1** performance compared to **VTM 6.0**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra** |  |  |
|  |  |  | **Over VTM-6.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.01% | 0.01% | 0.01% | 99% | 93% |
| Class A2 | 0.00% | 0.00% | 0.00% | 100% | 93% |
| Class B | 0.01% | 0.01% | 0.01% | 103% | 96% |
| Class C | 0.03% | 0.03% | 0.03% | 100% | 97% |
| Class E | 0.03% | 0.03% | 0.03% | 101% | 96% |
| **Overall** | 0.02% | 0.02% | 0.02% | 101% | 95% |
| Class D | 0.05% | 0.03% | 0.03% | 100% | 91% |
| Class F | 0.03% | 0.02% | 0.02% | 100% | 96% |
|  |  |  |  |  |  |
|  |  |  | **Random Access** |  |  |
|  |  |  | **Over VTM-6.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.00% | -0.03% | 0.01% | 98% | 87% |
| Class A2 | 0.00% | -0.04% | 0.04% | 98% | 90% |
| Class B | 0.00% | 0.00% | 0.00% | 99% | 88% |
| Class C | 0.00% | -0.01% | 0.05% | 99% | 88% |
| Class E |  |  |  |  |  |
| **Overall** | 0.00% | -0.01% | 0.02% | 99% | 88% |
| Class D | 0.00% | 0.03% | 0.08% | 100% | 83% |
| Class F | 0.02% | 0.01% | 0.01% | 102% | 89% |
|  |  |  |  |  |  |
|  |  |  | **Low Delay B** |  |  |
|  |  |  | **Over VTM-6.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | 0.00% | -0.09% | -0.13% | 99% | 85% |
| Class C | 0.00% | 0.06% | -0.06% | 99% | 81% |
| Class E | 0.02% | 0.23% | 0.06% | 100% | 83% |
| **Overall** | 0.01% | 0.04% | -0.06% | 99% | 83% |
| Class D | -0.02% | 0.29% | -0.09% | 100% | 83% |
| Class F | 0.03% | 0.02% | -0.03% | 99% | 81% |
|  |  |  |  |  |  |
|  |  |  | **Low Delay P** |  |  |
|  |  |  | **Over VTM-6.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | 0.00% | -0.04% | 0.07% | 98% | 84% |
| Class C | 0.00% | 0.14% | 0.00% | 99% | 81% |
| Class E | 0.13% | 0.01% | 0.26% | 100% | 82% |
| **Overall** | 0.03% | 0.03% | 0.10% | 99% | 82% |
| Class D | 0.06% | -0.57% | -0.30% | 100% | 83% |
| Class F | -0.03% | -0.11% | 0.25% | 101% | 82% |

Full.results are attached to this AHG report as Excel files.

Issues encountered during the software implementation process

Several issues were encountered during software development:

* Vacation time caused delays because people responsible for submitting software patches were not available.
  + The implementation of “JVET-O0050: avoid small intra prediction with a local dual-tree technique” was much larger than expected (~1000 lines of code changed) and the merge request was provided close to the VTM-6.0 deadline. It is generally a problem when large patches are provided late, because this gives software coordinators little time to review and test them and may thus cause delays in the release process.
  + It was discovered that “JVET-O0119: Base palette mode for 4:4:4” causes a significant increase in memory usage, even if not enabled (as in CTC). Coding tools should only have minimal impact on memory and coding time, when disabled. This needs to be fixed.
  + It is generally concerning that for many HLS implementations work seemed to start only close to the deadline or after the deadline. HLS implementations can start in parallel to the low-level implementations, because there are few conflicts to be expected.
  + Some software patches were submitted completely untested.
  + The quality of submitted SIMD code is generally not very high. A lot of SIMD code has been rewritten.
  + Configuration files were incorrect in VTM 6.0 release candidate 1 (incorrect naming of DBPCM parameter). This resulted in BDPCM not being enabled in the set (based on rc1) that was used to retrain initial CABAC states.
  + There was some confusion about how to configure QP settings in CTC for HDR PQ sequences following the adoption of JVET-O0650 (chroma QP mapping). In particular, the confusion arose from the fact that chroma offsets signaled in the PPS are now applied after QP mapping instead of before. This has a significant effect for PQ sequences, where custom chroma offsets are computed. The luma/chroma balance for PQ content may thus be significantly different in VTM 6 than in VTM 5. This should be addressed at the 16th meeting.
  + JVET-O0282 (low QP bug fix) was integrated under the macro of JVET-O0199 (base palette for 444), which led to confusion. Such practice should be avoided in the future.
  + An issue was identified regarding text and software integration of JVET-N0278, and the expectations of proponents, what would have been integrated. Draft 5 version 1 integrated the exact text of JVET-N0278, which defines an input filter for the decoder, that removes all layers, except for the target layer (LIdTarget). Software was provided implementing this filter into VTM. Later, in Draft 5 version 4 “fixes for JVET-N0278” were integrated that refer to layers in multiple locations of the specification, including definitions, reference picture list construction, and constraints on different NAL unit types. These changes are likely language from layered HEVC, but not required in the case, where a decoder would see only one specific value of nuh\_layer\_id. Proponents modified these editorially added constraints later on in the Gothenburg meeting. They expected the original constraints to be implemented in software. Also, for the implementation of scalable coding, proponents expected that the software would already contain some infrastructure for multi-layer coding, which does not exist.

At the beginning of the 16th meeting, the following implementations were still pending:

* + JVET-O0357 Maximum TU size for chroma format 4:2:2 and 4:4:4 [L. Li, J. Nam, J. Lim, S. Kim (LGE)]. O0389 was noted to be related [W. Cai, J. Zhu, J. Yao, K. Kazui (Fujitsu)]. The current text says that for chroma, the max TU size is:
    - For 4:4:4, max is 64x64
    - For 4:2:2, max is 32x64
    - For 4:2:0, max is 32x32

Proponents of O0357 and O0389 were asked to check these aspects for text and software. Revisit as a non-CE6 topic.

* + JVET-O0235: Constraints on nal\_unit\_type, TemporalId, etc. (Ericsson working on this)
  + JVET-O1143. Subpictures
  + JVET-O1159: Scalability

For the following implementations, issues remain:

* + JVET-O0147/JVET-O0226: A constraint was changed in the contributions to enable the use of more efficient field coding GOPs. An example field coding config file should be provided to guide users.
  + JVET-O0145/JVET-O0215: The number of entry points is derived instead of being signalled. For this the number of bricks needs to be known in the slice header. The software needs to be restructured to allow derivation of the slice/tile/brick related variables within the slice header parsing process. An initial version of the code has been merged, but disabled.
  + JVET-O0042: The syntax was included with JVET-O0041, but no configuration options exist for frame repetitions. Also, the decoder does not repeat frames.

*Software manual*

Few merge requests included the required contributions to the software manual. Updates were only provided after being requested by the software coordinators.

Many parameters still have their outdated HEVC documentation and need to be updated. Other parameters for VVC tools are completely missing.

To make the software manual a valuable document, those missing parts need to be added.

*CE software*

For each CE a group was created in GitLab and CE coordinators were given owner rights to the group. This way they could clone VTM as required, create branches for different tests and assign user access to the group themselves.

The CE development workflow is described at:

<https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/wikis/Core-experiment-development-workflow>

CE read access is available using shared accounts: One account exists for MPEG members, which uses the usual MPEG account data (as announced on the appropriate email lists). A second account exists for VCEG members. The account information for VCEG members is available in the TIES system:

<https://www.itu.int/ifa/t/2017/sg16/exchange/wp3/q06/vceg_account.txt>

*Bug tracking*

The bug tracker for VTM and specification text is located at:

<https://jvet.hhi.fraunhofer.de/trac/vvc>

The bug tracker uses the same accounts as the HM software bug tracker. Users may need to log in again due to the different sub-domain. For spam fighting reasons account registration is only possible at the HM software bug tracker at

<https://hevc.hhi.fraunhofer.de/trac/hevc>

Please file all issues related to the VVC reference software into the bug tracker. Try to provide all the details, which are necessary to reproduce the issue. Patches for solving issues and improving the software are always appreciated.

The AHG recommended to:

* Continue to develop the VTM reference software
* Improve documentation, especially the software manual
* Resolve any normative issues resulting from the large number of integrations in the most recent development cycle
* Encourage people to test VTM software more extensively outside of common test conditions.
* Encourage people to report all (potential) bugs that they are finding.
* Encourage people to submit bitstreams/test cases that trigger bugs in VTM.
* Encourage people to submit non-normative changes that reduce encoder run time without significantly sacrificing compression performance
* Make sure that contributions considered for adoption in the future are subject to adequate text and software review by the JVET at large
* Identify which recent additions contribute to the increase of encoder run time for low delay configurations, in particular for low QP values

In the discussion, it was noted that Broadcom and Allegro had been particularly helpful in the interim period with checking and bug-fixing both software and text. This was greatly appreciated.

It was commented that integration of HLS aspects in software has sometimes been difficult. One issue has been the need for clarity on who is responsible for software for some of these aspects. Making sure we have a clear identification of one person responsible was a suggestion for how to improve this.

Problem with palette mode memory footprint – revisit in context of non-CE8.

Proponents of O0257 and should report on implementation status (and match with text) of maximum chroma TU size for 4:2:2 and 4:4:4 cases – revisit in context of non-CE6

[JVET-P0004](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8567) JVET AHG report: Test material and visual assessment (AHG4) [T. Suzuki, M. Wien, V. Baroncini, R. Chernyak, A. Norkin, J. Ye]

The mandates of this AHG were:

• Maintain the video sequence test material database for development of the VVC standard.

• Identify and recommend appropriate test materials for use in the development of the VVC standard.

• Identify missing types of video material, solicit contributions, collect, and make available a variety of video sequence test material.

• Evaluate new test sequences, particularly including the material recently submitted by the Blender Foundation / Blender Animation Studio and Twitch.

• Propose a new structure for the test sequence repository.

• Prepare availability of viewing equipment and facilities arrangements for the next meeting, and prepare testing upon consultation with CE coordinators.

• Coordinate with AHG11 on test material for screen content coding

2 Test sequences

The test sequences used for CfP/CTC are available on ftp://jvet@ftp.ient.rwth-aachen.de in directory “/jvet-cfp” (accredited members of JVET may contact the JVET chairs for login information).

Due to copyright restrictions, the JVET database of test sequences is only available to accredited members of JVET (i.e. members of ISO/IEC MPEG and ITU-T VCEG).

3 New structure at test sequence repository

There was discussion in the last 2-3 meetings that the current directory structure of test sequence ftp site is not good for the current activities. The ftp directory structure was changed as follows.

- ctc/ Contains the active test set of the common testing conditions

- ahg/ Contains subdirectories with sequences under consideration.

- ce/ Contains subdirectories for data exchange for specific CE

- jvet-cfe/ The sequences used for CfE

- jvet-cfp/ The sequences used for CfP

- old/ Contains the JEM bitstreams directory, used before the CfP

- upload Stays as before

In the CTC directory, following subdirectories have been created:

ctc/360/

ctc/hdr/

ctc/scc/

ctc/sdr/

The directories are populated with the CTC test sets in each of the categories.

4 Related contributions

The no related contributions were submitted.

5 Recommendations

The AHG recommends:

• To continue to collect new test sequences available for JVET with licensing statement

It is mentioned that CE5 uses some sequences that cannot be made available from the ftp site (SVT sequences by EBU). In such cases, the CE description should contain information how to get such sequences.

[JVET-P0005](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8568) JVET AHG report: Memory bandwidth consumption of coding tools (AHG5) [R. Hashimoto, T. Ikai, X. Li, D. Luo, H. Yang, M. Zhou]

Mandates of this AHG

• Develop improved software tools for measuring both average and worst case of memory bandwidth, and provide information for usage of these tools.

• Study cache configurations for measuring decoder memory bandwidth consumption.

• Identify coding tools in CEs and VTM with significant memory bandwidth impact.

• Study the impact of memory bandwidth on specific application cases.

There is no related email discussion during this meeting cycle.

There is no related contribution in this meeting.

It was recommended to discontinue this AHG in this meeting if there is no strong opinion.

It was agreed to close the AHG, and include mandate of maintaining the SW into AHG13 and/orAHG16.

[JVET-P0006](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8543) JVET AHG Report: 360° video coding tools, software and test conditions (AHG6) [Y. He, J. Boyce, K. Choi, J.-L. Lin, Y. Ye]

The mandates of this AHG are as follows:

• Study the effect on compression and subjective quality of different projections formats, resolutions, and packing layouts.

• Discuss refinements of common test conditions, test sequences, and evaluation criteria.

• Solicit additional test sequences, and evaluate suitability of test sequences on head-mounted displays and normal 2D displays.

• Study coding tools dedicated to 360° video, their impact on compression, and implications to the core codec design.

• Study the effect of viewport resolution, field of view, and viewport speed/direction on visual comfort.

• Study complexity of GPU rendering of projection formats

• Study syntax for signalling of projection formats, cubeface layouts, spherical rotations

• Generate CTC (PHEC) anchors and PERP results for VTM according to JVET-L1012, and finalize the reporting template for the common test conditions.

Brief summary for the activities:

The 360Lib-9.2-dev software package included following changes:

Integrating FishEye project format in 360Lib software:

(1) Received one version of the FishEye projection format implementation from proponents (LGE), but the implementation was not completed yet.

Fixed the bug #536 in VTM-6.1:

(2) The bug #536 is caused by the change of mv clipping in VTM-6.1, and it affected the wrap-around in 360-degree video coding.

2 Software repository and versions

The 360Lib software is developed using a Subversion repository located at:

https://jvet.hhi.fraunhofer.de/svn/svn\_360Lib/

The released version of 360Lib-9.2-dev can be found at:

https://jvet.hhi.fraunhofer.de/svn/svn\_360Lib/branches/360Lib-9.2-dev/

360Lib-9.2-dev testing results can be found at:

ftp.ient.rwth-aachen.de/testresults/360Lib-9.1

360Lib bug tracker

https://hevc.hhi.fraunhofer.de/trac/jem/newticket?component=360Lib

3 360Lib-9.2-dev results

Table 1 is for the projection formats comparison using VTM-6.1 according to 360o video CTC (JVET-M1012). It compares padded hybrid equi-angular cubemap (PHEC) coding and padded equi-rectangular projection (PERP) coding using VTM-6.1.

Table 2 is for PERP coding comparison between VTM-6.1 and HM-16.16. Table 3 is to compare VTM-6.1 with PHEC coding and HM-16.16 with CMP coding.

Table 1. VTM-6.1 PHEC vs PERP (VTM-6.1 PERP as anchor)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **PHEC over PERP (VTM-6.1)** | | | | | |
|  | **End-to-end WS-PSNR** | | | **End-to-end S-PSNR-NN** | | |
|  | Y | U | V | Y | U | V |
| Class S1 | -11.59% | -6.36% | -6.69% | -11.52% | -6.27% | -6.63% |
| Class S2 | -5.27% | -1.72% | -1.69% | -5.26% | -1.62% | -1.62% |
| **Overall** | -9.06% | -4.51% | -4.69% | -9.02% | -4.41% | -4.63% |

Table 2. VTM-6.1 PERP vs HM-16.16 PERP (HM-16.16 PERP as anchor)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **VTM-6.1 PERP - Over HM-16.16 PERP** | | | | | |
|  | **End-to-end WS-PSNR** | | | **End-to-end S-PSNR-NN** | | |
|  | Y | U | V | Y | U | V |
| Class S1 | -24.95% | -40.43% | -43.03% | -24.92% | -40.45% | -43.00% |
| Class S2 | -34.72% | -39.52% | -42.32% | -34.71% | -39.55% | -42.37% |
| **Overall** | -28.86% | -40.07% | -42.75% | -28.83% | -40.09% | -42.75% |

Table 3. VTM-6.1 PHEC vs HM-16.16 CMP (HM-16.16 CMP as anchor)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **VTM-6.1 PHEC - Over HM-16.16 CMP** | | | | | |
|  | **End-to-end WS-PSNR** | | | **End-to-end S-PSNR-NN** | | |
|  | Y | U | V | Y | U | V |
| Class S1 | -29.32% | -41.70% | -43.88% | -29.20% | -41.68% | -43.85% |
| Class S2 | -37.40% | -42.15% | -44.69% | -37.39% | -42.15% | -44.73% |
| **Overall** | -32.55% | -41.88% | -44.20% | -32.48% | -41.87% | -44.20% |

4 Contributions

There are 4 input documents related to syntax for signalling of cubeface layouts, which are listed below.

JVET-P0315 Modified 360Lib for more flexible cube face arrangements [J. Sauer, M. Bläser (RWTH Aachen University)]

JVET-P0316 AHG6/AHG12/AHG17: Coding of 360° video in non-compact cube layout using uncoded areas [J. Sauer, M. Bläser (RWTH Aachen University)]

JVET-P0462 AHG6/AHG17: 360-degree video related SEI messages [ R. Skupin, Y. Sanchez, K. Suehring, T. Schierl (HHI)]

JVET-P0597 AHG6/AHG17: Generalized cubemap projection syntax for 360-degree videos [Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek), J. Boyce, M. Dmitrichenko (Intel)]

5 RecommendationsAHG recommends:

• To continue software development of the 360Lib software package (e.g. integrate FishEye projection format).

• To generate CTC VTM anchors according to 360 video CTC, and provide the reporting template for the common test conditions.

• Review input contributions

Target new version of 360lib

It is suggested to study the compression performance of subpictures in VTM (Minhua Zhou will help with recommending configuration). At least to be studied with ERP, potentially cubemap.

[JVET-P0007](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8569) JVET AHG report: Coding of HDR/WCG material (AHG7) [A. Segall, E. François, W. Husak, S. Iwamura, D. Rusanovskyy]

1 MandatesAHG was established with the following mandates:

• Study and evaluate available HDR/WCG test content.

• Study objective metrics for quality assessment of HDR/WCG material, including investigation of the correlation between subjective and objective results.

• Compare the performance of the VTM and HM for HDR/WCG content.

• Prepare for expert viewing of HDR content at the next JVET meeting if feasible.

• Investigate the implications of chroma sampling location.

• Coordinate implementation of HDR anchor aspects in the test model software with AHG3.

• Study additional aspects of coding HDR/WCG content.

2 Activities

The AHG used the main JVET reflector, jvet@lists.rwth-aachen.de, with an [AHG7] indication on message headers. The primary activity of the AhG was related to the mandates of (i) comparing the performance of the VTM for HDR/WCG content; (ii) preparing for expert viewing of HDR content at the 16th JVET meeting; (iii) investigating the implications of chroma sampling locations, and (iv) coordinating implementation of HDR anchor aspects in the test model software. This work is described in the following subsection.

2.1 Performance Comparison

The AhG performed experiments comparing the performance of the VTM 6.0 on HDR content. The first part of this work included determining the performance of VTM 6.0 relative to the VTM 5.0 and HM 16.18. A summary of the performance is provided below, and more detailed information may be found in the included XLS data.

It was observed that the bit-allocation between luma and chroma in the HDR configuration changed between the two releases of the VTM – especially for Class H1. This is likely due to the change in the chroma table mapping function adopted into VTM 6, as well as the merge of request 857 (discussed later).

2.1.1 VTM 6.0 versus VTM 5.0

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | | | | | |
|  | **Over VTM-5.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -9.90% | 1.15% | 1.19% | -13.94% | -28.44% | 1.14% | -13.57% | -26.92% | 86% | 125% |
| Class H2 |  |  |  |  |  | -0.40% | 1.30% | 0.05% | 80% | 92% |
| **Overall** | -9.90% | 1.15% | 1.19% | -13.94% | -28.44% | 0.58% | -8.17% | -17.11% | 84% | 112% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access** | | | | | | | | | |
|  | **Over VTM-5.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -8.65% | 1.17% | 1.11% | -18.02% | -32.70% | 1.03% | -18.39% | -32.42% | 106% | 100% |
| Class H2 |  |  |  |  |  | -1.69% | -2.59% | -2.17% | 98% | 78% |
| **Overall** | -8.65% | 1.17% | 1.11% | -18.02% | -32.70% | 0.04% | -12.64% | -21.42% | 103% | 91% |

2.1.2 VTM 6.0 versus HM 16.18

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | | | | | |
|  | **Over HM-16.18** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -46.38% | -23.60% | -23.40% | -58.05% | -49.74% | -21.83% | -53.54% | -43.10% | - | - |
| Class H2 |  |  |  |  |  | -21.15% | -37.56% | -39.83% | - | - |
| **Overall** | -46.38% | -23.60% | -23.40% | -58.05% | -49.74% | -21.58% | -47.73% | -41.91% | - | - |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access** | | | | | | | | | |
|  | **Over HM-16.18** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -43.94% | -28.23% | -28.04% | -59.64% | -68.05% | -26.01% | -55.82% | -61.81% | - | - |
| Class H2 |  |  |  |  |  | -28.23% | -45.86% | -49.57% | - | - |
| **Overall** | -43.94% | -28.23% | -28.04% | -59.64% | -68.05% | -26.82% | -52.20% | -57.36% | - | - |

2.2 Tool-On / Tool-Off Comparisons

In addition to evaluating the performance of VTM 6.0, the AhG also studied the performance of individual coding tools in the context of HDR content. This was accomplished by conducting a Tool-On/Tool-Off test according to the methodology established in AhG13. The only exception was for the LMCS tool. Currently, the HDR CTC defines the tool to be off when coding Class H1 content. So, to account for this configuration, the AhG performed a Tool-On test (instead of a Tool-Off test) for the tool instead.

are summarized in the tables below. Additionally, more detailed results are provided in the included XLS data.

The AhG would like to thank the following companies for contributing to the Tool-On tests: Alibaba, Dolby, InterDigital, LG, MediaTek, NHK, and Sharp.

2.2.1 Class H1 (PQ)

Simulation Results for AI (Class H1)

**Simulation Results for AI (Class H1)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **AI** |  |  |  |  |
| **Acronym** | **DE100** | **PSNR-L** | **BDR-wY** | **BDR-wU** | **BDR-wV** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| **CST** | **19.02%** | **0.77%** | **0.71%** | **22.69%** | **50.33%** | **155%** | **100%** | **151%** | **101%** |
| **DQ** | **-1.52%** | **1.58%** | **1.68%** | **-4.79%** | **-8.80%** | **100%** | **101%** | **98%** | **105%** |
| **CCLM** | **26.79%** | **2.94%** | **2.74%** | **96.24%** | **199.89%** | **101%** | **100%** | **101%** | **100%** |
| **MTS** | **0.86%** | **1.11%** | **1.23%** | **0.68%** | **0.59%** | **86%** | **100%** | **86%** | **101%** |
| **ALF** | **3.73%** | **2.75%** | **2.24%** | **6.88%** | **7.26%** | **99%** | **86%** | **94%** | **90%** |
| **MRLP** | **0.27%** | **0.39%** | **0.36%** | **0.40%** | **0.11%** | **99%** | **101%** | **98%** | **101%** |
| **IBC on** | **-0.28%** | **-0.34%** | **-0.34%** | **0.09%** | **-0.01%** | **138%** | **103%** | **148%** | **101%** |
| **ISP** | **0.29%** | **0.55%** | **0.61%** | **0.05%** | **-0.29%** | **90%** | **97%** | **87%** | **100%** |
| **LMCS on\*** | **2.36%** | **-1.46%** | **-1.01%** | **6.36%** | **14.44%** | **104%** | **101%** | **100%** | **101%** |
| **RDPCM on** | **0.09%** | **0.00%** | **-0.04%** | **0.26%** | **0.10%** | **105%** | **100%** | **106%** | **101%** |
| **MIP** | **0.51%** | **0.59%** | **0.50%** | **0.63%** | **-0.10%** | **86%** | **99%** | **91%** | **101%** |
| **LFNST** | **-0.58%** | **0.86%** | **0.75%** | **-1.04%** | **-0.83%** | **103%** | **100%** | **101%** | **102%** |
| **JCCR** | **-0.05%** | **0.66%** | **0.66%** | **4.05%** | **-3.31%** | **95%** | **99%** | **97%** | **102%** |
| **SAO** | **0.64%** | **0.07%** | **0.18%** | **0.67%** | **2.29%** | **101%** | **98%** | **100%** | **99%** |

\* Note: Unlike in AhG13, LMCS is evaluated with a Tool-On test here

**Simulation Results for RA (Class H1)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Acronym** | **DE100** | **PSNR-L** | **BDR-wY** | **BDR-wU** | **BDR-wV** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| **CST** | **13.05%** | **0.37%** | **0.32%** | **15.55%** | **25.44%** | **103%** | **102%** | **104%** | **100%** |
| **DQ** | **-0.73%** | **1.66%** | **1.57%** | **-3.50%** | **-6.64%** | **101%** | **100%** | **100%** | **101%** |
| **CCLM** | **18.66%** | **1.41%** | **1.31%** | **91.24%** | **190.73%** | **99%** | **101%** | **101%** | **100%** |
| **MTS** | **1.00%** | **0.88%** | **0.96%** | **1.45%** | **1.38%** | **94%** | **98%** | **96%** | **100%** |
| **ALF** | **3.96%** | **2.23%** | **2.00%** | **6.11%** | **11.62%** | **94%** | **85%** | **91%** | **89%** |
| **AFF** | **0.80%** | **0.97%** | **0.98%** | **0.70%** | **0.30%** | **80%** | **97%** | **80%** | **99%** |
| **SbTMVP** | **0.74%** | **0.45%** | **0.45%** | **0.50%** | **0.52%** | **100%** | **103%** | **101%** | **102%** |
| **AMVR** | **1.11%** | **0.70%** | **0.73%** | **2.39%** | **4.72%** | **80%** | **89%** | **83%** | **101%** |
| **TPM** | **0.31%** | **0.17%** | **0.20%** | **1.10%** | **1.16%** | **98%** | **100%** | **99%** | **100%** |
| **BDOF** | **0.75%** | **0.92%** | **0.97%** | **0.24%** | **-0.03%** | **97%** | **97%** | **97%** | **98%** |
| **PROF** | **0.07%** | **0.10%** | **0.11%** | **0.13%** | **-0.11%** | **99%** | **100%** | **100%** | **99%** |
| **CIIP** | **-0.15%** | **0.10%** | **0.13%** | **-0.25%** | **-0.49%** | **97%** | **99%** | **97%** | **100%** |
| **MMVD** | **0.49%** | **0.29%** | **0.27%** | **0.71%** | **0.96%** | **89%** | **102%** | **89%** | **100%** |
| **BCW** | **0.61%** | **0.24%** | **0.22%** | **0.69%** | **1.00%** | **92%** | **102%** | **91%** | **102%** |
| **MRLP** | **0.21%** | **0.20%** | **0.18%** | **0.02%** | **0.35%** | **99%** | **101%** | **99%** | **100%** |
| **IBC on** | **0.10%** | **-0.05%** | **0.06%** | **0.72%** | **0.78%** | **105%** | **103%** | **105%** | **100%** |
| **ISP** | **0.26%** | **0.36%** | **0.35%** | **0.14%** | **0.82%** | **98%** | **100%** | **98%** | **100%** |
| **DMVR** | **1.13%** | **0.99%** | **0.84%** | **1.37%** | **1.66%** | **100%** | **96%** | **101%** | **97%** |
| **SBT** | **0.08%** | **0.13%** | **0.33%** | **0.28%** | **0.47%** | **97%** | **101%** | **98%** | **100%** |
| **LMCS on\*** | **0.20%** | **-1.12%** | **-0.92%** | **2.62%** | **11.66%** | **103%** | **102%** | **100%** | **102%** |
| **SMVD** | **0.21%** | **0.14%** | **0.16%** | **0.30%** | **0.58%** | **95%** | **101%** | **91%** | **100%** |
| **RDPCM on** | **0.16%** | **-0.01%** | **-0.01%** | **0.13%** | **0.79%** | **101%** | **102%** | **100%** | **100%** |
| **MIP** | **0.42%** | **0.42%** | **0.33%** | **0.68%** | **0.60%** | **93%** | **97%** | **98%** | **100%** |
| **LFNST** | **0.17%** | **0.49%** | **0.41%** | **0.66%** | **1.47%** | **94%** | **100%** | **97%** | **100%** |
| **JCCR** | **-0.61%** | **0.49%** | **0.52%** | **2.88%** | **-3.91%** | **97%** | **99%** | **100%** | **101%** |
| **SAO** | **0.72%** | **-0.03%** | **0.01%** | **0.79%** | **2.21%** | **99%** | **101%** | **100%** | **99%** |
| **SIF** | **0.25%** | **0.13%** | **0.10%** | **0.43%** | **1.04%** | **97%** | **100%** | **97%** | **100%** |



Figure 1. wPSNR-Y vs encoding runtime ratio of VTM with VTM tool tests (Class H1)



Figure 2. wPSNR-Y vs decoding runtime ratio of VTM with VTM tool tests (Class H1)



Figure 3. wPSNR-Y vs weighted runtime ratio (a = 6) of VTM with VTM tool tests (Class H1)

2.2.2 Class H2 (HLG)

**Simulation Results for AI (Class H2)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Acronym** | **BDR-Y** | **BDR-U** | **BDR-V** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| **CST** | **0.60%** | **13.59%** | **21.01%** | **171%** | **104%** | **162%** | **101%** |
| **DQ** | **1.86%** | **-1.29%** | **-1.52%** | **99%** | **103%** | **99%** | **105%** |
| **CCLM** | **1.72%** | **40.73%** | **20.54%** | **102%** | **100%** | **101%** | **99%** |
| **MTS** | **1.85%** | **2.59%** | **1.90%** | **86%** | **97%** | **84%** | **98%** |
| **ALF** | **2.83%** | **2.16%** | **3.20%** | **97%** | **84%** | **94%** | **86%** |
| **MRLP** | **0.06%** | **-0.12%** | **0.08%** | **99%** | **101%** | **97%** | **101%** |
| **IBC on** | **-0.11%** | **-0.06%** | **0.03%** | **163%** | **101%** | **148%** | **100%** |
| **ISP** | **0.32%** | **-0.59%** | **-0.15%** | **87%** | **99%** | **86%** | **100%** |
| **LMCS** | **0.05%** | **-0.83%** | **-0.59%** | **93%** | **96%** | **97%** | **93%** |
| **RDPCM on** | **0.00%** | **-0.05%** | **0.03%** | **108%** | **101%** | **108%** | **100%** |
| **MIP** | **0.62%** | **0.85%** | **0.55%** | **92%** | **101%** | **92%** | **101%** |
| **LFNST** | **0.49%** | **-0.61%** | **-0.94%** | **106%** | **101%** | **103%** | **100%** |
| **JCCR** | **0.27%** | **0.38%** | **5.19%** | **99%** | **100%** | **97%** | **100%** |
| **SAO** | **0.05%** | **0.25%** | **0.59%** | **100%** | **96%** | **98%** | **97%** |

**Simulation Results for RA (Class H2)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Abbreviation** | **BDR-Y** | **BDR-U** | **BDR-V** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| **CST** | **0.26%** | **8.07%** | **15.98%** | **103%** | **100%** | **102%** | **100%** |
| **DQ** | **1.81%** | **-0.41%** | **-0.86%** | **103%** | **102%** | **103%** | **102%** |
| **CCLM** | **0.76%** | **47.97%** | **25.56%** | **101%** | **100%** | **100%** | **101%** |
| **MTS** | **1.19%** | **1.43%** | **0.81%** | **95%** | **100%** | **95%** | **100%** |
| **ALF** | **3.53%** | **3.41%** | **3.04%** | **97%** | **84%** | **94%** | **89%** |
| **AFF** | **0.70%** | **0.45%** | **0.56%** | **80%** | **98%** | **81%** | **98%** |
| **SbTMVP** | **0.40%** | **0.28%** | **0.27%** | **102%** | **103%** | **100%** | **102%** |
| **AMVR** | **0.72%** | **1.12%** | **1.59%** | **82%** | **100%** | **81%** | **101%** |
| **TPM** | **0.34%** | **0.63%** | **0.57%** | **99%** | **100%** | **99%** | **100%** |
| **BDOF** | **0.60%** | **0.21%** | **0.17%** | **96%** | **98%** | **96%** | **98%** |
| **PROF** | **0.14%** | **0.04%** | **0.04%** | **100%** | **99%** | **99%** | **100%** |
| **CIIP** | **0.18%** | **-0.32%** | **-0.45%** | **98%** | **100%** | **97%** | **100%** |
| **MMVD** | **0.19%** | **0.29%** | **0.56%** | **89%** | **100%** | **89%** | **100%** |
| **BCW** | **0.21%** | **0.18%** | **0.23%** | **92%** | **102%** | **92%** | **102%** |
| **MRLP** | **0.06%** | **0.05%** | **0.06%** | **100%** | **100%** | **97%** | **100%** |
| **IBC on** | **0.11%** | **0.13%** | **-0.13%** | **106%** | **100%** | **102%** | **100%** |
| **ISP** | **0.21%** | **0.29%** | **0.17%** | **99%** | **100%** | **98%** | **100%** |
| **DMVR** | **0.83%** | **1.06%** | **0.91%** | **101%** | **96%** | **101%** | **98%** |
| **SBT** | **0.30%** | **-0.20%** | **-0.34%** | **97%** | **100%** | **97%** | **100%** |
| **LMCS** | **0.95%** | **1.35%** | **1.10%** | **97%** | **98%** | **98%** | **98%** |
| **SMVD** | **0.20%** | **0.05%** | **0.15%** | **92%** | **100%** | **90%** | **100%** |
| **RDPCM on** | **0.02%** | **0.12%** | **0.05%** | **102%** | **100%** | **101%** | **100%** |
| **MIP** | **0.46%** | **0.95%** | **0.08%** | **98%** | **100%** | **97%** | **99%** |
| **LFNST** | **0.41%** | **-0.26%** | **-0.78%** | **95%** | **99%** | **96%** | **101%** |
| **JCCR** | **0.21%** | **0.12%** | **7.06%** | **99%** | **99%** | **100%** | **101%** |
| **SAO** | **0.06%** | **0.32%** | **1.81%** | **100%** | **97%** | **101%** | **100%** |
| **SIF** | **0.12%** | **0.14%** | **0.23%** | **96%** | **99%** | **97%** | **100%** |



Figure 4. PSNR-Y vs encoding runtime ratio of VTM with VTM tool tests (Class H2)



Figure 5. PSNR-Y vs decoding runtime ratio of VTM with VTM tool tests (Class H2)



Figure 6. PSNR-Y vs weighted runtime ratio (a = 6) of VTM with VTM tool tests (Class H2)

2.3 Preparations for Expert Viewing at the 16th JVET meeting

The AhG coordinated the availability of an HDR display for the 16th meeting in order to better support the visual evaluation of HDR content. This includes the planned viewing of HDR content in CE5. A SONY BVM X 300 will be available for this activity. Currently, it is planned to be located at the EBU, to ensure that the necessary playback equipment is available to drive the display.

It is noted that the BVM X 300 is able to show HLG content natively. However, tone mapping will be required to display PQ content.

The AhG also wishes to thank Frans De Jong and Paola Sunna from EBU for providing support for the activity.

2.4 Investigate the implications of chroma sampling process

During the 15th meeting, it was decided to change the HDR common test conditions for Class H1 (PQ) to reflect that the chroma type of the content was Type 2. This resulted in changing the configuration file to include the following parameter “CclmCollocatedChroma: 1”

During the AhG period, the AhG investigated if a similar change was needed for the Class H2 (HLG) content. Simulations were performed measuring the improvement in coding efficiency by setting the chroma type to Type 2 for the CCLM coding tool. The results are provided below, and the AhG concluded that a change was not needed for Class H2.

**VTM-5.0 with CclmCollocatedChroma:1 versus VTM-5.0**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | | | | | |
|  | **Over VTM-5.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | #VALUE! | -0.23% | -0.19% | -5.14% | -10.59% | -0.19% | -4.32% | -8.33% | - | - |
| Class H2 |  |  |  |  |  | 0.14% | 3.55% | 4.28% | - | - |
| **Overall** | #VALUE! | -0.23% | -0.19% | -5.14% | -10.59% | -0.07% | -1.46% | -3.75% | - | - |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access** | | | | | | | | | |
|  | **Over VTM-5.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | #VALUE! | -0.17% | -0.11% | -4.82% | -7.39% | -0.13% | -3.80% | -5.60% | - | - |
| Class H2 |  |  |  |  |  | 0.09% | 2.73% | 6.97% | - | - |
| **Overall** | #VALUE! | -0.17% | -0.11% | -4.82% | -7.39% | -0.05% | -1.43% | -1.03% | - | - |

2.5 Coordinate implementation of HDR anchor aspects in the test model software with AHG3

2.5.1 Integration of HDR metric calculation into the VTM

Prior to this AhG period, the calculation of HDR specific metrics required use of an external HDRMetrics application. This also required the management of additional configuration files to control the conversion of decoded YUV sequences to float point representations in linear light. Software to address this issue was provided at the 15th meeting in JVET-O0756.

During the AhG period, the AhG worked to coordinate and support the integration of the HDRMetrics functionality into the VTM software. The functionality was provided as part of the VTM6.0. The timeline for the release was as follows:

o 2019/08/09

 VTM 6.0 released including support for calling external HDRLib for metric calculation

 HDRTools 0.19-dev branch available to support linking HDRLib into VTM 6.0

o 2019/09/24

 HDRTools 0.19 released with official support for linking HDRLib into VTM. However, it was later determined that the release included a change in the API that effected the linking process.

o 2019/09/27

 HDRTools 0.19.1 released with bugfix to support linking HDRLib into VTM

Enabling the HDRLib functionality in the VTM software is accomplished by doing the following:

1. Create a local copy of the VTM Version 6 or newer software.

2. Create a local copy of the HDRTools v0.19.1 or newer utility available at https://gitlab.com/standards/HDRTools. More recent versions are encouraged where applicable.

3. Copy the HDRTools/common directory from the HDRTools utility into the source/Lib/HDRLib directory of the VTM software.

Example: On a Linux system, this could be accomplished with the command:

ln -s <HDRTools\_dir>/HDRTools/common <VTM\_dir>/souce/Lib/HDRLib

4. Append “-DEXTENSION\_HDRTOOLS=on” when building the VTM software using CMake.

Example: If the VTM is normally built using the command:

cmake -DCMAKE\_BUILD\_TYPE=Release

The HDRLib functionality is enabled by using the command:

cmake -DCMAKE\_BUILD\_TYPE=Release -DEXTENSION\_HDRTOOLS=on

The class specific parameters and sequence specific parameters provided with the VTM will then enable and configure the metric calculation parameters appropriately. Note that these instructions are also available in the HDR CTC.

It was observed that most participants interested in performing HDR experiments used the integrated HDRTool functionality to calculate the HDR metric. However, as the functionality was only officially released a week before the meeting, it is possible that some proponents chose to use the previous, standalone approach for calculating the metric. The AhG compared the performance of using the integrated metric calculation and the (previously defined) external metric calculation to determine the significance of using the different approaches.

Results are provided below and show that the objective difference between the two approaches is less than .025%.

**VTM-6.0 External Metric Calculation vs Integrated Metric Calculation**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | | | | | |
|  | **Over VTM 6.0 (with external metric calculation)** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | 0.010% | 0.020% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access** | | | | | | | | | |
|  | **Over VTM 6.0 (with external metric calculation)** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -0.006% | 0.024% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |  |  |

2.5.2 Addressing chroma loss observation in previous AhG period

As part of the AhG report provided to the 15th meeting of JVET, it was observed that there was a rather large chroma loss between VTM 4.0 and VTM 5.0. It was identified that the integration of JVET-M0091 resulted in the loss (commit: 65c9bacdf38).

During this AhG activity, merge request 857 addressed this chroma loss issue. The merge request was integrated into the VTM (commit: 95246223) and provided as part of the VTM 6.0 release.

3 Contributions

There are two contributions related to HDR video coding. While not listed here, it is noted that responses to CE5-1 and CE5-2 sub-categories consider the performance of in-loop filtering on HDR content:

JVET-P0335 AHG15: Chroma QP mapping table for HDR T. Lu, F. Pu, P. Yin, S. McCarthy, W. Husak, T. Chen (Dolby)

JVET-P0371 AHG7/AHG15: Signalling of corrective values for chroma residual scaling

E. François, F. Galpin, K. Naser, P. de Lagrange (InterDigital)

JVET-P0623 Crosscheck report of JVET-P0335 on Chroma QP mapping table for HDR E. François (InterDigital)

JVET-P0711 Crosscheck of JVET-P0371 (AHG7/AHG15: signalling of corrective values for chroma residual scaling) T. Lu (Dolby)

4 Recommendations

The AHG recommends the following:

• Identify HDR visual testing to be performed at the 16th meeting

• Review all input contributions

It is commented that the results for HLG show similar tendency like for SDR in terms of the improvements of VTM6.

LMCS is also working appropriately for HLG, but should stay turned off for PQ CTC.

The results on CCLM collocated chroma indicate that the CTC is appropriate (not needed for HLG, only for PQ)

Plans for viewing session at EBU:

- PQ with LMCS switched on/off

- VTM5 vs. VTM6 (in terms of chroma quality)

- VTM6 vs. HM at approximately same quality (if possible)

The two contributions are currently allocated under “quantization”. It is commented that, in case that subjective viewing would be needed for assessment, this should be decided early in the meeting.

[JVET-P0008](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8501) JVET AHG report: Layered coding and resolution adaptivity (AHG8) [S. Wenger, A. Segall, M.M. Hannuksela, Hendry, S. McCarthy, Y.-C. Sun, P. Topiwala, M Zhou]

Discussed Tuesday 1550 (GJS)

AHG8 was established by the 15th meeting (Gothenburg) to study layered coding and resolution adaptivity. Except for the kickoff message, no emails were exchanged on the reflector. Approximately 44 documents related to the subject matter of this ad hoc group were identified.

Approximately 43 documents were identified by the submitting organizations as related to AHG8’s mandates. An additional 5 documents marked as relating to AHG17 were also identified as relating to AHG8. Of these 48 total documents, 27 were allocated to scalability; 8 were allocated to reference picture resampling (RPR); and 13 were allocated to other parts of the meeting agenda (mostly CE1, AHG12, and AHG17)

The AHG recommended reviewing the related input contributions and to study layered coding and resolution adaptivity aspects.

[JVET-P0009](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8469) JVET AHG report: Neural Networks in Video Coding (AHG9) [S. Liu, Y.M. Li, B. Choi, K. Kawamura, Y. Li, L. Wang, P. Wu, H. Yang]

The AHG was established at Gothenburg, Sweden with the following mandates:

• Investigate the benefit of using neural networks in video compression such as CNN loop filter, intra prediction, resampling in adaptive resolution coding, and encoder-side partition mode decisions.

• Investigate the complexity impact of using neural networks in video compression.

• Investigate the complexity measurement of neural network coding tools.

• Investigate benefit of universal versus selectable networks, both in terms of compression benefit and complexity.

• Investigate how CNN parameters can be established for operation of the decoding process.

• Investigate the impact of training materials on the performance of neural network coding tools.

• Investigate the impact of the training process on performance and complexity.

2. Activities

Email activity for the AHG was conducted on the main jvet reflector, jvet@lists.rwth-aachen.de, with an [AHG9] indication on message headers. There was no email activity on the reflector during this period.

3. Related contributions

AHG9 related input documents for this meeting are summarized as follows.

• H.Yin, R.Yang, X.Fang, Z.Gao, R.Yang, “AHG9: Multiple Convolution Neural Networks For Sequence-Independent Processing,” JVET-P0489

4. Recommendations

The AHG recommends:

• To review all related contributions

• To continue investigating the benefits and complexity of using neural networks in video coding

It was discussed that the AHG has fulfilled its mandates by studying the potential of NN technology over several meeting cycles. Currently, there is no evidence that non-shallow NN based technology provides a good tradeoff of complexity vs. compression (at least w.r.t. need of normative elements).

At this point of VVC development, and the low amount of recent contributions, it is suggested to discontinue the AHG.

[JVET-P0010](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8570) JVET AHG report: Encoding algorithm optimization (AHG10) A. Duenas, A. Tourapis, S. Ikonin, A. Norkin, R. Sjöberg, J. Le Tanou, J.-M. Thiesse]

1 Introduction

At the 15th JVET meeting, the AHG on Encoding algorithm optimizations was established with the following mandates:

• Study the impact of using techniques such as GOP structures and perceptually optimized adaptive quantization for encoder optimization.

• Study the impact of adaptive quantization on individual tools in the test model.

• Study the quantization adaptation tool in the test model.

• Investigate the feasibility of adding a CTC test category in which adaptive quantization is turned on.

• Study quality metrics for measuring subjective quality using e.g. the CfP response MOS scores.

• Investigate other methods of improving objective and/or subjective quality, including adaptive coding structures, adaptive quantization without signalling, and multi-pass encoding.

• Study methods of rate control and their impact on performance, subjective and objective quality.

The regular JVET e-mail reflector was used for discussions (jvet@lists.rwth-aachen.de). No e-mail related to AHG10 activity was sent to the JVET reflector during the AHG period.

2 Overview of input documents related to the AHG

The following input documents were identified to be related to the AHG:

2.1 JVET-P0328: AHG10: Performance of the GOP-based temporal filter in VTM-6.1

The encoder-only GOP-based temporal filter proposed in JVET-O0549 was adopted in the previous meeting in Gothenburg. This contribution provides performance numbers by enabling the filter on top of VTM-6.1. The average Y/U/V BD-rates for the common test conditions (CTC) for the filter on top of VTM-6.1 are reported to be −3.91%/−6.63%/−6.56% (RA), −0.96%/−1.30%/−2.18% (LDB) and −1.48%/−1.61%/−2.23% (LDP). This can be compared to the numbers compared in JVET-O0549-v2: −3.49%/−6.96%/−6.53% (RA), −1.00%/−1.24%/−2.24% (LDB) and −1.47%/−1.95%/−2.78% (LDP).

The proponents are willing to arrange a subjective viewing at the meeting.

2.2 JVET-P0570: AHG10/Non-CE5: Performance of encoder-side deblocking optimization in VTM-6.0

The encoder-only deblocking optimization is tested on top of VTM-6.0. The average Y/U/V BD-rates and encoding time for the common test conditions for the filter on top of VTM-6.0 are reported to be −0.77%/−1.53%/−1.56%/105% for all intra, −0.92%/−1.94%/−1.93%/103% for random access and −0.78%/−0.90%/−0.88%/102% for low delay B.

2.3 JVET-P0163: CE5-related: SAO encoder-only improvements

In this contribution, three encoder-only improvements for sample adaptive offset (SAO) are reported. First, the greedy SAO merge encoding algorithm, which is in VTM6.0 but disabled in common test conditions (CTC), is enabled to optimize SAO parameters for multiple coding tree units (CTUs) within one CTU row. Second, to explore more SAO merge possibilities across CTU rows, a picture-based SAO merge encoding algorithm is proposed. For each picture, the best SAO parameters, derived by either the picture-based SAO merge encoding algorithm or the greedy SAO merge encoding algorithm, are signalled. Third, the SAO picture-level on-off decision algorithm for the current picture using statistics from a previous picture, which is enabled in VTM6.0CTC, is disabled, and it is proposed to further allow changing the picture-level decision from on to off after SAO is tested for all CTUs in the picture. YCbCr BD-rates (using the AHG13 YCbCr BD-rate calculation method: (BD-Rate\_Y\*8+ BD-Rate\_U+ BD-Rate\_V)/10) under adaptive loop filter (ALF) on/off cases are summarized as follows.

Anchor: VTM6.0 + SAO off + ALF on

Test: anchor + SAO on

AI: -0.04%; RA: -0.13%; LB: -0.24%; LP: -0.26%

Anchor: VTM6.0 + SAO off + ALF on

Test: anchor + SAO on + SAO encoder-only improvements

AI: -0.15%; RA: -0.29%; LB: -0.52%; LP: -0.52%

Anchor: VTM6.0 + SAO off + ALF off

Test: anchor + SAO on

AI: -0.36%; RA: -0.78%; LB: -1.21%; LP: -2.74%

Anchor: VTM6.0 + SAO off + ALF off

Test: anchor + SAO on + SAO encoder-only improvements

AI: -0.56%; RA: -1.10%; LB: -1.70%; LP: -3.35%

It is known that SAO and ALF overlap in coding gains. Small coding losses are observed by disabling SAO when ALF is on, while large coding losses are observed by disabling SAO when ALF is off. Given that SAO has low complexity and is deployed in one billion HEVC devices per year, it is asserted that keeping SAO is beneficial for VVC, especially for real-time low complexity encoding applications.

2.4 JVET-P0345: Low-Delay B encoder configuration proposal

The coding gain of VVC over HEVC much higher in random access configuration than in low-delay B. This contribution proposes a new low-delay B encoder configuration, targeting improved coding efficiency. Basically, the GOP size is extended to 8 instead of 4. The proposed LDB GOP structure reportedly leads to -4.87%, -5.87%, -5.56% BD-rate gain in Y, Cb and Cr components respectively, over the current CTC LDB configuration.

2.5 JVET-P0445: Non-CE4: Encoder optimization for subblock-based merge candidate search

In this contribution, an encoder optimization method is proposed to separate luma and chroma components in motion compensation process. With this support, chroma motion compensation can be avoided during luma SATD based subblock merge candidate search so that encoding time is reduced. It is asserted that the proposed changes do not have any impact in coding performance. The proposed method was implemented based on VTM-6.0, and simulations were conducted with common test conditions. It is reported that there’s no BD-rate change with 98% encoding time for RA, and 99% encoding time for LB.

3 Recommendation

The AHG recommends that the related input contributions are reviewed and to further continue the study of encoding algorithm optimizations in JVET.

It is suggested performing subjective viewing on some of the contributions (if possible).

[JVET-P0011](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8571) JVET AHG report: Screen content coding (AHG11) [S. Liu, J. Boyce, A. Filippov, Y.-C. Sun, J. Xu, H. Yang]

1 Introduction

The AHG was established at Gothenburg, SE with the following mandates:

• Investigate coding tools targeted at screen content in terms of compression benefit and implementation complexity.

• Identify test materials, discuss testing conditions for screen content coding, and propose associated updated common test conditions.

• Study the impact of loop filters on screen content coding.

2 Activities

The AHG used the main JVET reflector, jvet@lists.rwth-aachen.de, with [AHG11] in message headers. There were a few emails exchanged regarding SCC testing sequences downloading locations in the ftp site. There were many email exchanges among CE8 participants using jvet-ce@lists.rwth-aachen.de reflector with tool specific discussions.

In total there are 44 SCC related technical contributions identified so far, among which there are 8 IBC related technical contributions, 27 Palette related technical contributions, 4 Transform Skip/BDPCM related technical contributions, 3 SCC tool deblocking settings related technical contributions and 2 other SCC tools contributions identified for this meeting.

4 Recommendations

The AHG recommends:

• To review all related contributions.

• To continue investigating SCC coding tool performance, complexity and interactions between themselves and with other coding tools.

• To continue evaluating new test materials.

[JVET-P0012](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8551) JVET AHG report: High-level parallelism and coded picture regions (AHG12) [S. Deshpande, M. M. Hannuksela, R. Sjöberg, R. Skupin, W. Wan, Y.-K. Wang, S. Wenger]

Discussed Tuesday 1530 (GJS)

The document summarizes activities of AHG on high-level parallelism and coded picture regions between the 15th and the 16th JVET meetings.

Relevant input documents (total 52) related to AHG12 were listed in the AHG report. An email conversation was conducted on the reflector based on a slide deck submitted by a member company regarding analysis of subpicture grip approach. A total of 9 emails were exchanged on this topic on the JVET email reflector between 2019-08-26 and 2019-09-06.

Contributions that summarize input contributions were noted:

* JVET-P0686 summarizes HLS proposal on slices, tiles and bricks
* JVET-P0693 summarizes some categories of the HLS proposals on subpictures

The AHG recommended:

* To review the related contributions
* To continue to study VVC high-level parallelism and coded picture regions aspects.

[JVET-P0013](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8572) JVET AHG report: Tool reporting procedure (AHG13) [W.-J. Chien, J. Boyce, W. Chen, Y.-W. Chen, R. Chernyak, K. Choi, R. Hashimoto, Y.-W. Huang, H. Jang, R.-L. Liao, S. Liu]

1 Mandates

The AHG was established with the following mandates:

• Prepare output document JVET-O2005, which describes the methodology of tool-off testing and a list of tools to be tested by identified testers.

• Provide configurations files, bitstreams, and results of the tool-on/tool-off testing.

• Use the tool usage counts and memory bandwidth usage to study the decoder complexity of features in on/off testing.

• Prepare a report with results of the tests.

2 Activities

The initial version of JVET-O2005 “Methodology and reporting template for tool testing” was provided on August 4th.

All tests described in JVET-O2005 were conducted. VTM tool tests were conducted on VTM-6.0 software with VTM configuration by switching off or on specific tool either in configuration files or macros.

The tested tools, testers, and cross-checkers are listed in the tables below.

2.1 Tools included in VTM (Tool off test vs VTM Anchor)

Table 1 List of adoptions included in VTM (Tool off test (unless specified) vs VTM anchor)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Tool Name** | **Acronym** | **Document reference(s)** | **AI** | **RA** | **LD** | **Tester** | **Crosscheck** |
| Chroma separate tree | CST | JVET-N0137 | X | X | X | Tzu-Der Chuang (peter.chuang@mediatek.com) | Wei-Jung Chien (wchien@qti.qualcomm.com) |
| Dependent quantization\* | DQ | JVET-M0173, JVET-M0251, JVET-M0470, | X | X | X | Tzu-Der Chuang (peter.chuang@mediatek.com) | Wei Chen (wei.chen@interdigital.com) |
| Cross-component linear model | CCLM | JVET-N0271, JVET-O1124 | X | X | X | Roman Chernyak (chernyak.roman@huawei.com) | Shan Liu (shanl; leolzhao@ tencent.com) |
| multiple transform set | MTS | JVET-N0866, JVET-O0294, JVET-O0474, JVET-O0541, | X | X | X | Kiho Choi (kiho14.choi@samsung.com) | Shan Liu (shanl; xinzzhao@ tencent.com) |
| Adaptive loop filter | ALF | JVET-N0242, JVET-N0415, JVET-N0180, JVET-O0064, JVET-O0090, JVET-O0216, JVET-O0228, JVET-O0247, JVET-O0625, JVET-O0662, JVET-O0669 | X | X | X | Wei-Jung Chien (wchien@qti.qualcomm.com) | Wei Chen (wei.chen@interdigital.com) |
| Affine motion model | AFF | JVET-N0068, JVET-N0194, JVET-N0334, JVET-N0481, JVET-O0070 |  | X | X | Roman Chernyak (chernyak.roman@huawei.com) | Shan Liu (shanl; guichunli@ tencent.com) |
| subblock-based temporal merging candidates | SbTMC | JVET-M0273, JVET-O0163, JVET-O0220 |  | X | X | Shan Liu  (shanl; guichunli@ tencent.com) | Wei-Jung Chien (wchien@qti.qualcomm.com) |
| Adaptive motion vector resolution | AMVR | JVET-M0246, JVET-O0057 |  | X | X | Shan Liu (shanl; guichunli@ tencent.com) | Wei-Jung Chien (wchien@qti.qualcomm.com) |
| Triangular partition mode | TPM | JVET-N0340, JVET-N0483, JVET-O0265 | X | X | X | Kiho Choi (kiho14.choi@samsung.com) | Shan Liu (shanl; leolzhao@ tencent.com) |
| Bi-directional optical flow | BDOF | JVET-N0444,  JVET-N0146, JVET-N0325, JVET-O0055, JVET-O0304, JVET-O0570, JVET-O0594 |  | X |  | Kiho Choi (kiho14.choi@samsung.com) | Tzu-Der Chuang (peter.chuang@mediatek.com) |
| Combined intra/inter prediction | CIIP | JVET-N0302, JVET-O0108, JVET-O0681 |  | X | X | Kiho Choi (kiho14.choi@samsung.com) | Tzu-Der Chuang (peter.chuang@mediatek.com) |
| Merge with MVD | MMVD | JVET-N0127,  JVET-N0332, JVET-N0448, JVET-N0380 |  | X | X | Kiho Choi (kiho14.choi@samsung.com) | Hyeongmun Jang ([hm.jang@lge.com](mailto:hm.jang@lge.com)) |
| Bi-predictive with CU weights | BCW | JVET-N0481, JVET-O0366 |  | X | X | Wei Chen (wei.chen@interdigital.com) | Tzu-Der Chuang (peter.chuang@mediatek.com) |
| Multi-reference line prediction | MRLP | JVET-L0283, JVET-O0426 | X | X | X | Shan Liu (shanl; leolzhao@ tencent.com) | Hyeongmun Jang (hm.jang@lge.com) |
| Intra block copy mode\*\* | IBC | JVET-N0383,  JVET-N0175,  JVET-N0251, JVET-N0384,  JVET-N0317,  JVET-N0383, JVET-N0251,  JVET-N0318, JVET-N0467, JVET-N0843, JVET-O0078, JVET-O0162, JVET-O0258, JVET-O0455, JVET-O1170 | X | X | X | Shan Liu (shanl; xiaozhongxu@ tencent.com) | Wei-Jung Chien (wchien@qti.qualcomm.com) |
| Intra sub-partitioning | ISP | JVET-N0308, JVET-O0106, JVET-O0341, JVET-O0502 | X | X | X | Roman Chernyak (chernyak.roman@huawei.com) | Hyeongmun Jang (hm.jang@lge.com) |
| Decoder motion vector refinement | DMVR | JVET-N0407,  JVET-N0178,  JVET-N0146, JVET-N0153, JVET-N0442, JVET-N0162, JVET-N0262, JVET-N0440, JVET-N0086, JVET-O0297, JVET-O0590, JVET-O0634 |  | X |  | Wei Chen (wei.chen@interdigital.com) | Roman Chernyak  ([chernyak.roman@huawei.com](mailto:chernyak.roman@huawei.com)) |
| Sub-block transform | SBT | JVET-M0140 |  | X | X | Roman Chernyak (chernyak.roman@huawei.com) | Shan Liu (shanl; xinzzhao@ tencent.com) |
| Luma mapping with chroma scaling | LMCS | JVET-N0220, JVET-N0477, JVET-O0272, JVET-O0428, JVET-O1109 | X | X | X | Taoran Lu (tlu@dolby.com) | Hyeongmun Jang (hm.jang@lge.com) |
| Symmetric motion vector difference | SMVD | JVET-M0444, JVET-O0284, JVET-O0414, JVET-O0567, JVET-O0572 |  | X |  | Yi-Wen Chen(yiwenchen@kwai.com) | Hyeongmun Jang (hm.jang@lge.com) |
| Quantized residual DPCM | BDPCM | JVET-N0413, JVET-O0315, JVET-O1136 | X | X | X | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) | Yi-Wen Chen(yiwenchen@kwai.com) |
| Matrix based intra prediction | MIP | JVET-N0217, JVET-O0925 | X | X | X | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) | Yi-Wen Chen(yiwenchen@kwai.com) |
| Low frequency non-separable transform | LFNST | JVET-N0105, JVET-N0193, JVET-O0094, JVET-O0213, JVET-O0219, JVET-O0368, JVET-O0472, JVET-O0529 | X | X | X | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) | Yi-Wen Chen(yiwenchen@kwai.com) |
| Joint coding of chrominance residuals | JCCR | JVET-N0054, JVET-O0105, JVET-O0543 | X | X | X | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) | Yi-Wen Chen(yiwenchen@kwai.com) |
| Sampled-adaptive offset | SAO | HEVC | X | X | X | Tzu-Der Chuang (peter.chuang@mediatek.com) | Wei Chen (wei.chen@interdigital.com) |
| Prediction refinement using optical flow | PROF | JVET-O0070 |  | X | X | Wei Chen (wei.chen@interdigital.com) | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) |
| Switched interpolation filter | SIF | JVET-O0057 |  | X | X | Wei Chen (wei.chen@interdigital.com) | Wei-Jung Chien (wchien@qti.qualcomm.com) |

\* Test was conducted by disabling DQ and enabling Sign Data Hiding

\*\* Test was conducted with disabling IBC on class F in anchor

\*\*\* Test was conducted by disabling BDPCM on class F in anchor

3 Results

The results of the tests are summarized in Table 2-6 below. The attached spreadsheet provides additional data. Table 7 shows tool test results across several VTM versions. The combined BD-Rate is computed based on (BD-Rate\_Y\*8+ BD-Rate\_U+ BD-Rate\_V)/10. Scatter plots are also provided for the tested tools in random access configuration, comparing PSNR-Y based bd-rate on the Y axis vs. each of Enc runtime ratio, Dec runtime ratio, and a weighted average of Enc and Dec runtime ratio, (Enc + a\*Dec)/(a+1), with a configurable weight, a. The exemplary weighting is set to 6 and can be adjusted in the spreadsheet attached to this report.experimental results and configuration files can be found at the link below:

https://hevc.hhi.fraunhofer.de/svn/svn\_VVCTestConfig/branches/VTM-6.0/

There was no bitrate or PSNR differences between testers and cross-checkers.

Encoder and Decoder runtime ratios provided by both the testers and cross-checkers are included in the reporting template, to identify if there were significant runtime differences.

Table 3 Simulation results in all intra configuration (AI) of VTM tool tests. (VTM anchor)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **AI** |  |  |  |
| **Acronym** | **BDR-Y** | **BDR-U** | **BDR-V** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| CST | 0.43% | 9.85% | 9.79% | 154% | 104% | 156% | 101% |
| DQ | 2.03% | -0.84% | -0.91% | 97% | 106% | 96% | 104% |
| CCLM | 1.60% | 14.79% | 15.90% | 99% | 100% | 99% | 99% |
| MTS | 1.25% | 0.73% | 0.77% | 85% | 98% | 84% | 96% |
| ALF | 2.38% | 2.94% | 3.65% | 97% | 88% | 98% | 86% |
| MRLP | 0.39% | 0.18% | 0.22% | 99% | 101% | 98% | 100% |
| IBC | 0.64% | 0.62% | 0.69% | 62% | 100% | 65% | 99% |
| ISP | 0.41% | 0.29% | 0.32% | 86% | 97% | 85% | 98% |
| LMCS | 1.09% | -1.03% | -0.67% | 99% | 99% | 97% | 97% |
| BDPCM | 0.00% | -0.02% | 0.03% | 107% | 100% | 97% | 105% |
| MIP | 0.54% | 0.16% | 0.16% | 91% | 101% | 89% | 97% |
| LFNST | 0.96% | 0.19% | 0.44% | 105% | 101% | 104% | 100% |
| JCCR | 0.56% | 0.35% | 0.46% | 99% | 101% | 94% | 97% |
| SAO | 0.01% | 0.14% | 0.17% | 100% | 99% | 100% | 97% |

Table 4 Simulation results in random access configuration (RA) of VTM tool tests. (VTM anchor)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **RA** |  |  |  |
| **Acronym** | **BDR-Y** | **BDR-U** | **BDR-V** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| CST | 0.10% | 4.27% | 4.81% | 104% | 100% | 101% | 100% |
| DQ | 1.76% | -0.24% | -0.61% | 102% | 103% | 99% | 102% |
| CCLM | 0.94% | 11.95% | 13.87% | 99% | 100% | 99% | 100% |
| MTS | 0.70% | 0.62% | 0.56% | 93% | 100% | 92% | 98% |
| ALF | 4.53% | 5.14% | 5.10% | 97% | 87% | 98% | 83% |
| AFF | 3.02% | 2.15% | 2.01% | 86% | 98% | 86% | 98% |
| SbTMC | 0.50% | 0.40% | 0.42% | 101% | 101% | 101% | 100% |
| AMVR | 1.39% | 2.36% | 2.41% | 81% | 101% | 81% | 101% |
| TPM | 0.34% | 0.63% | 0.51% | 99% | 101% | 99% | 101% |
| BDOF | 0.77% | 0.35% | 0.29% | 98% | 97% | 100% | 95% |
| CIIP | 0.29% | 0.12% | 0.02% | 99% | 101% | 100% | 100% |
| MMVD | 0.52% | 0.55% | 0.55% | 93% | 103% | 91% | 100% |
| BCW | 0.41% | 0.49% | 0.52% | 93% | 101% | 94% | 102% |
| MRLP | 0.20% | 0.13% | 0.09% | 100% | 100% | 98% | 99% |
| IBC | -0.03% | 0.02% | 0.06% | 93% | 100% | 93% | 99% |
| ISP | 0.20% | 0.25% | 0.19% | 97% | 100% | 96% | 99% |
| DMVR | 0.81% | 1.11% | 1.11% | 100% | 97% | 100% | 96% |
| SBT | 0.39% | 0.06% | 0.01% | 95% | 100% | 95% | 98% |
| LMCS | 1.63% | -1.30% | -1.42% | 94% | 100% | 94% | 97% |
| SMVD | 0.27% | 0.26% | 0.28% | 88% | 98% | 90% | 100% |
| RDPCM on | -0.03% | -0.07% | -0.02% | 99% | 100% | 100% | 101% |
| MIP | 0.30% | 0.39% | 0.41% | 97% | 101% | 94% | 99% |
| LFNST | 0.67% | 0.20% | 0.56% | 94% | 100% | 91% | 98% |
| JCCR | 0.49% | 0.46% | -0.15% | 99% | 101% | 98% | 100% |
| SAO | 0.08% | 0.28% | 0.35% | 100% | 98% | 100% | 99% |
| PROF | 0.48% | 0.16% | 0.09% | 99% | 99% | 100% | 100% |
| SIF | 0.28% | 0.72% | 0.69% | 96% | 100% | 96% | 100% |

Table 5 Simulation results in low delay B configuration (LDB) of VTM tool tests. (VTM anchor)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **LDB** |  |  |  |
| **Acronym** | **BDR-Y** | **BDR-U** | **BDR-V** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| CST | 0.05% | 1.65% | 2.43% | 101% | 103% | 100% | 100% |
| DQ | 1.33% | 1.49% | 1.45% | 99% | 103% | 99% | 102% |
| CCLM | 0.02% | 3.70% | 4.48% | 100% | 100% | 100% | 100% |
| MTS | 0.57% | 0.46% | 0.40% | 96% | 101% | 95% | 97% |
| ALF | 4.07% | 5.88% | 5.12% | 95% | 87% | 97% | 85% |
| AFF | 2.50% | 1.98% | 1.94% | 78% | 95% | 78% | 95% |
| SbTMC | 0.71% | 0.81% | 0.74% | 101% | 100% | 101% | 100% |
| AMVR | 0.55% | 0.96% | 0.89% | 88% | 101% | 88% | 101% |
| TPM | 0.71% | 1.04% | 0.91% | 97% | 101% | 97% | 102% |
| CIIP | 0.35% | 0.51% | 0.45% | 96% | 96% | 98% | 102% |
| MMVD | 0.46% | 0.56% | 0.23% | 93% | 97% | 93% | 100% |
| BCW | 0.29% | 0.56% | 0.48% | 96% | 101% | 97% | 102% |
| MRLP | 0.02% | 0.38% | 0.22% | 100% | 99% | 99% | 100% |
| IBC | -0.03% | -0.23% | 0.08% | 87% | 100% | 88% | 101% |
| ISP | 0.10% | 0.39% | 0.23% | 98% | 100% | 98% | 100% |
| SBT | 0.64% | 0.13% | 0.24% | 93% | 99% | 92% | 97% |
| LMCS | 0.80% | -0.32% | -1.06% | 94% | 98% | 95% | 96% |
| RDPCM on | -0.02% | -0.07% | -0.30% | 99% | 101% | 99% | 100% |
| MIP | 0.11% | 0.33% | 0.45% | 96% | 102% | 96% | 103% |
| LFNST | 0.38% | -2.00% | -2.00% | 91% | 100% | 94% | 102% |
| JCCR | 0.14% | 1.96% | 3.00% | 100% | 101% | 99% | 99% |
| SAO | 0.07% | 0.58% | 1.24% | 101% | 101% | 100% | 99% |
| PROF | 0.33% | 0.36% | 0.35% | 98% | 99% | 99% | 100% |
| SIF | 0.13% | 0.21% | 0.03% | 96% | 100% | 97% | 101% |

Table 6 Luma sample usage and memory bandwidth results of VTM tool “off” test. (VTM anchor)   
(needs update)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | AI |  | RA |  |  | LDB |  |
| Acronym | Sample usage | Sample usage | Ave mem BW | Max mem BW | Sample usage | Ave mem BW | Max mem BW |
| CCLM | 49.40% | 3.76% |  |  | 1.18% |  |  |
| ALF | 99.00% | 56.78% |  |  | 54.46% |  |  |
| AFF |  | 22.83% |  |  | 30.30% |  |  |
| SBTMC |  | 14.93% |  |  | 15.99% |  |  |
| AMVR |  | 5.43% |  |  | 2.61% |  |  |
| TPM |  | 2.00% |  |  | 5.03% |  |  |
| BDOF |  | 42.42% |  |  |  |  |  |
| CIIP |  | 0.88% |  |  | 1.39% |  |  |
| MMVD |  | 6.96% |  |  | 8.51% |  |  |
| BCW |  | 9.98% |  |  | 8.61% |  |  |
| MRLP | 6.93% | 0.68% |  |  | 0.28% |  |  |
| DMVR |  | 36.65% |  |  |  |  |  |
| SBT |  | 2.50% |  |  | 4.06% |  |  |
| SMVD |  | 2.80% |  |  |  |  |  |
| MIP | 21.29% | 4.86% |  |  | 2.43% |  |  |
| LFNST | 7.90% | 0.69% |  |  |  |  |  |
| JCCR | 10.84% | 0.50% |  |  | 0.17% |  |  |
| SAO | 31.14% | 7.04% |  |  | 9.07% |  |  |
| SIF |  | 0.98% |  |  | 0.66% |  |  |

Table 7 test results of VTM tool “off” test on various VTM versions (needs update)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **VTM RA** |  |  |
| **Abbreviation** | **VTM3** | **VTM4** | **VTM5** | **VTM6** |
| CST | 0.74% | 1.25% | 1.47% | 0.99% |
| DQ | 1.39% | 1.36% | 1.24% | 1.32% |
| CCLM | 4.09% | 4.20% | 4.00% | 3.33% |
| MTS | 1.25% | 0.80% | 0.36% | 0.68% |
| ALF | 3.61% | 3.73% | 4.79% | 4.65% |
| AFF | 2.42% | 2.46% | 2.38% | 2.84% |
| SbTMVP | 0.52% | 0.43% | 0.40% | 0.48% |
| AMVR | 0.98% | 1.13% | 1.14% | 1.59% |
| TPM | 0.43% | 0.43% | 0.41% | 0.39% |
| BDOF | 1.02% | 0.63% | 0.66% | 0.68% |
| CIIP | 0.43% | 0.51% | 0.31% | 0.24% |
| MMVD | 0.81% | 0.52% | 0.59% | 0.52% |
| BCW | 0.48% | 0.45% | 0.45% | 0.43% |
| MRLP | 0.24% | 0.18% | 0.16% | 0.18% |
| IBC | 0.07% | 0.00% | 0.05% | -0.01% |
| ISP |  | 0.24% | 0.12% | 0.20% |
| DMVR |  | 0.80% | 0.87% | 0.87% |
| SBT |  | 0.33% | 0.33% | 0.32% |
| LMCS |  | 0.62% | 0.57% | 1.03% |
| SMVD |  | 0.26% | 0.24% | 0.27% |
| BDPCM |  |  | -0.02% | -0.03% |
| MIP |  |  | 0.27% | 0.32% |
| LFNST |  |  | 0.75% | 0.61% |
| JCCR |  |  | 0.34% | 0.42% |
| SAO | 0.81% | 0.64% | 0.17% | 0.13% |

Figure 1. PSNR-Y vs encoding runtime ratio of VTM with VTM tool tests (VTM anchor)

Figure 2. PSNR-Y vs decoding runtime ratio of VTM with VTM tool tests (VTM anchor)

Figure 3. PSNR-Y vs weighted runtime ratio (a = 6) of VTM with VTM tool tests (VTM anchor)

4 Related contributions

JVET-P0092 AHG13: Encoder speed-up for SMVD H. Chen, H. Yang (Huawei)

JVET-P0394 AHG13: Luma Clipping instead of LMCS S. Keating, K. Sharman, A. Browne (Sony)

JVET-P0417 AHG13: Removal of ISP T. Hellman, B. Heng, W. Wan (Broadcom)

JVET-P0616 AHG13: Compression performance analysis for 8K HLG sequences S. Nemoto, S. Iwamura, A. Ichigaya (NHK), K. Kazui (Fujitsu)

JVET-P0622 AHG13: Low Delay results for Affine, ALF and DBF (Class A included) M. Sychev (Huawei)

5 Recommendations

The AHG recommends the following:

• Consider the reported tool test results during tool adoption decision making

• Review related contributions

• Refine list of tested tools and test methodology for the next meeting cycle

o Consider the reported tool test results as a benchmark for CE tests

o Consider including reporting of compute system information for testers and cross-checkers

o Consider additional performance or complexity metrics

The gain of SAO has gone low, but it is suggested to provide mainly subjective benefit, and also is attractive when ALF is off.

Bandwidth measurements tool in DMVR SW requires bug fix.

Decision (CTC): It is agreed to disable MIP for the LD configurations, as the runtime increase for some sequences is high.

The chroma loss in LMCS is likely due to the increase in rate due to LM. Results show that the chroma SNR is still increased at same QP.

It is mentioned that LFNST shows loss on chroma (also in PSNR) for the LB case. Some concern is raised that this may be due to the fact that LB was not included in the training of the matrices.

[JVET-P0014](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8529) JVET AHG report: Operation modes for low latency support (AHG14) [J.-M. Thiesse, S. Deshpande, A. Duenas, Hendry, K. Kazui, R. Sjöberg, A. Tourapis]

1 Introduction

At the 15th JVET meeting, the AHG on Operation modes for low latency support was established with the following mandates:

• Define relevant test conditions for the study of low latency modes

• Study and propose low-latency performance assessment criteria/metrics

• Update the implementation in the VTM model for supporting GRA as in JVET-N0865.

• Study a parallel framework for GRA assessment

The regular JVET email reflector was used for discussions (jvet@lists.rwth-aachen.de). There was no discussion on the email reflector regarding AHG14.

2 Related contributions

The following contributions (5) are identified for the AHG.

1. Contribution in CE 2 (3)

JVET-P0022 CE2: Summary Report on Gradual Decoding Refresh [K. Kazui, J.-M. Thiesse, Hendry, L. Wang, K. Kawamura]

JVET-P0112 CE2-3: Wavefront-Based GRA [L. Wang, S. Hong, K. Panusopone (Nokia)]

JVET-P0193 CE2: Gradual Random Access (GRA) using encoder and normative restrictions (Tests 2.1.a, 2.1.b and 2.1.c) [D. Gommelet, J.-M. Thiesse, D. Nicholson (VITEC)]

2. Contributions within AHG8 and AHG17 (2)

JVET-P0128 AHG8: Scalability - GDR [Y. He, A. Hamza (InterDigital)]

JVET-P0356 AHG17: Bitstream constraints on RPL and GDR [R. Sjöberg, M. Pettersson, M. Damghanian (Ericsson)]

3 Recommendations

The AHG recommends to review all related contributions.

AHG may be no longer needed – revisit after CE2 review.

[JVET-P0015](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8573) JVET AHG report: Quantization control (AHG15) [R. Chernyak, E. François, C. Helmrich, S. McCarthy, A. Segall]

1 Introduction

At the 15th JVET meeting, the AHG on Quantization control was established with the following mandates:

• Identify methods for quantization step size control for luma and chroma, including spatially and frequency-adaptive approaches

• Develop methods for evaluating quantization step size control operation

• Study the association between transforms and quantization matrices

• Develop testing conditions for evaluating QP signalling improvements including rate control and perceptual optimization strategies as appropriate

• Evaluate the performance of the current VVC QP design using the adaptive quantization control techniques currently available in the VTM

2 Activities

The regular JVET e-mail reflector was used for discussions (jvet@lists.rwth-aachen.de) with [AHG15] in message headers. There was one email besides AHG kickoff message sent to the JVET reflector during the AHG period.

3 Related contributions

Input documents related to AHG15 are summarized in 6.9.

4 Recommendations

The AHG recommends to:

• Review all related contributions;

• Continue investigating VTM Quantization control techniques.

•

[JVET-P0016](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8443) JVET AHG report: Implementation studies (AHG16) [M. Zhou, J. An, E. Chai, K. Choi, S. Sethuraman, T. Hsieh, X. Xiu]

The AHG was established with the following mandates:

• Study draft and proposed coding tools to identify implementation issues relating to decoder pipelines, decoder throughput, and other aspects of implementation difficulty.

• Solicit hardware analysis of complex tools.

• Provide feedback on potential solutions to address identified issues.

1 Activities

Active email discussions were held on the main JVET email reflector (jvet@lists.rwth-aachen.de) with an [AHG16] indication on message headers. A summary of the AHG activities is provided as follows:

1.1 Topics discussed on the email reflector

1) VVC subpicture support (also for AHG12/AHG17)

a. Confirm understanding of the adoption and design philosophy.

b. Provide feedback on the implementation implications.

c. Motivate development of alternative approaches to reduce the implementation impact while still satisfying the general subpicture functionality.

2) Design inconsistency in the de-blocking of the affine mode and TPM mode.

a. In the affine mode, two 4x4 subblock edges can be treated differently even if they have the exactly same conditions (i.e. having no non-zero coefficients and the same amount of large enough MV differences that can trigger de-blocking along the edge).

b. In the TPM mode, an inner TU edge with no non-zero coefficients can still be de-blocked if the edge is located along the diagonal TPM boundary and the triangle block MV difference is large enough to trigger de-blocking.

1) 16-bit overflow issue in the newly adopted PROF (Prediction Refinement with Optical Flow)

a. The adopted version of PROF does not include the clipping of the refinement offset to 14-bit that was in the original PROF proposal.

b. The prediction samples after the PROF refinement can exceed 16-bit, which overflows the 16-bit multiplication logic in the weighted prediction.

2) Tile column boundary processing

a. It was proposed to disable the longer-tap de-blocking filtering along the vertical CTU boundary as well, to reduce the column buffer size for decoder implementations that run in the tile-scan order (instead of raster scan order).

b. It was commented that such a change is not needed from the decoder point of view, as there is already an existing standard to support that requires 18-sample wide column buffers for in-loop filters. The VVC so far requires 15-sample wide column buffers.

c. It was commented that the is not required from the encoder point of view, as there are multiple ways to achieve quality and cost trade-offs on the encoder side.

3) ALF sample padding

a. There two padding methods defined in the current draft, i.e. the repetitive padding and the ALF virtual boundaries (VB) mirrored padding.

b. For the ALF filtering, the repetitive padding is applied to the picture boundaries and to the 360 video VBs that are not CTU boundary aligned.

c. For the ALF filtering, the ALF VB mirrored padding is applied to the sub-picture/slice/tile/brick boundaries and to the 360 video VBs that are CTU boundary aligned.

d. For the 4x4 based ALF classifications, the repetitive padding is applied along all the boundaries.

e. It was asserted that the current design causes implementation difficulties.

f. To simply the design and to improve the design consistency, it was advocated using the ALF VB mirrored padding along the ALF VBs only and the repetitive padding everywhere else, and considering the removal of the 360 VBs that are not CTU boundary aligned.

1.2 Feedback provided on tools being tested in CEs

1) RPR (Reference Picture Resampling)

a. Recommended modifying the down-sampling filter coefficients to avoid overflowing the 16-bit weighted prediction logic.

b. Recommended using the 6-tap filters for affine motion compensation.

2) GEO (Geometric partitions)

a. The partial transform is sort of “generalized SBT”, populating the residual data from the received partial transform block (which also includes the residual padding to mitigate potential visual artefacts in de-blocking) to the coding unit creates an additional processing step in the inverse transform.

b. Using the sample weights to select motion vectors for the GEO motion context storage requires a decoder either to compute the sample weights twice or to carry the sample weights through multiple pipeline stages until they are consumed by the GEO MC.

c. The need of supporting up to 140 GEO partitioning types is likely a concern too (the current TPM has only two partitioning types).

3) Using DMVR-refined MVs in de-blocking

a. Recommended to use the refined MVs along the both sides of a vertical CTU boundary. Otherwise, the un-refined MVs along the vertical CTU boundary would also need to be passed from the MV reconstruction block to the DMVR block.

4) Combined bilateral and SAO filter

a. Recommended to use the repetitive padding (as opposed to the ALF VB mirrored padding) to simply the design.

5) Cross-component ALF (CCALF)

a. Suggested to cut the filter coefficient precision from 11-bit to 8-bit, to reduce the number of multiplications, and to align the CCALF on/off granularity with the existing ALF design (i.e. CTU based on/off).

1.3 Additional comments posted on the email reflector

1) The newly adopted CU level dual tree that removes the 2x2/4x2/2x4 chroma intra prediction blocks has re-introduced 4x4 inter PUs back into the design. This should be fixed.

2) It is desirable to lower the worst case number of context coded bins per residual from 2 to 1.75 in the transform skip residual coding. This change would improve the overall CABAC throughput and make the CABAC design more consistent. Currently the worst case number in the transform coefficients coding is 1.75 context coded bins per coefficient.

3) It is worth taking a second look whether the shared merge is absolutely essential for the small block size IBC merge list derivation. The shared merge requires more conditional checks and more bookkeeping to keep up with the required throughput.

4) The multiplication overhead of the CCALF being tested in the CE is about 50% of the current luma and chroma ALF design, while the expected gain is about 1% (on the top of existing ~5% ALF gain in RA). It would be desirable to study whether a better trade-off exists outside the CE.

1.4 Memory bandwidth study for VTM6.0

Broadcom conducted a memory bandwidth study by running both the VTM6.0 and VTM5.0 for CTC with a commercial motion compensation cache model integrated. The summary results of the random access configuration are provided in the Table 1 (for informational purposes).

For class A1 and A2 4K video both the average (see ABW\_diff column) and the peak memory bandwidth consumption (see MBW\_diff column) are slightly increased. Changing the DMVR reference block padding to 16x16 based and the adoption of PROF do not have a noticeable impact on the memory bandwidth consumption as expected.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access Main 10** | | | | | | | |
|  | **Over VTM-5.0** | | | | | | | |
|  | Y | U | V | TCM\_diff | ABW\_diff | MBW\_diff | EncT | DecT |
| Class A1 | -3.36% | -0.91% | -5.52% | 0.38% | 1.29% | 1.29% | 93% | 112% |
| Class A2 | -3.81% | -4.62% | -4.39% | 0.88% | 1.82% | 1.60% | 94% | 113% |
| Class B | -1.74% | -8.44% | -7.61% | 0.43% | 1.18% | -3.30% | 95% | 117% |
| Class C | -0.97% | -8.36% | -6.25% | -0.25% | 0.46% | -0.71% | 91% | 115% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -2.27% | -6.15% | -6.19% | 0.36% | 1.19% | -0.28% | 93% | 115% |
| Class D | -0.43% | -6.82% | -3.99% | -0.71% | -0.09% | 1.49% | 92% | 127% |
| Class F (optional) | -1.10% | -7.65% | -6.59% | -1.27% | -0.16% | -0.31% | 89% | 125% |

***Table 1. Memory bandwidth comparison (VTM6.0 vs. VTM5.0, RA)***

Where

• TCM\_diff : Total cache misses (over all the frames coded), percentage difference relative to VTM5.0.

• ABW\_diff: Average memory bandwidth (over all the frames coded), percentage difference relative to VTM4.0.

• MBW\_diff : Worst case (Max) memory bandwidth (among all the frames coded), percentage difference relative to VTM5.0.

MBW\_diff is the most important measure, which shows the worst case memory bandwidth consumption difference of VTM6.0 relative to VTM5.0.

1.5 Bin to bit ratio study for VTM6.0

It has been reported that the bin to bit ratio has decreased from VTM5.0 to VTM6.0, and returned to a similar level as VTM4.0, thanks to the reduction of the maximum number of context coded bins from 2 to 1.75 per coefficient in the transform coefficient coding. The summary results are provided in Table 2 and Table 3 for informational purposes (data from JVET-P0050).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Bin2bit ratio (peak, weighted)*** | | | | | | | | | | |
|  | HM16.19 | VTM4.0 | VTM5.0 | VTM6.0 | diff (%, VMT4.0 vs. HM16.19) | diff (%, VMT5.0 vs. HM16.19) | diff (%, VMT6.0 vs. HM16.19) | diff\* (%, VMT5.0 vs. VTM4.0) | diff\* (%, VMT6.0 vs. VTM5.0) | diff\* (%, VMT6.0 vs. VTM4.0) |
|  | ***QP = (22, 27, 32, 37), CTC*** | | | | | | | |  |  |
| ***AI*** | 0.95 | 1.10 | 1.13 | 1.14 | 15.72% | 19.71% | 19.89% | 3.99% | 0.18% | 4.17% |
| ***RA*** | 0.93 | 1.09 | 1.12 | 1.13 | 17.39% | 20.88% | 21.70% | 3.49% | 0.82% | 4.31% |
| ***LDB*** | 0.96 | 1.09 | 1.13 | 1.13 | 13.34% | 16.99% | 17.14% | 3.64% | 0.16% | 3.80% |
| ***LDP*** | 0.96 | 1.09 | 1.13 | 1.13 | 13.24% | 17.30% | 17.21% | 4.06% | -0.09% | 3.97% |
|  | ***QP = (2, 7, 12, 17), 100 frames*** | | | | | | | |  |  |
| ***AI*** | 0.79 | 0.94 | 0.95 | 0.93 | 18.11% | 20.24% | 17.71% | 2.12% | -2.53% | -0.40% |
| ***RA*** | 0.74 | 0.87 | 0.88 | 0.86 | 17.17% | 19.00% | 15.15% | 1.83% | -3.85% | -2.02% |
| ***LDB*** | 0.78 | 0.92 | 0.93 | 0.92 | 17.67% | 19.67% | 17.73% | 2.00% | -1.94% | 0.06% |
| ***LDP*** | 0.78 | 0.92 | 0.93 | 0.92 | 17.46% | 19.46% | 17.52% | 2.00% | -1.94% | 0.06% |
| ***Note\*: Percentage difference is measured against HM16.19*** | | | | | | | | |  |  |

***Table 2. Bin to bit ratio in VTM4.0, VTM5.0 and VTM6.0 (weighted)***

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Bin2bit ratio (peak, unweighted)*** | | | | | | | | | | |
|  | HM16.19 | VTM4.0 | VTM5.0 | VTM6.0 | diff (%, VMT4.0 vs. HM16.19) | diff (%, VMT5.0 vs. HM16.19) | diff (%, VMT6.0 vs. HM16.19) | diff\* (%, VMT5.0 vs. VTM4.0) | diff\* (%, VMT6.0 vs. VTM5.0) | diff\* (%, VMT6.0 vs. VTM4.0) |
|  | ***QP = (22, 27, 32, 37), CTC*** | | | | | | | |  |  |
| ***AI*** | 1.23 | 1.38 | 1.40 | 1.38 | 12.38% | 14.21% | 12.91% | 1.82% | -1.30% | 0.53% |
| ***RA*** | 1.21 | 1.38 | 1.40 | 1.39 | 13.75% | 15.25% | 14.36% | 1.50% | -0.89% | 0.61% |
| ***LDB*** | 1.24 | 1.37 | 1.39 | 1.38 | 11.25% | 12.88% | 11.57% | 1.63% | -1.30% | 0.32% |
| ***LDP*** | 1.23 | 1.37 | 1.39 | 1.38 | 11.08% | 13.02% | 11.49% | 1.94% | -1.53% | 0.42% |
|  | ***QP = (2, 7, 12, 17), 100 frames*** | | | | | | | |  |  |
| ***AI*** | 1.19 | 1.31 | 1.33 | 1.31 | 10.45% | 11.40% | 9.85% | 0.95% | -1.55% | -0.60% |
| ***RA*** | 1.18 | 1.28 | 1.28 | 1.27 | 7.63% | 8.39% | 6.87% | 0.76% | -1.52% | -0.76% |
| ***LDB*** | 1.18 | 1.30 | 1.31 | 1.29 | 9.54% | 10.28% | 8.98% | 0.74% | -1.30% | -0.56% |
| ***LDP*** | 1.18 | 1.30 | 1.31 | 1.29 | 9.50% | 10.24% | 8.94% | 0.74% | -1.30% | -0.56% |
| ***Note\*: Percentage difference is measured against HM16.19*** | | | | | | | | | | |

***Table 3. Bin to bit ratio in VTM4.0, VTM5.0 and VTM6.0 (un-weighted)***

In Table 2 and Table 3, a bypass bin is counted as 0.25 context coded bins in the weighted measurements; and a bypass bin and a context coded bin carry an equal weight (1:1) in the unweighted measurements.

As far as low-QP AI configuration is concerned, the weighted and un-weighted bin to bit ratio of the VTM6.0 is roughly 18% and 10% higher than that of VTM16.19, respectively.

2 Related contributions

Various contributions in different categories are identified being relevant to the AHG.

3 Recommendations

The AHG recommends reviewing the input contributions.

[JVET-P0017](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8503) JVET AHG report: High-level syntax (AHG17) [R. Sjöberg, J. Boyce, S. Deshpande, M. Hannuksela, R. Skupin, A. Tourapis, Y.-K. Wang, W. Wan, S. Wenger]

Discussion Tuesday 1545 (GJS)

This AHG report summarizes the activities of the AHG on High-level syntax (HLS) between the 15th JVET meeting in Gothenburg, SE (3–12 July 2019).and the 16th JVET meeting in Geneva, CH (1–11 October 2019).

It was reported that the estimated number of input contributions related to high-level syntax has increased from 123 at the 15th JVET meeting to 137 at this 16th meeting (10%).

The number of related contributions in particular categories was summarized as:

|  |  |
| --- | --- |
| **Category** | **HLS inputs (AHG estimation)** |
| Layered coding and resolution adaptivity (AHG8) | 36 |
| High-level parallelism and coded picture regions (AHG12) | 46 |
| Gradual random access (CE2) | 3 |
| High level tool control | 5 |
| SEI messages | 6 |
| Other general high-level syntax (AHG17) | 41 |
| Total | 137 |

It is noted that the first two days of the 16th meeting in Geneva were previously announced to be devoted to high-level syntax related topics.

An email conversation was conducted on the reflector labeled AHG12/AHG16/AHG17 based on a slide deck submitted by a member company regarding analysis of subpicture grid approach.

The AHG noted the following summary contribution

* JVET-P0687 contains a summary of HLS proposals on access unit delimiter, picture header, and slice header parameters signalling

The AHG recommended that this JVET meeting is planned such that there is enough time allocated to review high-level syntax related contributions.

[JVET-P0018](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8574) JVET AHG report: Lossless and near-lossless coding tools (AHG18) [T. Nguyen, T.-C. Ma, M. Ikeda, S. Iwamura, H. Jang, X. Zhao]

1 Introduction

The JVET established the AHG 18 at the Gothenburg meeting with the following mandates:

• Study coding tools for lossless and near-lossless coding, including transform skip, BDPCM, and other potential technologies

• Consider the interaction between coding tools and other processing such as loop filtering and LMCS for lossless and near-lossless coding

• Develop proposals for lossless and near-lossless coding for chroma and non-YCbCr colour space content

• Consider throughput bottlenecks for lossless and near-lossless coding at high resolutions and frame rates

2 Activities

Discussions related to AHG18 used the JVET email reflector (jvet@lists.rwth-aachen.de), and the AHG chairs sent a kick-off message on 27th August 2019. In total, the participants exchanged 18 emails related to the AHG.

The AHG identified the following issues:

• Design of the lossless support in VVC

• Mixed lossy/lossless

• BDPCM not activated (due to implementation) for lossless

The AHG chairs provided a reference implementation that reused the existing cu\_transquant\_bypass syntax in the VTM-6.0 software. Note that the syntax is not part of the current VVC Draft. The AHG chairs also provided lossless results using the sequences specified for the CTC, generated with HM-16.20 as representative for HEVC Main/Main10 and HEVC RExt.

The results for HEVC RExt relative to HEVC Main/Main10 are as follows.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | **Random Access** | | |
| **ratio** | | bit-rate savings | **ratio** | | bit-rate savings |
| HM-16.20 | HM-16.20 RExt | HM-16.20 | HM-16.20 RExt |
| Class A1 | 2.1 | 2.2 | -5.25% | 2.2 | 2.3 | -4.07% |
| Class A2 | 1.7 | 1.8 | -5.87% | 1.8 | 1.9 | -4.51% |
| Class B | 2.0 | 2.1 | -4.84% | 2.2 | 2.3 | -2.00% |
| Class C | 2.0 | 2.1 | -5.34% | 2.5 | 2.6 | -1.93% |
| Class D | 1.8 | 2.0 | -7.45% | 2.6 | 2.7 | -2.64% |
| Class E | 2.7 | 3.0 | -8.19% |  |  |  |
| Class F | 4.5 | 5.2 | -11.93% | 30.3 | 35.5 | -9.73% |
| TGM | 6.2 | 8.2 | -23.29% | 81.3 | 106.3 | -20.34% |
| **Overall** | **2.1** | **2.2** | **-5.75%** | **2.2** | **2.3** | **-2.89%** |
| Enc Time[%] | 94% | | | 106% | | |
| Dec Time[%] | 94% | | | 94% | | |

The results for VVC VTM-6.0 relative to HEVC Main/Main10 are as follows.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | **Random Access** | | |
| **ratio** | | bit-rate savings | **ratio** | | bit-rate savings |
| HM-16.20 | VTM6 | HM-16.20 | VTM6 |
| Class A1 | 2.1 | 2.2 | -5.97% | 2.2 | 2.3 | -4.87% |
| Class A2 | 1.7 | 1.7 | -3.63% | 1.8 | 1.9 | -3.18% |
| Class B | 2.0 | 2.1 | -4.21% | 2.2 | 2.3 | -3.20% |
| Class C | 2.0 | 2.1 | -5.47% | 2.5 | 2.6 | -3.52% |
| Class D | 1.8 | 1.9 | -5.69% | 2.6 | 2.8 | -3.87% |
| Class E | 2.7 | 2.9 | -7.62% |  |  |  |
| Class F | 4.5 | 5.5 | -16.21% | 30.3 | 39.4 | -13.89% |
| TGM | 6.2 | 12.3 | -45.77% | 81.3 | 112.6 | -29.01% |
| **Overall** | **2.1** | **2.2** | **-5.26%** | **2.2** | **2.3** | **-3.62%** |
| Enc Time[%] | 5667% | | | 1613% | | |
| Dec Time[%] | 193% | | | 157% | | |

The results for VVC VTM-6.0 relative to HEVC RExt are as follows.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | **Random Access** | | |
| **ratio** | | bit-rate savings | **ratio** | | bit-rate savings |
| HM-16.20 RExt | VTM6 | HM-16.20 RExt | VTM6 |
| Class A1 | 2.2 | 2.2 | -0.75% | 2.3 | 2.3 | -0.83% |
| Class A2 | 1.8 | 1.7 | 2.41% | 1.9 | 1.9 | 1.44% |
| Class B | 2.1 | 2.1 | 0.71% | 2.3 | 2.3 | -1.21% |
| Class C | 2.1 | 2.1 | -0.13% | 2.6 | 2.6 | -1.62% |
| Class D | 2.0 | 1.9 | 1.95% | 2.7 | 2.8 | -1.25% |
| Class E | 3.0 | 2.9 | 0.62% |  |  |  |
| Class F | 5.2 | 5.5 | -5.07% | 35.5 | 39.4 | -4.80% |
| TGM | 8.2 | 12.3 | -29.76% | 106.3 | 112.6 | -10.17% |
| **Overall** | **2.2** | **2.2** | **0.55%** | **2.3** | **2.3** | **-0.71%** |
| Enc Time[%] | 6022% | | | 1529% | | |
| Dec Time[%] | 205% | | | 167% | | |

3 Related contributions

Contributions are listed in 6.13. The AHG chairs also found out that several contributions related to the interaction between deblocking filter and other coding tools were input to this meeting. It is recommended that these contributions are reviewed in combination with CE5 and AHG16 discussions which also focus on deblocking filter process.

4 Recommendations

The AHG recommends:

• To review all related contributions

• Solving the aspect on the design for lossless support

• To continue the investigation on lossless and near-lossless performance of VVC

Current results show that current VTM6 anchor of the AHG does not have benefit over RExt.

Screen content probably benefits from IBC.

Further actions to be decided after review of input contributions. Would be desirable to support lossless coding in a non-specific profile if it comes for free without substantial change of tools.

# Project development (X)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX (chaired by XXX)

## Text and software development (1)

[JVET-P0113](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7902) AHG2: Editorial input on VVC draft text [Y.-K. Wang (Futurewei), B. Bross (HHI), J. Chen (Futurewei), G. J. Sullivan (Microsoft)] [late]

Discussed Thursday 0925 (GJS & JRO)

This is input from editors which should be checked for issues and used as the basis for integration of proposals.

## Test conditions (1)

[JVET-P0345](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8134) Low-Delay B encoder configuration proposal [F. Le Léannec, R. Jullian, E. François (InterDigital)]

[JVET-P0958](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8773) Crosscheck of JVET-P345 : Low-Delay B encoder configuration proposal [S. Yoo, J. Lim (LGE)]

## Performance assessment (3)

[JVET-P0328](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8117) AHG10: Performance of the GOP-based temporal filter in VTM-6.1 [J. Enhorn, R. Sjöberg, J. Ström, P. Wennersten (Ericsson)]

[JVET-P0616](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8410) AHG13: Compression performance analysis for 8K HLG sequences [S. Nemoto, S. Iwamura, A. Ichigaya (NHK), K. Kazui (Fujitsu)] [late] [miss]

[JVET-P0622](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8417) AHG13: Low Delay results for Affine, ALF and DBF (Class A included) [M. Sychev (Huawei)] [late]

## Coding studies on specific use cases (0)

## Test material (0)

## Conformance (6)

[JVET-P0099](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7888) Level limits for number of luma samples, tiles, and subpictures [M. M. Hannuksela (Nokia)]

[JVET-P0133](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7922) AHG17: DPB size analysis of VTM6.0 using RA configuration in current CTC [X. Ma, H. Yang (Huawei)]

[JVET-P0295](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8084) Level restrictions on maximum tile width for line buffer reduction [M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

[JVET-P0388](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8177) On VVC Conformance [J. Boyce, I. Moccagatta (Intel), L. Litwic (Ericsson), A. Stein (Technicolor), S. McCarthy, W. Husak, B. Lee (Dolby)]

[JVET-P0389](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8178) Proposal of preliminary list of VVC conformance bit streams [I. Moccagatta, J. Boyce (Intel)]

[JVET-P0894](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8709) Preliminary text for Annex A: Profiles, tiers and levels [J. Boyce (Intel)] [late]

## Implementation (2)

[JVET-P0207](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7996) Mobile based heterogeneous multi-core for a VVC Decoder [W. Liu, Y. B. Cho (??)]

[JVET-P0307](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8096) Early Implementation of VVC software player and Demonstration on Mobile devices [J. R. Arumugam, S. Kotecha, S. Ramamurthy, A. Chelawat, Jayasanker J., A. K. Bedgujar, N. M. Thomas, S. Agrawal, Vijayakumar G. R., K. Patankar (Ittiam)]

# Core Experiments

## CE1: Reference picture resampling filters (4)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0021](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8424) CE1: Summary report on reference picture resampling filters [J. Luo, V. Seregin, W. Wan]

Discussed Thursday 3 October Track B (GJS).

This contribution provides a summary report of Core Experiment 1 on reference picture resampling filters.

All techniques as planned in the context of CE1 are implemented on top of and tested against VTM-6.1 with the affine patch distributed with the CE1 description. Simulation results and crosschecking reports of each test specified in this document are provided.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test #** | **Description** | **Source** | **Tester** | **Cross-checker** |
| CE1-1.1 | Use integer version of 8-tap Lanczos2 filter when reference picture is larger than current picture | JVET-O0240 | Jonatan Samuelsson  samuelssonj@sharplabs.com | Peisong Chen  [peisong.chen@broadcom.com](mailto:peisong.chen@broadcom.com)  Krishna Rapaka  [krapaka@apple.com](mailto:krapaka@apple.com) |
| CE1-1.2 | Use integer version of 8-tap Lanczos1 filter when reference picture is larger than current picture | JVET-O0240 | Jonatan Samuelsson  samuelssonj@sharplabs.com | Peisong Chen  [peisong.chen@broadcom.com](mailto:peisong.chen@broadcom.com)  Krishna Rapaka  [krapaka@apple.com](mailto:krapaka@apple.com) |
| CE1-1.3 | Use integer version of 8-tap Lanczos2.67 filter when reference picture is larger than current picture | JVET-O0240 | Jonatan Samuelsson  samuelssonj@sharplabs.com | Peisong Chen  [peisong.chen@broadcom.com](mailto:peisong.chen@broadcom.com)  Krishna Rapaka  [krapaka@apple.com](mailto:krapaka@apple.com) |
| CE1-2.1 | Use 9-tap downsampling when the reference picture is larger than the current picture, and extended SHVC filters for upsampling when it is smaller. Resampling and motion compensation are done in one stage as in VTM. | JVET-O0319 | Pankaj Topiwala  pankajtva@gmail.com |  |
| CE1-2.2 | Use 9-tap downsampling when the reference picture is larger than the current picture, and extended SHVC filters for upsampling when it is smaller. Resampling is done separately from motion compensation.  The tester clarified that this test is not conforming to the agreed CTC of CE1. It is agreed that this test is removed from CE1. | JVET-O0319 | Pankaj Topiwala  pankajtva@gmail.com |  |
| CE1-3 | Use SHM filters for downsampling | JVET-O0641 | Mohammed Golam Sarwer  m.sarwer@alibaba-inc.com | Vadim Seregin  [vseregin@qti.qualcomm.com](mailto:vseregin@qti.qualcomm.com) |

CE 1-1.X is to test downsampling filters

It was commented that arbitrary scaling ratios are not especially difficult to support (e.g., versus supporting only 2x or only 2x and 1.5x).

An extreme ratio could be an issue. Currently the text restrict the ratio range of the reference picture relative to the current picture from 1/8 (upsampling) to 2 (downsampling).

Test cases:

* 1.5:1
* 2:1
* 4:1 optional

PSNR1 is "codec PSNR"

PSNR2 is high-res to high-res end-to-end.

Resampling ratio 1.5 : 1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay Main 10 PSNR1** | | | | | **Low delay B Main10 PSNR2** | | | | |
| **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 1-1.1  Lanczos2 (8) | 1.12% | 1.00% | 1.19% | 100% | 102% | 0.97% | 0.76% | 0.97% | 100% | 102% |
| 1-1.2  Lanczos1 (8) | - | - | - | - | - | - | - | - | - | - |
| 1-1.3  Lanczos2.67 (8) | -2.23% | -1.23% | -1.06% | 100% | 102% | -1.85% | -1.68% | -1.34% | 100% | 102% |
| 1-2.1 (9) | - | - | - | - | - | - | - | - | - | - |
| 1-3  SHM-A (12) | -3.13% | -2.50% | -2.28% | 99% | 101% | -2.23% | -2.21% | -1.87% | 99% | 101% |

Resampling ratio 2 : 1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay Main 10 PSNR1** | | | | | **Low delay B Main10 PSNR2** | | | | |
| **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 1-1.1 Lanczos2 | -4.45% | -2.70% | -2.47% | 100% | 100% | -2.89% | -1.79% | -1.72% | 100% | 100% |
| 1-1.2 Lanczos1 | 2.97% | 1.74% | 1.63% | #DIV/0! | #DIV/0! | 2.18% | 1.43% | 1.27% | #DIV/0! | 99% |
| 1-1.3 Lanczos2.67 | -2.80% | -1.95% | -1.83% | 99% | 99% | -1.77% | -1.28% | -1.25% | 99% | 99% |
| 1-2.1 | -2.05% | 1.17% | 0.77% | N/A | N/A | -0.25% | 1.39% | 1.02% | N/A | N/A |
| 1-3  SHM-B | -6.47% | -4.55% | -4.62% | 99% | 102% | -3.98% | -2.67% | -3.00% | 99% | 102% |

Resampling ratio 4 : 1 (Optional)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay Main 10 PSNR1** | | | | | **Low delay B Main10 PSNR2** | | | | |
| **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 1-1.1 Lanczos2 | -3.48% | -6.81% | -6.77% | 99% | 99% | -1.63% | -3.36% | -3.30% | 99% | 99% |
| 1-1.2 Lanczos1 | -9.47% | -9.10% | -9.16% | 99% | 99% | -4.57% | -4.74% | -4.76% | 99% | 99% |
| 1-1.3 Lanczos2.67 | - | - | - | - | - | - | - | - | - | - |
| 1-2.1 | - | - | - | - | - | - | - | - | - | - |
| 1-3  SHM-C | - | - | - | - | - | - | - | - | - | - |

The resampling assumed type 2 (collocated), although the content was actually type 0.

It was agreed in principle that the design needs to support adjusting the phase to match the chroma location. This is more relevant to a case where you would actually watch the lower resolution video without upsampling it back to the higher resolution, and what matters most is just whether the upsampling is matched to the downsampling.

The SHM has 12 taps.

It was commented that dynamic range analysis confirmed that there is no problem with the proposed filters (which are all 8 taps with 6 bit magnitude coefficients) – they fit within 16 bit – see JVET-P0855.

Decision: Adopt CE1-1.3 for the 1.5:1 case (after non-CE consideration). When resampling, the same filter is applied for all positions with no special treatment of half-pel positions. Switching points are 1.25 and 1.75 – see P0088 for details (it needs a fix for the half pel case).

(For the 2:1 case, see notes for P0353.)

[JVET-P0083](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7872) CE1-3: Reference picture resampling filters [J. Luo, M. Sarwer, Y. Ye, (Alibaba)] [late]

[JVET-P0088](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7877) CE1-1: RPR downsampling filter [J. Samuelsson, S. Deshpande, A. Segall (Sharp Labs of America)] [late]

[JVET-P0563](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8353) Crosscheck of JVET-P0088: CE1-1: RPR downsampling filter [W. Wan, M. Zhou, P. Chen (Broadcom)] [late]

[JVET-P0628](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8423) CE1-2: RPR Resampling Filters [P. Topiwala, M Krishnan, W. Dai (FastVDO)] [late]

## CE2: Gradual decoding refresh (3)

Contributions in this category were discussed XXday X July XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0022](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8403) CE2: Summary Report on Gradual Decoding Refresh [K. Kazui, J.-M. Thiesse, Hendry, L. Wang, K. Kawamura]

Discussed in Track B Thursday 3 October 1620 (GJS)

A summary of Core Experiment 2 (CE2) on gradual decoding refresh (GDR) is reported. The goal of CE2 is to study GDR tools/methods, for potential inclusion into the VVC standard.

Seven tests were defined in CE2:

– CE2-1: Virtual boundary-based method (4 tests)

– CE2-2: Slice boundary-based method (2 tests) (withdrawn)

– CE2-3: Wavefront-based method (1 test)

All tests are evaluated based on the common test conditions defined in JVET-O2022. All tests and crosscheck results are integrated in this report.

CTC conditions for SDR as agreed at the 15th JVET meeting are used for the evaluation of objective performance. The following constraints are further applied as specified in the CE2 document.

* Low-delay B configuration only
* Interval of GDR or IRAP picture (1.0 second)
* QP setting (no offset for IDR and B picture)
* The GOP size is 1. Each picture refers up to 4 immediately preceding pictures in decoding order

The anchor is the ‘VVC Test Model’ or VTM. The VTM version 6.0 software is used with ‘vtm’ configuration files to produce the VTM anchor. Tools are implemented into the VTM version 6.0 software. Proposals are primarily compared with respect to objective compression efficiency while bitrate fluctuation and “exact match” aspects are also assessed.

Source codes corresponding with the test descriptions contained in this document are uploaded to the following CE2 GitLab project:

<https://vcgit.hhi.fraunhofer.de/jvet-o-ce2/VVCSoftware_VTM.git>

The current draft standard has "virtual boundary" support (vertical or horizontal) for disabling in-loop filtering.

List of tested tools in CE2

|  |  |  |  |
| --- | --- | --- | --- |
| Test # | Short description | Doc. # | Cross-checker |
| CE2-1.a | Virtual boundary-based method   * Vertical virtual boundary * Position accuracy: 8 samples * Encoder-side control on MV search range * Encoder-side control on intra prediction mode restriction * Virtual boundary position signaled in PPS header send at every picture * Filters disabled across virtual boundary * LMCS disabled / CE2-1.a.bis: virtual boundary for LMCS chroma residue scale computation. | [JVET-O0](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=5038)100  [JVET-O1048](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=5038)  (VITEC) | KDDI |
| CE2-1.b | Virtual boundary-based method, variation of CE2-1.a   * Virtual boundary position signaled in slice header * Encoder-side control on intra prediction mode restriction * Filters disabled across virtual boundary * Encoder-side control on MV search range | [JVET-O0](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=5038)100  [JVET-O1048](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=5038)  (VITEC) | Nokia |
| CE2-1.c | Virtual boundary-based method, variation of CE2-1.b   * Normative reference sample restriction at virtual boundary for intra prediction * Filters disabled across virtual boundary * Encoder-side control on MV search range | [JVET-O0](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=5038)100  [JVET-O1048](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=5038)  (VITEC) | Futurewei |
| CE2-1.d *withdrawn* | Virtual boundary-based method, variation of CE2-1.c   * Normative reference sample restriction at virtual boundary for intra prediction * Filters disabled across virtual boundary * Treating virtual boundary as picture boundary for motion compensation | [JVET-O0](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=5038)100  [JVET-O1048](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=5038)  (VITEC) | Fujitsu |
| CE2-2.a  *withdrawn* | Slice boundary-based method   * Vertical slice boundary * Position accuracy: CTU width * Encoder-side control on MV search range | JVET-O0124  (Futurewei) |  |
| CE2-2.b  withdrawn | Slice boundary-based method, variation of CE2-2.a   * Treating slice boundary as picture boundary for motion compensation | JVET-O0124  (Futurewei) |  |
| CE2-3 | Wavefront-based method   * MV restrictions and in-loop filtering disabled * Virtual boundary syntax is moved to slice header * Virtual boundary syntax signals the start address and the length of intra coded area on wavefront | JVET-O0976  JVET-O0979  (Nokia) | VITEC |

**Refreshing scheme**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Test # | Shape of refreshed area | Signalling of area | Precision of boundary position | Spatial direction of refresh |
| CE2-1.a | Vertically striped | PPS | 8 luma samples | Left to right |
| CE2-1.b | Vertically striped | Slice | 8 luma samples | Left to right |
| CE2-1.c | Vertically striped | Slice | 8 luma samples | Left to right |
| CE2-3 | Diagonally striped | Virtual boundary | GDR block size dependent upon picture size and refresh cycle | Upper left to lower right |

**Method for avoiding contamination of sample from dirty area to clean area**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Test # | In intra prediction | In inter prediction | In MV prediction | In in-loop filtering |
| CE2-1.a | Encoder-side mode restriction | Encoder-side MV restriction | Constrained by limiting the reference frame buffer when recycling (encoder-side restriction) | Disabled at virtual boundary (PPS level) |
| CE2-1.b | Encoder-side mode restriction | Encoder-side MV restriction | Constrained by limiting the reference frame buffer when recycling (encoder-side restriction) | Disabled at virtual boundary (Slice level) |
| CE2-1.c | Avoid the use of reference samples across the virtual boundary (normative) | Encoder-side MV restriction | Constrained by limiting the reference frame buffer when recycling (encoder-side restriction) | Disabled at virtual boundary (Slice level) |
| CE2-3 | Not necessary due to its boundary shape. | Encoder-side MV restriction | TMVP is not used if a CU is inside the clean region. | Disabled at virtual boundary (Slice level) |

**Other aspects**

|  |  |  |
| --- | --- | --- |
| Test # | Additional normative changes | Decoding unit |
| CE2-1.a | Only on CE2-1.a.bis: Picture reconstruction with luma dependent chroma residual scaling process for chroma samples in LMCS – prevent use of pixels across the virtual boundaries | If DU operation is desired, each CTU column can be coded as one tile. One tile one slice. |
| CE2-1.b | Picture reconstruction with luma dependent chroma residual scaling process for chroma samples in LMCS – prevent use of pixels across the virtual boundaries | If DU operation is desired, each CTU column can be coded as one tile. One tile one slice. |
| CE2-1.c | Picture reconstruction with luma dependent chroma residual scaling process for chroma samples in LMCS – prevent use of pixels across the virtual boundaries | If DU operation is desired, each CTU column can be coded as one tile. One tile one slice. |
| CE2-3 | Signalling of the length of intra coded area on wavefront | If DU operation is desired, each CTU column can be coded as one tile. One tile one slice. |

**Other aspects**

|  |  |  |
| --- | --- | --- |
| Test # | Encoding condition | Cross-checker’s comment |
| CE2-1.a | Disabling of LMCS at PPS level. |  |
| CE2-1.b |  | For class F, HashME is disabled. |
| CE2-1.c |  |  |
| CE2-3 | ALF, LMCS and local dual tree are disabled. | ALF, LMCS and local dual tree are disabled.  For class F, IBC, HashME and BDPCM are disabled |

**BD-rate and runtime**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Low-delay B Main10 – Over VTM-6.0 with CE2 condition | | | | | | | | | |
|  | Tester | | | | | Cross-checker | | | | |
| Test # | Y | U | V | EncT | DecT | Y | U | V | EncT | DecT |
| CE2-1.a | Class-C 6.34% | Class-C 5.27% | Class-C 5.61% | Class-C 100% | Class-C 105% |  |  |  |  |  |
| CE2-1.a.bis | Class-C  5.88% | Class-C  6.98% | Class-C  7.58% | Class-C  102% | Class-C  104% | Class-C 5.88% | Class-C 6.98% | Class-C 7.58% |  |  |
| CE2-1.b | 6.54% | 8.86% | 11.14% | 107% | 102% | 6.54% | 8.86% | 11.14% |  |  | |
| CE2-1.c | 5.92% | 8.46% | 10.6% | 108% | 102% |  |  |  |  |  | |
| CE2-3 | Class-C  9.69% | Class-C  10.88% | Class-C  11.43% | Class-C  152% |  | Class-C  9.69% | Class-C  10.88% | Class-C  11.43% |  |  | |

CE2-1.a is basically the anchor. It uses virtual boundary disabling.

CE2-1.b is an encoder-side restriction. There were some indications that there was a bug in this, and an exact match was not achieved.

CE2-1.c considers changing intra prediction at virtual boundary. This did not have a lot of gain relative to the anchor (0.6%), but was suggested by the proponent to be helpful from the encoder perspective).

In CE2-3, ALF, LMCS and local dual tree were disabled, which may be causing the result. There was also a mismatch observed in this case.

An interaction was described between the virtual boundary case and LMCS.

A proponent of CE2-1.c said it could also have a subjective benefit that may exceed the measured PSNR benefit, although this had not been demonstrated to the group.

It was commented that the GDR functionality already has a very large penalty relative to not using it.

It was suggested that virtual boundary signalling be supported in the PH.

Decision: Put it in the SPS; if present there, it cannot change. If not present there, it becomes a gated presence in the PPS or PH. J.-M. Thiesse volunteered the text work (and software for handling the syntax).

[JVET-P0112](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7901) CE2-3: Wavefront-Based GRA [L. Wang, S. Hong, K. Panusopone (Nokia)] [late]

[JVET-P0193](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7982) CE2: Gradual Random Access (GRA) using encoder and normative restrictions (Tests 2.1.a, 2.1.b and 2.1.c) [D. Gommelet, J.-M. Thiesse, D. Nicholson (VITEC)] [late]

[JVET-P0842](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8657) Crosscheck of JVET-P0193: Gradual Decoding Refresh (GDR) using encoder and normative restrictions (Test 2.1.b) [L. Wang, S. Hong (Nokia)]

## CE3: Intra prediction and mode coding (4)

Contributions in this category were discussed Thursday 3 July 1445–1645 in Track A (chaired by JRO).

[JVET-P0023](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8369) CE3: Summary Report on Intra Prediction and Mode Coding [G. Van der Auwera, L. Li, A. Filippov]

This is the summary report of the third Core Experiment (CE3) [1]. The goal of CE3 is to study intra prediction tools, including mode coding, for potential inclusion into the VVC standard.

A total of 6 tests are defined on the matrix intra prediction (MIP) topic:

• CE3-1: MIP down-sampling process (2 tests)

• CE3-2: On rounding shift of MIP (2 tests)

• CE3-3: Up-sampling with fixed order in MIP (2 tests)

This document summarizes the objective results (BD-rates, runtimes), cross-check reports, and related input contributions.

Each test is covered by at least one cross-checker and the cross-check reports are included within the respective sub-test sections. Within CE3 it was agreed that cross-checkers answer the following questions:

• Did the cross-checker study the software? If so, did the cross-checker find any inconsistencies between the test description, the provided final software, and the VVC spec text changes?

• Do the cross-checked results match the proponent results for the test conditions? Were additional results cross-checked?

• Additional comments that may be helpful to the group?

This report summarizes the answers in tables reporting whether the objective test results match in one table column and all other comments in a second table column. The spreadsheets with cross-checked results are attached to this summary report.

The deadline for providing the cross-check reports to the CE coordinators was 21 September 2019. The following cross-check reports were received late or were missing spreadsheets with cross-checked results:

Test # Date received Comment

CE3-1 27 Sept. 2019 one report Result excels missing for second cross-check of CE3-1.1 and CE3-1.2

|  |  |  |
| --- | --- | --- |
| **Test #** | **Short description** | **Doc. #** |
| 3-1.1 | MIP downsampling by averaging two samples from the original boundary | JVET-P0064 (Ericsson) |
| 3-1.2 | MIP downsampling by N-tap filtering N samples from the original boundary |

CE3-1.1

MIP downsampling process derives reduced boundary *bdryred* for matrix multiplication by averaging two samples from the original boundary.



Figure 1. An example of *bdryred* derivation for a 32 × 16 block.

CE3-1.2

In CE3-1.2, four different M-tap low-pass boundary filters are designed depending on the boundary size.

* For boundary size is equal to 8, M = 2, the filter coefficients to use are [1 1] / 2
* For boundary size is equal to 16, M = 3, the filter coefficients to use are [1 2 1] / 4
* For boundary size is equal to 32, M = 5, the filter coefficients to use are [1 2 2 2 1] / 8
* For boundary size is equal to 64, M = 9, the filter coefficients to use are [1 2 2 2 2 2 2 2 1] / 16



Figure 2. An example of *bdryred* derivation for a 32 × 8 block.



Figure 3. An example of *bdryred* derivation for a 64 × 16 block.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra - Over VTM-6.0** | | | | | **Random Access - Over VTM-6.0** | | | | |
| **Test #** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 3-1.1 | 0.02% | -0.02% | -0.01% | 100% | 100% | 0.01% | 0.07% | 0.04% | 100% | 100% |
| 3-1.2 | 0.03% | 0.01% | 0.03% | 100% | 100% | 0.01% | 0.02% | -0.02% | 100% | 100% |

The original proposal (CE3-1.1) was claiming compression benefit, which is no longer the case from the results of the CE. It is somewhat simpler by using less samples than the current design for block sides >8. It does not reduce the worst case complexity of MIP, therefore not a relevant simplification.

CE3-1.2 is an extension which has similar complexity as current MIP, but does not show compression gain.

CE3-2.1

In this method, a variable (sW), the number of shifts to compute a variable predMip is fixed to 5. The equations are changed as below. Also, the weighting parameters (mWeight) and the offset factor (fO) are modified because the number of shifts was changed from the original design.

oW = ( 1 << 4~~( sW − 1 )~~ ) −( (fO \* ()+1) >> 1)

predMip[ x ][ y ] = ( ( ( ) +   
 oW ) >> 5~~sW~~ ) + pTemp[ 0 ]

Memory storage reduction: 102 bits (= 3 bits \* 34 elements)

CE3-2.2

In this method, the variable (sW) depends on MipSizeId. the sW is set to 6 when MipSizeId is equal to 1. Otherwise, it is set to 5. Thus, the equations are changed as below.

oW = ( 1 << ((MipSizeId==1)? 5:4) ) −( (fO \* ()+1) >> 1)

predMip[ x ][ y ] = ( ( ( ) +   
 oW ) >>  ((MipSizeId==1)? 6:5)~~sW~~ ) + pTemp[ 0 ]

Memory storage reduction: 102 bits (=3 bits \* 34 elements); additional conditions

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra - Over VTM-6.0** | | | | | **Random Access - Over VTM-6.0** | | | | |
| **Test #** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 3-2.1 | 0.03% | -0.01% | 0.02% | 100% | 100% | 0.02% | 0.05% | 0.01% | 101% | 99% |
| 3-2.2 | 0.03% | 0.01% | 0.00% | 100% | 100% | 0.02% | 0.08% | 0.01% | 100% | 100% |

Several experts expressed that CE3-2.1 could be regarded as a desirable cleanup in various aspects. However, it is also noted that there are numerous non-CE proposals that suggest other ways of cleanup. Need to get a better picture which are the aspects desirable to be resolved. Revisit in context of non-CE contribution.

CE3-2.2 does not appear to have any benefit.

CE3-3:

|  |  |  |
| --- | --- | --- |
| **Test #** | **Short description** | **Doc. #** |
| 3-3.1 | Up-sampling is performed firstly in the vertical direction and secondly in the horizontal direction | JVET-P0054 (Bytedance) |
| 3-3.2 | Up-sampling is performed firstly in the horizontal direction and secondly in the vertical direction |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test #** | **All Intra - Over VTM-6.0** | | | | | **Random Access - Over VTM-6.0** | | | | |
| **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 3-3.1 | 0.00% | 0.02% | -0.01% | 99% | 100% | -0.01% | 0.04% | 0.01% | 100% | 100% |
| 3-3.2 | 0.00% | -0.01% | 0.01% | 100% | 100% | 0.00% | 0.11% | 0.02% | 100% | 100% |

Current MIP is performing the order of upsampling filters depending on the block shape (upsampling is applied for blocks >8x8 where the prediction is first generated in a downsampled version). The results show that switching the order is not necessary, no compression loss.

CE3-3.2 is the desirable solution, also aligned with the order of filtering in motion comp.

Decision: Adopt JVET-P0054, version of CE3-3.2.

[JVET-P0054](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7843) CE3-3: Up-sampling with a fixed order in MIP [H. Liu, L. Zhang, K. Zhang, Z. Deng, J. Xu, Y. Wang (Bytedance)]

[JVET-P0056](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7845) CE3-2: On rounding shift of MIP [K. Kondo (Sony), J.-Y. Huo (Xidian Univ.)]

[JVET-P0064](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7853) CE3-1: MIP downsampling process – align positions of reduced boundary samples with positions of reduced prediction samples [Z. Zhang, K. Andersson, D. Saffar, R. Sjöberg, J. Ström, R Yu (Ericsson)]

## CE4: Inter prediction (8)

Contributions in this category were discussed XXday X July XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0024](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8416) CE4: Summary report on inter prediction [C.-C. Chen, H. Yang, X. Xiu]

Planning of viewing CE4:

- Viewing sessions can have 10-12 cases (A/B comparison)

1. GEO without adaptive blending - one session 2 rate points, 5 sequences

2. CIIP with triangular - one session 2 rate points, 5 sequences

3. Adaptive blending for screen content a) with TPM b) with TPM+GEO - one session 2 rate points, 3 sequences

In total 3 viewing sessions (3 experts each), 5 groups, 15x10min, approx. 3 hrs.

Anchor is always VTM6 CTC

Discussed Track B Wednesday 3 Oct 1715 GJS

This contribution provides a summary report of Core Experiment 4 on inter prediction. This CE comprises two categories,

1. Geometric partition related merge modes,
2. Simplification on PROF and BDOF.

All techniques as planned in the context of CE4 are implemented on top of and tested against VTM-6.0. Simulation results and crosschecking reports of each test specified in this document are provided.

Subjective evaluation of representative CE4-1 tests is planned to identify whether there is an observable subjective improvement. Test materials are provided for consideration.

There are four tools for CE4-1, geometric partition, partial transform for geometric partition, adaptive blending for screen content and CIIP with triangle partition.

Variants of the four tools and the combination are tested.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test #** | **Description** | | | | | | | | | | **Source** | | |
| 4-1.1\* | Geometric (GEO) merge mode as proposed in JVET-O0489 with 32 angles and 5 distance values | | | | | | | | | | JVET-P0068 | | |
| 4-1.2a | Geometric (GEO) merge mode with reduced number of partitions with N angles and 4 distance values, i.e., N=32 | | | | | | | | | | JVET-P0068 | | |
| 4-1.2b | Geometric (GEO) merge mode with reduced number of partitions with N angles and 4 distance values, i.e., N=24 | | | | | | | | | | JVET-P0068 | | |
| 4-1.5 | GEO + ¼ and ½ adaptive-size partial transform | | | | | | | | | | JVET-P0074 | | |
| 4-1.6 | GEO + ½ fixed-size partial transform | | | | | | | | | | JVET-P0074 | | |
| 4-1.7 | Adaptive blending filtering for TPM | | | | | | | | | | JVET-P0069 | | |
| 4-1.8 | Test 4-1.7 + GEO | | | | | | | | | | JVET-P0069 | | |
| 4-1.9 | CIIP with triangular partitions | | | | | | | | | | JVET-P0071 | | |
| 4-1.10 | Test 4-1.9 + GEO | | | | | | | | | | JVET-P0070 | | |
| 4-1.12 | Test 4-1.9 + Partial transform as in Test 4.1.5 | | | | | | | | | | JVET-P0075 | | |
| 4-1.13 | Test 4-1.12 + Test 4.1.5 (GEO with partial transform) | | | | | | | | | | JVET-P0075 | | |
| 4-1.14 | GEO with TPM-like motion storage method vs GEO with the proposal motion storage method in JVET-O0489 | | | | | | | | | | JVET-P0068 | | |
|  | | **Random Access** | | | | | **Low delay B** | | | | | |
| **Test#** | | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | | **DecT** |
| 4-1.1\* | | -0.36% | -0.45% | -0.54% | 104% | 100% | -0.72% | -0.66% | -0.76% | 105% | | 100% |
| 4-1.2a | | -0.34% | -0.42% | -0.54% | 104% | 100% | -0.73% | -0.69% | -0.76% | 104% | | 99% |
| 4-1.2b | | -0.34% | -0.39% | -0.52% | 103% | 100% | -0.68% | -0.46% | -0.60% | 103% | | 99% |
| 4-1.5 | | -0.35% | -0.41% | -0.49% | 104% | 100% | -0.83% | -0.67% | -0.67% | 105% | | 100% |
| 4-1.6 | | -0.34% | -0.43% | -0.49% | 104% | 100% | -0.87% | -0.56% | -0.60% | 105% | | 100% |
| 4-1.7 | | / | / | / | / | / | / | / | / | / | | / |
| 4-1.8 | | / | / | / | / | / | / | / | / | / | | / |
| 4-1.9 | | -0.07% | -0.05% | -0.05% | 101% | 100% | -0.18% | -0.14% | -0.15% | 103% | | 99% |
| 4-1.10 | | -0.39% | -0.48% | -0.49% | 104% | 100% | -0.77% | -0.84% | -0.62% | 106% | | 98% |
| 4-1.12 | | -0.09% | -0.05% | -0.01% | 103% | 100% | -0.31% | 0.02% | -0.08% | 103% | | 100% |
| 4-1.13 | | -0.41% | -0.47% | -0.47% | 106% | 100% | -0.97% | -0.79% | -0.63% | 108% | | 100% |
| 4-1.14 | | -0.37% | -0.40% | -0.53% | 104% | 100% | -0.71% | -0.71% | -0.59% | 105% | | 100% |

Results for Class F and Class SCC is shown for CE4-1.7 and CE4-1.8 since the two tests applies to screen content only.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Random Access Main 10** | | | | | **Low delay B Main10** | | | | |
| **Test#** | **Sequence** | Y | U | V | EncT | DecT | Y | U | V | EncT | DecT |
| CE4-1.7 | Class F | -0.02% | -0.02% | -0.03% | 100% | 100% | 0.02% | 0.00% | 0.48% | 99% | 100% |
| Class SCC | -0.73% | -0.58% | -0.55% | 100% | 100% | -0.94% | -0.69% | -0.68% | 98% | 100% |
| CE4-1.8 | Class F | -0.47% | -0.55% | -0.48% | 101% | 100% | -0.70% | -0.83% | -0.49% | 102% | 99% |
| Class SCC | -2.35% | -2.01% | -1.98% | 100% | 100% | -3.11% | -2.77% | -2.72% | 99% | 100% |

GEO would extend the triangle mode to support different paritionings.

TM mode has been about 0.4% gain. (It had 1% gain for LB and more gain for low resolution.)

The masking for this mode is somewhat different from GEO.

It was commented that we should check visual results.

The proponents suggested a combination in P0884 rather than the CE tested method. A particant commented that 4-1.14 is probably better understood.qqqq

It was agreed to do this test. If not subjective gain is evident, we do not plan to adopt this feature.

It was also suggested to subjectively test 4-1.9, combining CIIP with triangle mode.

It was also suggested to subjectively test CE4-1.7 and CE4-1.8 for SCC, disabling of blending in TPM and GEO for SCC.

Revisit for test results of these four things to be tested.

**Test 4-2.1 and 4-1.2 in JVET-P0057 (Kwai, Qualcomm, Mediatek, InterDigital)**

Common modifications in both tests,

* The range of BDOF motion refinements is changed from [-32, 32] to [-32, 31],

Modifications specific to test 4-2.1,

* PROF motion refinement is clipped into the range of [-32, 31], and
* The precision of the PROF motion refinement is changed from 1/64-pel to 1/32-pel.

Modifications specific to test 4-2.2,

* PROF motion refinement is clipped into the range of [-32, 31].

|  |  |  |
| --- | --- | --- |
| **Test #** | **Description** | **Source** |
| 4-2.1 | 1/32-pel precision of PROF motion refinement + [-32, 31] for PROF clipping range | JVET-P0057 |
| 4-2.2 | [-32, 31] for PROF clipping range | JVET-P0057 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access Main 10** | | | | | **Low delay B Main10** | | | | |
| **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 4-2.1 | 0.01% | 0.02% | 0.01% | 100% | 99% | 0.02% | 0.01% | 0.04% | 100% | 100% |
| 4-2.2 | 0.01% | 0.05% | -0.05% | 101% | 101% | 0.02% | 0.00% | 0.04% | 100% | 101% |

The motivation is unification/harmonization of PROF and BDOF schemes.

Decision: Adopt CE4-2.1 JVET-P0057.

[JVET-P0057](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7846) CE4: Harmonization of BDOF and PROF (Test 4-2.1 and 4-2.2) [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai), H. Huang, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm), C.-Y. Lai, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek), Y. He, W. Chen (InterDigital)

[JVET-P0068](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7857) CE4: CE4-1.1, CE4-1.2 and CE4-1.14: Geometric Merge Mode (GEO) [H. Gao, S. Esenlik, E. Alshina, A. M. Kotra, B. Wang (Huawei), M. Bläser, J. Sauer (RWTH Aachen Univ.)]

[JVET-P0069](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7858) CE4: CE4-1.7, CE4-1.8: GEO and TPM Blending Off for SCC [H. Gao, S. Esenlik, E. Alshina, A. M. Kotra, B. Wang (Huawei), M. Bläser, J. Sauer (RWTH Aachen Univ.)]

[JVET-P0070](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7859) CE4-1.10: CIIP with triangular partitions + GEO [S. Blasi, A. Seixas Dias, G. Kulupana (BBC), H. Gao, S. Esenlik, E. Alshina, A. M. Kotra, B. Wang (Huawei)]

[JVET-P0071](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7860) CE4-1.9: CIIP with triangular partitions [S. Blasi, A. Seixas Dias, G. Kulupana (BBC)]

[JVET-P0074](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7863) CE4: Geometric merge mode (GEO) with partial transform (tests CE4-1.5 and CE4-1.6) [A. Filippov, V. Rufitskiy (Huawei)]

[JVET-P0075](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7864) CE4: CIIP with triangular partitions and partial transform (tests CE4-1.12 and CE4-1.13) [A. Filippov, V. Rufitskiy (Huawei), S. Blasi, A. Seixas Dias, G. Kulupana (BBC)]

[JVET-P0808](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8623) Cross-check of CE4-1.1 and CE4-1.2: Geometric Merge Mode (GEO) (JVET-P0068), and CE4-1.2 restricted to 64 modes (JVET-P0107) [A. Wieckowski (HHI)]

## CE5: Loop filtering (8)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0025](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8425) CE5: Summary Report on Loop filtering [C.-Y. Chen, A. Norkin]

Planning of viewing CE5:

- Viewing sessions can have 10-12 cases (A/B comparison)

1. cross component ALF (only in loop) – one session 2 rate points, 5 sequences

2. DMVR deblocking: one session, test DMVR off and one version of deblocking with DMVR vectors, 2 rate points, 3 sequences

3. a) Aligning deblocking chroma decisions and b) longer tap filter at CTU, 2 rate points, 3 sequences

4. Hadamard+SAO, bilateral+SAO, 2 rate points, 3 sequences, RDO on

Anchor is always VTM6 CTC (with ALF on)

In total 4 viewing sessions (3 experts each), 5 groups, 20x10min, approx. 4 hrs.

[JVET-P0045](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7834) CE5-3.3: Signalling EO signs in SAO [C.-Y. Lai, C.-Y. Chen, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0639](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8436) CE5: Crosscheck of JVET-P0045 (CE5-3.3: Signalling EO signs in SAO) [E. Alshina, A.M. Kotra (Huawei)] [late]

[JVET-P0061](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7850) CE5-1.2: Consistent chroma deblocking [J. Xu, J. Wang, W. Zhu, L. Zhang, K. Zhang, H. Liu, Z. Deng (Bytedance)]

[JVET-P0062](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7851) CE5-1.1.1: DMVR deblocking, CE5-1.1.2: DMVR restricted deblocking and CE5-1.1.3: DMVR off [K. Andersson, J. Enhorn (Ericsson)]

[JVET-P0073](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7862) CE5-3.1: Combination of bilateral filter and SAO [J. Ström, P. Wennersten, J. Enhorn, D. Liu, K. Andersson, L. Litwic, D. Saffar, C. Hollmann, R. Yu, R. Sjöberg (Ericsson)]

[JVET-P0078](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7867) CE5-3: Combination of Hadamard filter and SAO (CE5-3.2, CE5-3.4) [S. Ikonin, V. Stepin, A. Karabutov, S. Nikolaeva (Huawei)]

[JVET-P0080](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7869) CE5-2.1, CE5-2.2: Cross Component Adaptive Loop Filter [K. Misra, F. Bossen, A. Segall (Sharp Labs of America)]

[JVET-P0081](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7870) CE5-1.3: Unified design for longer tap deblocking line buffer reduction [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)]

[JVET-P0819](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8634) Cross-check of CE5.3.1, CE5.3.2, CE5.3.3, and CE5.3.4 [K. Choi, Y. Piao, W. Choi, K. P. Choi (Samsung)]

## CE6: Transforms and transform signalling (6)

Contributions in this category were discussed Thursday 3 Oct. 1700–1815 in Track A (chaired by JRO).

[JVET-P0026](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8376) CE6: Summary Report on Transforms and Transform Signalling [X. Zhao, H. E. Egilmez, M. Salehifar]

This contribution summarizes the activities of Core Experiment (CE) on Transforms and Transform Signaling. The goal of this CE is to study transform design and signaling for the VVC standard. The CE studies were divided into two categories, including:

(1) CE6-1: LFNST with one mode (6 tests), targeting for encoder run-time saving.

(2) CE6-2: LFNST with reduced kernels (5 tests), targeting for memory cost reduction (all tests), unification (CE6-2.2 a/c/d) and multiplication reduction (CE6-2.2d, CE6-2.3).

In this CE all experiments were done using based on the VTM-6.0 SW. This document summarizes the test results, brief experiment definition, cross-check reports and complexity measurements, and also related contributions.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test #** | **Doc #** | **Description** | **Tester** | **Cross-checker** |
| 6-1.1a | JVET-P0041 | LFNST kernel selection according to the equation in JVET-O0292 with normative change | M.-S. Chiang (MediaTek)  J. Lainema (Nokia) | M. Koo (LGE) |
| 6-1.1b | JVET-P0041 | LFNST kernel selection according to the equation in JVET-O0292 with encoder-only change | M.-S. Chiang (MediaTek)  J. Lainema (Nokia) | M. Koo (LGE) |
| 6-1.1c | JVET-P0041 | LFNST kernel selection according to the equation in JVET-O0292 with encoder-only change and the last bit used to signal LFNST index is context coded. | M.-S. Chiang (MediaTek)  J. Lainema (Nokia) | M. Koo (LGE) |
| 6-1.1d | JVET-P0041 | LFNST kernel selection according to the equation in JVET-O0350 with normative change | J. Lainema (Nokia)  M.-S. Chiang (MediaTek) | M. Koo (LGE) |
| 6-1.1e | JVET-P0041 | LFNST kernel selection according to the equation in JVET-O0350 with encoder-only change | J. Lainema (Nokia)  M.-S. Chiang (MediaTek) | M. Koo (LGE) |
| 6-1.1f | JVET-P0041 | LFNST kernel selection according to the equation in JVET-O0350 with encoder-only change and the last bit used to signal LFNST index is context coded. | J. Lainema (Nokia)  M.-S. Chiang (MediaTek) | M. Koo (LGE) |
| CE6-2.1 | JVET- P0044 | Reduce 4 transform sets to 3 transform sets  - set 0 for DC / Planar  - set 1 for angular modes between 19 and 49  - set 3 for the other angular modes | Y. Zhao (Huawei) | M. Salehifar (LGE) |
| CE6-2.2a | JVET-P0051 | LFNST with the original 16x48 kernels defined in VTM-6.0 and apply them to all block sizes | X. Zhao (Tencent) | M.Siekmann (HHI)  M. Salehifar (LGE)  H. E. Egilmez (Qualcomm) |
| CE6-2.2c | JVET-P0051 | Combined test of CE6-2.2a and CE6-2.1 | X. Zhao (Tencent) | M.Siekmann (HHI)  M. Salehifar (LGE) |
| CE6-2.2d | JVET-P0052 | Combination of CE6-2.2a and CE6-2.3a - For larger block sizes, the new kernels in CE6-2.3a are applied - For 4xN and Nx4 blocks, the new kernels in CE6-2.3a are applied, but only pick the overlapping part with current block as output, as proposed in CE6-2.2a | X. Zhao (Tencent)  T. Zhou (Sharp) | M.Siekmann (HHI)  M. Salehifar (LGE)  H. E. Egilmez (Qualcomm) |
| CE6-2.3 | JVET-P0065 | Simplification of the low frequency separable transform using 36x16 RST matrices | T. Zhou (Sharp) | M.Siekmann (HHI)  M. Salehifar (LGE)  X. Zhao (Tencent)  C. Rosewarne (Canon) |

The following table summarizes the results of CE6 tests using CTC configuration and VTM-6.0 as anchor.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | **Random Access** | | | | |
| **Test #** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| CE6-1.1a | 0.11% | 0.66% | 0.82% | 90% | 101% | 0.09% | 0.49% | 0.50% | 97% | 102% |
| CE6-1.1b | 0.53% | 0.99% | 1.06% | 92% | 101% | 0.29% | 0.53% | 0.63% | 98% | 103% |
| CE6-1.1c | 0.48% | 0.99% | 1.11% | 91% | 101% | 0.27% | 0.50% | 0.56% | 98% | 103% |
| CE6-1.1d | 0.11 % | 0.64 % | 0.80 % | 90% | 99% | 0.07 % | 0.48 % | 0.49 % | 98% | 100% |
| CE6-1.1e | 0.53 % | 0.97 % | 1.10 % | 91% | 99% | 0.29 % | 0.53 % | 0.60 % | 98% | 99% |
| CE6-1.1f | 0.46 % | 0.97 % | 1.08 % | 91% | 99% | 0.27 % | 0.53 % | 0.56 % | 98% | 100% |
| CE6-2.1 | 0.03% | 0.06% | 0.11% | 100% | 101% | -0.01% | 0.06% | 0.03% | 100% | 100% |
| CE6-2.2a | -0.02% | 0.03% | 0.07% | 100% | 98% | -0.02% | 0.06% | 0.04% | 100% | 99% |
| CE6-2.2c | 0.01% | 0.12% | 0.14% | 100% | 98% | -0.01% | -0.01% | -0.01% | 100% | 99% |
| CE6-2.2d | -0.01% | 0.14% | 0.16% | 99% | 96% | -0.02% | 0.12% | 0.03% | 99% | 97% |
| CE6-2.3 | 0.02% | 0.09% | 0.10% | 100% | 100% | 0.03% | 0.11% | 0.05% | 100% | 101% |

Comparison on memory saving for CE6-2 tests:

|  |  |
| --- | --- |
| **Test** | **Memory cost** |
| VTM-6.0 | 8KB |
| CE6-2.1 | 6KB (25% reduction) |
| CE6-2.2a | 6KB (25% reduction) |
| CE6-2.2c (CE6-2.2a + CE6-2.1) | 4.6KB (44% reduction) |
| CE6-2.2d (CE6-2.2a + CE6-2.3) | 4.6KB (44% reduction) |
| CE6-2.3 | 6.7KB (19% reduction) |

The following table summarizes the results of CE6 tests using Low QP configuration and VTM-6.0, as specified in JVET-O2026.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | |
| **Test #** | **Y** | **U** | **V** | **EncT** | **DecT** |
| CE6-1.1a |  |  |  |  |  |
| CE6-1.1b |  |  |  |  |  |
| CE6-1.1c |  |  |  |  |  |
| CE6-1.1d |  |  |  |  |  |
| CE6-1.1e |  |  |  |  |  |
| CE6-1.1f |  |  |  |  |  |
| CE6-2.1 |  |  |  |  |  |
| CE6-2.2a | 0.02% | 0.04% | 0.04% | 98% | 98% |
| CE6-2.2c | 0.04% | 0.01% | 0.03% | 98% | 97% |
| CE6-2.2d | 0.03% | 0.03% | 0.04% | 98% | 97% |
| CE6-2.3 | 0.00% | -0.01% | 0.00% | 100% | 100% |

For CE6-1, both methods determine the transform kernel type from the intra mode rather than signalling it explicitly. The main motivation is reduction of encoding time (approx. 10% for AI, 2-3% for RA). Losses are in the range of 0.1% (slightly less for RA). It is reported that another simplification of LFNST adopted in the last meeting gave approx. 20% reduction in AI, penalizing 0.1%. Compared to that, the results of CE6-1 are not giving a similar good tradeoff, and some flexibility in the transform kernel selection is also lost (which more sophisticated encoders might want to use).

No action on CE6-1.

CE6-2.1 reduces the number of LFNST sets from 4 to 3 (no separate set for close to horizontal and vertical directions). This comes at very low loss. The memory for storing LFNST kernels is reduced by approx. 2 kByte. It is also reported that, if other tools are disabled in additional non-CTC tests, the loss becomes larger up to 0.2%.

CE6-2.2 replaces the 16x16 kernels (used for 4xN and Nx4) by using a part of the 16x48 kernels. One aspect of the proposal is that now a larger kernel is applied to 4x8 and 8x4 blocks, which however is confirmed that it does not increase worst case complexity (in number of multiplications). Picking the part of larger transform basis requires some additional logic, but the storage is reduced by approx. 2 kByte. It is also reported that, if other tools are disabled in additional non-CTC tests, the loss becomes larger up to 0.1%. Some concern is expressed that this is losing orthogonality.

The transforms for CE6-2.1 and CE6-2.2 were not retrained.

CE6-2.2.c is a combination of CE6-2.1 and CE6-2.2, saving a total of 3.4 kbyte of memory (about 44%)

CE6-2.3 reduces the 48x16 matrices into 36x16 matrices (applied in different shapes for the two transform types). There are several CE related proposals which propose different shapes, or even more reduction. Memory saving is slightly lower than for the other two proposals (32x16 would achieve that, which is proposed in a CE related proposal).

The opinion is expressed that the irregularity switching between two shapes might be undesirable, and it also does not reduce worst case of multiplications.

The 36x16 transform was retrained.

The main benefit of all three proposals is saving of memory. Hardware experts expressed that this is not a real problem (ROM, fixed table). No reason to change the existing design.

[JVET-P0041](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7830) CE6-1: LFNST with one mode [M.-S. Chiang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek), J. Lainema (Nokia)]

JVET-P0044 CE6-2.1: LFNST with 3 transform sets [Y. Zhao, H. Yang (Huawei)]

[JVET-P0051](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7840) CE6-2.2a/c: LFNST with unified kernels [X. Zhao, X. Li, S. Liu (Tencent)]

[JVET-P0052](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7841) CE6-2.2d: Combination of CE6-2.2a and CE6-2.3 [X. Zhao, X. Li, S. Liu (Tencent), T. Zhou, T. Hashimoto, T. Ikai (Sharp)]

[JVET-P0065](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7854) CE6-2.3a: Simplification with new LFNST transform basis [T. Zhou, T. Hashimoto, T. Ikai (Sharp)] [late]

[JVET-P0594](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8386) Crosscheck of CE6-2.2a and CE6-2.2d: An Orthogonality Analysis [H. E. Egilmez]

[JVET-P0647](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8445) Crosscheck of CE6 Proposals, Under non-CTC Configuration [M. Koo (LGE)]

[JVET-P0899](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8714) Crosscheck of JVET-P0647: Crosscheck of CE6 Proposals, Under non-CTC Configuration [T. Zhou (Sharp)]

## CE7: Quantization and coefficient coding (9)

Contributions in this category were discussed Thursday 3 Oct. 1815–XXXX in Track A (chaired by JRO).

[JVET-P0027](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8396) CE7: Summary report on quantization and coefficient coding [H. Schwarz, M. Coban, C. Auyeung]

The CE report summarizes the test results and crosscheck reports for CE7 on quantization and coefficient coding. The CE includes 4 sub-CEs on the following topics:

• CE7-1: Coding order and bypass switch for transform skip residual coding

• CE7-2: Context modelling and binarization for transform skip residual coding

• CE7-3: Context reduction for regular transform coefficient coding

• CE7-4: Chroma cbf coding

**CE7-1: Summary of tests**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tester** | **Tool** | **Cross checker** |
| CE7-1.1 | S.-T. Hsiang (Mediatek) | Re-positioning of parity flag (JVET-O0295) | M. Sarwer (Alibaba) |
| CE7-1.2a | Y.-H- Chao (Qualcomm) | 2-pass variant (JVET-O0623) | T. Nguyen (HHI) |
| CE7-1.2b | Y.-H- Chao (Qualcomm) | re-positioning of the parity flag after gtx scan (JVET-O0623) | T. Nguyen (HHI) |
| CE7-1.2c | Y.-H- Chao (Qualcomm) | Rice-Golomb coding after bypass switch (JVET-O0623) for 2 pass scan | T. Nguyen (HHI) |
| CE7-1.2d | Y.-H- Chao (Qualcomm) | Rice-Golomb coding after bypass switch (JVET-O0623) for 3 pass scan | T. Nguyen (HHI) |
| CE7-1.3a | M. Sarwer (Alibaba) | Swap position of parity\_flag and abs\_gt3\_flag (JVET-O0619) | S.-T. Hsiang (Mediatek) |
| CE7-1.3b | M. Sarwer (Alibaba) | Simplified bypass coding / unification of bypass switch for transform skip and regular transform coefficient coding (JVET-O0619) | S.-T. Hsiang (Mediatek) |
| CE7-1.3c | M. Sarwer (Alibaba) | Combination of CE7-1.3a and CE7-1.3b | S.-T. Hsiang (Mediatek) |

Remarks:

* One CE participant considered the test CE7-1.2d as new proposal and objected to include this test in the core experiment. There was no agreement among the CE participants regarding this point.
* One CE participant considered the alternative bypass coding for tests CE7-1.3b/c as new proposal and objected to include this alternative method in the core experiment. There was no agreement among the CE participants regarding this point.
* The starred versions “\*” in the result tables represent alternatives for the corresponding CE tests.
* One CE participant remarked that the CABAC initialization tables in CE tests CE7-1.2a/c/d were modified relative to VTM-6, which may have an impact on comparing the BD rate results.

During the drafting of the CE document, no consensus was reached on the bullets above. However, no such concern was raised when discussing the results in track A.

*Table 1: Average test results for CE7-1 and Common Test Conditions (CTC).*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Overall** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-1.1** | 0.00% | -0.01% | 0.01% | 100% | 99% | 0.01% | 0.06% | -0.04% | 100% | 100% | -0.02% | -0.14% | -0.23% | 101% | 106% |
| **CE7-1.2a** | 0.00% | 0.00% | 0.00% | 101% | 101% | 0.00% | 0.06% | 0.05% | 101% | 100% | -0.03% | 0.07% | -0.22% | 101% | 99% |
| **CE7-1.2b** | 0.00% | 0.00% | 0.00% | 101% | 101% | 0.01% | 0.04% | 0.02% | 101% | 100% | -0.02% | -0.01% | -0.23% | 100% | 99% |
| **CE7-1.2c** | 0.00% | -0.01% | -0.01% | 100% | 101% | 0.00% | 0.03% | 0.00% | 101% | 100% | -0.06% | 0.07% | 0.01% | 100% | 100% |
| **CE7-1.2c\*** | 0.00% | 0.00% | -0.02% | 101% | 101% | 0.00% | 0.05% | 0.02% | 101% | 100% | -0.04% | 0.13% | -0.11% | 100% | 99% |
| **CE7-1.2d** | 0.00% | -0.01% | 0.00% | 101% | 101% | 0.00% | 0.03% | 0.01% | 101% | 99% | -0.01% | 0.09% | -0.24% | 100% | 100% |
| **CE7-1.2d\*** | 0.00% | -0.01% | 0.00% | 101% | 100% | 0.00% | 0.04% | -0.04% | 101% | 100% | 0.00% | 0.17% | -0.22% | 100% | 99% |
| **CE7-1.3a** | 0.00% | -0.02% | -0.01% | 101% | 102% | -0.01% | 0.04% | 0.01% | 101% | 100% | -0.02% | -0.12% | -0.05% | 101% | 102% |
| **CE7-1.3b** | 0.00% | 0.01% | 0.00% | 101% | 102% | 0.01% | 0.06% | 0.04% | 101% | 101% | 0.01% | 0.00% | -0.06% | 101% | 102% |
| **CE7-1.3b\*** | 0.00% | 0.00% | -0.02% | 101% | 102% | 0.00% | 0.10% | 0.07% | 101% | 101% | 0.01% | 0.07% | -0.13% | 101% | 102% |
| **CE7-1.3c** | 0.00% | -0.02% | 0.01% | 100% | 102% | 0.00% | 0.03% | 0.07% | 101% | 100% | -0.06% | 0.16% | -0.11% | 101% | 102% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Class F** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-1.1** | -0.06% | -0.09% | -0.07% | 102% | 100% | -0.02% | -0.08% | -0.03% | 100% | 95% | -0.02% | -0.07% | 0.30% | 99% | 98% |
| **CE7-1.2a** | 0.02% | 0.00% | -0.13% | 100% | 98% | -0.01% | 0.02% | 0.13% | 102% | 101% | 0.06% | -0.25% | 0.28% | 102% | 99% |
| **CE7-1.2b** | -0.05% | -0.05% | 0.07% | 101% | 101% | -0.02% | 0.01% | 0.02% | 102% | 100% | 0.03% | 0.11% | 0.90% | 101% | 98% |
| **CE7-1.2c** | -0.03% | 0.04% | -0.05% | 99% | 98% | -0.07% | -0.10% | -0.06% | 101% | 100% | 0.08% | 0.07% | 0.08% | 100% | 100% |
| **CE7-1.2c\*** | -0.01% | 0.05% | -0.07% | 101% | 99% | 0.00% | -0.11% | 0.10% | 101% | 100% | -0.08% | 0.33% | 0.25% | 100% | 98% |
| **CE7-1.2d** | -0.05% | -0.05% | -0.15% | 99% | 99% | -0.03% | -0.11% | -0.04% | 101% | 100% | -0.15% | -0.03% | 0.15% | 100% | 98% |
| **CE7-1.2d\*** | -0.06% | -0.04% | -0.14% | 101% | 98% | -0.10% | -0.08% | -0.15% | 101% | 101% | 0.05% | -0.12% | 0.29% | 100% | 98% |
| **CE7-1.3a** | 0.00% | -0.06% | -0.01% | 102% | 101% | 0.02% | 0.01% | -0.05% | 101% | 100% | 0.08% | 0.05% | 0.54% | 101% | 102% |
| **CE7-1.3b** | 0.00% | -0.07% | -0.16% | 102% | 101% | -0.04% | 0.02% | 0.01% | 101% | 100% | 0.07% | 0.13% | 0.55% | 102% | 103% |
| **CE7-1.3b\*** | 0.00% | -0.05% | -0.02% | 102% | 101% | 0.01% | -0.04% | 0.14% | 101% | 101% | 0.10% | 0.26% | 0.54% | 102% | 103% |
| **CE7-1.3c** | 0.00% | -0.03% | -0.09% | 101% | 101% | -0.06% | 0.04% | 0.01% | 101% | 100% | 0.05% | -0.11% | 0.30% | 101% | 102% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **TGM** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-1.1** | -0.04% | -0.03% | -0.05% | 100% | 99% | -0.04% | -0.10% | -0.07% | 100% | 98% | -0.04% | 0.00% | 0.07% | 101% | 100% |
| **CE7-1.2a** | 0.01% | 0.06% | 0.05% | 101% | 99% | 0.02% | 0.02% | 0.01% | 102% | 100% | -0.02% | -0.02% | 0.06% | 99% | 101% |
| **CE7-1.2b** | -0.05% | -0.05% | -0.05% | 101% | 98% | -0.09% | -0.03% | -0.09% | 102% | 99% | -0.04% | -0.02% | 0.04% | 98% | 102% |
| **CE7-1.2c** | -0.04% | 0.02% | 0.00% | 99% | 100% | -0.07% | -0.05% | -0.05% | 102% | 98% | -0.06% | -0.02% | -0.05% | 99% | 98% |
| **CE7-1.2c\*** | 0.06% | 0.12% | 0.09% | 101% | 97% | 0.00% | 0.02% | 0.05% | 102% | 100% | -0.02% | 0.01% | 0.03% | 99% | 100% |
| **CE7-1.2d** | -0.15% | -0.11% | -0.12% | 99% | 100% | -0.10% | -0.07% | -0.12% | 101% | 99% | -0.10% | -0.06% | -0.04% | 99% | 100% |
| **CE7-1.2d\*** | -0.12% | -0.11% | -0.11% | 101% | 100% | -0.09% | -0.11% | -0.09% | 102% | 101% | -0.06% | -0.01% | -0.04% | 98% | 102% |
| **CE7-1.3a** | -0.04% | -0.03% | -0.03% | 101% | 101% | -0.05% | -0.07% | -0.08% | 101% | 100% | -0.04% | -0.08% | -0.03% | 102% | 100% |
| **CE7-1.3b** | -0.02% | 0.02% | 0.01% | 101% | 101% | -0.04% | -0.06% | -0.02% | 101% | 100% | -0.06% | -0.01% | 0.03% | 103% | 104% |
| **CE7-1.3b\*** | 0.04% | 0.08% | 0.05% | 102% | 101% | -0.03% | -0.01% | 0.03% | 101% | 101% | -0.09% | -0.07% | -0.05% | 103% | 101% |
| **CE7-1.3c** | -0.02% | -0.01% | 0.01% | 101% | 101% | -0.04% | -0.04% | -0.04% | 101% | 100% | -0.11% | -0.09% | -0.01% | 102% | 100% |

*Table 2: Average test results for CE7-1 and low QP (2, 7, 12, 17).*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Overall** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-1.1** | 0.00% | 0.00% | 0.00% | 97% | 98% | 0.00% | 0.00% | 0.00% | 96% | 98% | -0.01% | 0.00% | -0.01% | 97% | 97% |
| **CE7-1.2a** | 0.00% | 0.00% | 0.01% | 100% | 100% | 0.00% | -0.01% | 0.00% | 100% | 98% | -0.01% | -0.01% | -0.01% | 100% | 99% |
| **CE7-1.2b** | 0.00% | 0.00% | 0.00% | 99% | 98% | 0.00% | -0.01% | 0.00% | 99% | 100% | 0.00% | 0.01% | -0.01% | 99% | 98% |
| **CE7-1.2c** | -0.01% | -0.01% | 0.00% | 99% | 98% | 0.00% | 0.00% | -0.01% | 99% | 99% | -0.01% | 0.00% | -0.01% | 99% | 98% |
| **CE7-1.2c\*** | -0.03% | -0.03% | -0.01% | 99% | 98% | -0.02% | 0.00% | 0.00% | 99% | 99% | -0.03% | 0.00% | -0.01% | 99% | 99% |
| **CE7-1.2d** | -0.02% | -0.01% | 0.00% | 99% | 98% | -0.01% | -0.01% | -0.01% | 99% | 99% | -0.01% | 0.00% | -0.01% | 99% | 98% |
| **CE7-1.2d\*** | -0.03% | -0.02% | -0.02% | 100% | 98% | -0.01% | -0.01% | -0.01% | 99% | 99% | -0.01% | -0.01% | -0.03% | 99% | 98% |
| **CE7-1.3a** | 0.00% | 0.00% | 0.00% | 100% | 101% | -0.01% | -0.02% | 0.00% | 100% | 100% | -0.01% | 0.01% | -0.01% | 101% | 102% |
| **CE7-1.3b** | -0.01% | -0.02% | -0.01% | 100% | 98% | -0.01% | -0.01% | 0.00% | 100% | 100% | -0.02% | -0.01% | 0.00% | 100% | 98% |
| **CE7-1.3b\*** | -0.02% | -0.02% | 0.00% | 99% | 98% | -0.01% | -0.01% | -0.01% | 100% | 100% | -0.02% | 0.01% | -0.03% | 100% | 98% |
| **CE7-1.3c** | -0.01% | -0.02% | -0.01% | 99% | 99% | -0.01% | -0.01% | 0.00% | 100% | 100% | -0.02% | 0.01% | 0.01% | 100% | 98% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Class F** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-1.1** | -0.09% | -0.06% | -0.09% | 103% | 103% | -0.05% | -0.09% | -0.09% | 101% | 104% | -0.13% | -0.09% | -0.15% | 102% | 101% |
| **CE7-1.2a** | -0.10% | -0.07% | -0.06% | 100% | 99% | -0.11% | -0.16% | -0.13% | 99% | 100% | -0.16% | -0.19% | -0.17% | 100% | 97% |
| **CE7-1.2b** | -0.06% | -0.08% | -0.07% | 99% | 96% | -0.13% | -0.07% | -0.01% | 98% | 99% | -0.13% | -0.04% | -0.04% | 99% | 97% |
| **CE7-1.2c** | -1.02% | -0.54% | -0.49% | 98% | 95% | -0.99% | -0.63% | -0.50% | 98% | 98% | -0.48% | -0.41% | -0.38% | 98% | 96% |
| **CE7-1.2c\*** | -1.47% | -0.65% | -0.64% | 99% | 94% | -1.83% | -0.60% | -0.54% | 98% | 97% | -0.67% | -0.47% | -0.51% | 99% | 98% |
| **CE7-1.2d** | -1.33% | -0.71% | -0.71% | 97% | 94% | -1.28% | -0.78% | -0.80% | 98% | 97% | -0.50% | -0.41% | -0.54% | 98% | 98% |
| **CE7-1.2d\*** | -1.56% | -0.78% | -0.80% | 99% | 95% | -2.00% | -0.78% | -0.67% | 98% | 97% | -0.68% | -0.62% | -0.57% | 99% | 97% |
| **CE7-1.3a** | -0.04% | -0.04% | -0.06% | 100% | 100% | -0.08% | -0.11% | -0.10% | 100% | 99% | -0.15% | -0.20% | -0.13% | 101% | 100% |
| **CE7-1.3b** | -0.68% | -0.33% | -0.34% | 99% | 96% | -0.73% | -0.41% | -0.38% | 99% | 99% | -0.43% | -0.32% | -0.29% | 100% | 91% |
| **CE7-1.3b\*** | -1.21% | -0.50% | -0.51% | 99% | 96% | -1.51% | -0.57% | -0.67% | 100% | 99% | -0.49% | -0.28% | -0.27% | 100% | 91% |
| **CE7-1.3c** | -0.68% | -0.32% | -0.33% | 99% | 96% | -0.81% | -0.51% | -0.50% | 99% | 100% | -0.28% | -0.28% | -0.26% | 100% | 91% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **TGM** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-1.1** | -0.27% | -0.25% | -0.25% | 102% | 102% | -0.30% | -0.25% | -0.26% | 102% | 105% | -0.20% | -0.14% | -0.09% | 103% | 99% |
| **CE7-1.2a** | -0.31% | -0.19% | -0.19% | 99% | 102% | -0.20% | -0.21% | -0.26% | 100% | 100% | -0.30% | -0.20% | -0.16% | 100% | 98% |
| **CE7-1.2b** | -0.20% | -0.18% | -0.18% | 99% | 99% | -0.27% | -0.16% | -0.16% | 98% | 96% | -0.14% | -0.18% | -0.08% | 99% | 100% |
| **CE7-1.2c** | -1.82% | -1.47% | -1.47% | 97% | 98% | -2.26% | -1.29% | -1.28% | 98% | 96% | -1.33% | -1.06% | -1.00% | 97% | 99% |
| **CE7-1.2c\*** | -1.53% | -1.15% | -1.14% | 99% | 99% | -2.15% | -0.97% | -0.98% | 98% | 97% | -1.05% | -0.68% | -0.62% | 98% | 99% |
| **CE7-1.2d** | -2.03% | -1.67% | -1.66% | 97% | 98% | -2.56% | -1.32% | -1.30% | 98% | 97% | -1.33% | -1.17% | -1.15% | 97% | 99% |
| **CE7-1.2d\*** | -1.97% | -1.61% | -1.61% | 98% | 99% | -2.63% | -1.31% | -1.35% | 98% | 97% | -1.31% | -1.01% | -0.94% | 98% | 98% |
| **CE7-1.3a** | -0.20% | -0.15% | -0.15% | 100% | 99% | -0.17% | -0.17% | -0.18% | 100% | 99% | -0.20% | -0.11% | -0.05% | 101% | 98% |
| **CE7-1.3b** | -1.27% | -0.95% | -0.96% | 98% | 96% | -1.50% | -0.83% | -0.84% | 99% | 99% | -0.87% | -0.72% | -0.59% | 100% | 86% |
| **CE7-1.3b\*** | -1.41% | -1.03% | -1.02% | 98% | 96% | -2.02% | -0.90% | -0.90% | 100% | 99% | -1.00% | -0.57% | -0.47% | 100% | 85% |
| **CE7-1.3c** | -1.25% | -0.93% | -0.93% | 98% | 96% | -1.43% | -0.78% | -0.82% | 100% | 99% | -0.96% | -0.70% | -0.64% | 100% | 85% |

CE7-1.2c/d and CE7-1.3b are suggested to provide benefit in performing less checks for maximum allowed number of context coded bins in case of TS specific coding. Proponents and cross-checkers to perform more analysis and report back. Revisit.

It is also pointed out that the number of maximum number of context coded bins is still higher in TS specific coding than it is in regular coefficient coding. JVET-P0072 includes additional results on this aspect, and there are also non-CE contributions. Should be resolved at this meeting (was not investigated in CE).

CE7-2

**CE7-2: Summary of tests**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tester** | **Tool** | **Cross checker** |
| CE7-2.1 | S.-T. Hsiang (Mediatek) | CE7-1.1 + Improved context modelling for abs\_gtx\_flags and par\_level\_flag (JVET-O0295) | M. Sarwer (Alibaba) |
| CE7-2.2a | Y.-H. Chao (Qualcomm) | QP dependent binarization (JVET-O0559) | Y. Chen (InterDigital) |
| CE7-2.2b | Y.-H. Chao (Qualcomm) | QP-dependent binarization + varying QP offset (JVET-O0559) | Y. Chen (InterDigital) |

Remarks:

* The starred versions “\*” in the result tables represent alternatives for the corresponding CE tests.

*Table 5: Average test results for CE7-2 and Common Test Conditions (CTC).*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Overall** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-2.1** | 0.00% | -0.02% | -0.01% | 102% | 101% | 0.00% | 0.02% | 0.07% | 103% | 99% | -0.06% | 0.19% | -0.13% | 101% | 100% |
| **CE7-2.2a** | 0.00% | -0.01% | 0.00% | 101% | 101% | 0.01% | 0.06% | 0.06% | 101% | 100% | -0.05% | 0.26% | 0.18% | 100% | 99% |
| **CE7-2.2a\*** | 0.00% | -0.01% | 0.01% | 101% | 101% | 0.00% | -0.01% | 0.04% | 101% | 100% | -0.05% | 0.16% | 0.01% | 100% | 99% |
| **CE7-2.2b** | 0.00% | 0.00% | -0.01% | 100% | 99% | 0.00% | -0.05% | 0.04% | 99% | 100% | 0.08% | 0.05% | -0.05% | 99% | 100% |
| **CE7-2.2b\*** | 0.00% | 0.00% | -0.02% | 100% | 98% | -0.01% | -0.07% | -0.03% | 100% | 99% | 0.01% | 0.12% | 0.14% | 99% | 101% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Class F** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-2.1** | -0.10% | -0.05% | -0.14% | 100% | 97% | -0.08% | -0.11% | -0.06% | 101% | 106% | -0.07% | -0.06% | 0.45% | 100% | 102% |
| **CE7-2.2a** | -0.03% | -0.18% | -0.23% | 102% | 99% | -0.22% | -0.20% | -0.22% | 103% | 100% | -0.13% | 0.12% | 0.40% | 102% | 97% |
| **CE7-2.2a\*** | -0.08% | -0.23% | -0.19% | 102% | 102% | -0.32% | -0.29% | -0.14% | 102% | 100% | -0.07% | 0.28% | 0.32% | 101% | 100% |
| **CE7-2.2b** | -0.14% | -0.28% | -0.05% | 101% | 98% | -0.28% | -0.23% | -0.31% | 100% | 100% | -0.13% | -0.20% | -0.58% | 100% | 101% |
| **CE7-2.2b\*** | -0.20% | -0.24% | -0.07% | 101% | 99% | -0.36% | -0.26% | -0.36% | 99% | 98% | -0.24% | -0.38% | -0.21% | 99% | 96% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **TGM** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-2.1** | -0.19% | -0.16% | -0.14% | 101% | 100% | -0.14% | -0.16% | -0.16% | 102% | 93% | -0.17% | -0.07% | -0.08% | 100% | 100% |
| **CE7-2.2a** | -0.01% | -0.09% | -0.08% | 102% | 103% | -0.11% | -0.14% | -0.13% | 103% | 100% | -0.09% | 0.01% | -0.05% | 98% | 101% |
| **CE7-2.2a\*** | -0.15% | -0.22% | -0.24% | 102% | 100% | -0.24% | -0.21% | -0.26% | 103% | 100% | -0.18% | -0.12% | 0.03% | 99% | 100% |
| **CE7-2.2b** | -0.26% | -0.24% | -0.26% | 102% | 101% | -0.30% | -0.31% | -0.33% | 100% | 100% | -0.14% | -0.14% | -0.10% | 100% | 99% |
| **CE7-2.2b\*** | -0.37% | -0.41% | -0.40% | 101% | 98% | -0.39% | -0.40% | -0.46% | 100% | 99% | -0.25% | -0.19% | -0.10% | 101% | 99% |

*Table 6: Average test results for CE7-2 and low QP (2, 7, 12, 17).*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Overall** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-2.1** | 0.00% | -0.01% | 0.00% | 100% | 100% |  |  |  |  |  | 0.00% | 0.00% | -0.01% | 97% | 96% |
| **CE7-2.2a** | 0.07% | 0.02% | 0.03% | 100% | 99% | 0.02% | 0.01% | 0.00% | 100% | 99% | 0.05% | -0.03% | -0.04% | 100% | 99% |
| **CE7-2.2a\*** | 0.03% | 0.01% | 0.01% | 99% | 98% | 0.00% | 0.00% | -0.01% | 99% | 99% | 0.03% | -0.01% | -0.01% | 99% | 98% |
| **CE7-2.2b** | 0.08% | 0.03% | 0.02% | 100% | 99% | 0.01% | 0.00% | 0.00% | 100% | 100% | 0.04% | 0.00% | -0.01% | 100% | 100% |
| **CE7-2.2b\*** | 0.03% | 0.01% | 0.01% | 100% | 98% | 0.00% | 0.00% | 0.00% | 100% | 101% | 0.02% | 0.00% | -0.01% | 99% | 98% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Class F** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-2.1** | -0.12% | -0.09% | -0.10% | 102% | 101% | -0.26% | -0.29% | -0.30% | 101% | 102% | -0.06% | -0.06% | -0.03% | 100% | 99% |
| **CE7-2.2a** | -1.01% | -1.57% | -1.60% | 101% | 96% | -1.04% | -1.71% | -1.65% | 100% | 101% | -1.06% | -1.00% | -1.05% | 101% | 100% |
| **CE7-2.2a\*** | -2.06% | -1.57% | -1.54% | 99% | 96% | -1.76% | -1.68% | -1.55% | 99% | 99% | -1.13% | -1.05% | -1.06% | 99% | 98% |
| **CE7-2.2b** | -1.46% | -1.57% | -1.53% | 101% | 98% | -1.64% | -1.67% | -1.71% | 101% | 102% | -1.10% | -1.10% | -1.18% | 100% | 102% |
| **CE7-2.2b\*** | -1.72% | -1.61% | -1.57% | 99% | 97% | -1.92% | -1.74% | -1.77% | 100% | 100% | -1.04% | -1.08% | -1.13% | 99% | 100% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **TGM** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-2.1** | -0.32% | -0.26% | -0.25% | 102% | 102% | -0.31% | -0.25% | -0.23% | 100% | 99% | -0.28% | -0.15% | -0.09% | 102% | 97% |
| **CE7-2.2a** | -5.60% | -4.88% | -4.86% | 101% | 98% | -5.28% | -3.92% | -3.94% | 101% | 99% | -3.56% | -2.89% | -2.85% | 102% | 101% |
| **CE7-2.2a\*** | -5.43% | -4.74% | -4.74% | 100% | 97% | -5.36% | -3.67% | -3.66% | 100% | 97% | -3.41% | -2.94% | -2.90% | 100% | 99% |
| **CE7-2.2b** | -5.69% | -4.96% | -4.97% | 102% | 97% | -4.62% | -3.90% | -3.88% | 102% | 100% | -3.51% | -3.10% | -3.14% | 101% | 99% |
| **CE7-2.2b\*** | -5.51% | -4.82% | -4.80% | 101% | 94% | -4.49% | -3.74% | -3.72% | 100% | 97% | -3.30% | -2.93% | -2.94% | 101% | 102% |

Modifications only for TS specific entropy coding case

CE7-2.1 requires an additional coding pass.

The proposed methods show no benefit in CTC for camera captured content, and small benefit for screen content in CTC range of QPs.

For low QP, this stays similar for CE7-2.1, whereas CE7-2.2 (QP dependent binarization in TS) has small loss for natural coding, while the gain is significant for screen content.

From the results of the CE, no immediate action, behavior of CE7-2.2 needs to be better understood (is it specifically good on screen content only?).

It is reported that the methods are also investigated in the context of lossless coding in the AHG18 investigation.

CE7-3

**CE7-3: Summary of tests**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tester** | **Tool** | **Cross checker** |
| CE7-3.1a | S.-T. Hsiang (Mediatek) | Context reduction for sig\_coeff\_flag (JVET-O0928) on 6 context subsets | C. Auyeung (Tencent) |
| CE7-3.1b | S.-T. Hsiang (Mediatek) | Context reduction for sig\_coeff\_flag (JVET-O0928) on 9 context subsets | M. Sarwer (Alibaba) |
| CE7-3.2 | F. Le Léannec (InterDigital) | Context reduction by reducing the template for chroma blocks (JVET-O1098) | Y.-H. Chao (Qualcomm) |
| CE7-3.3a | S.-T. Hsiang (Mediatek),  F. Le Léannec (InterDigital) | Combination of CE7-3.1a and CE7-3.2 | Y.-H. Chao (Qualcomm) |
| CE7-3.3b | S.-T. Hsiang (Mediatek),  F. Le Léannec (InterDigital) | Combination of CE7-3.1b and CE7-3.2 | Y.-H. Chao (Qualcomm) |

Remarks:

* For the starred versions “\*” in the result tables, the CABAC initialization tables have been retrained (despite of that nothing was modified).

*Table 9: Average test results for CE7-3 and Common Test Conditions (CTC).*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Overall** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-3.1a** | 0.01% | -0.04% | 0.00% | 102% | 103% | 0.02% | 0.02% | 0.07% | 103% | 100% | -0.05% | 0.43% | -0.25% | 102% | 101% |
| **CE7-3.1b** | 0.02% | -0.05% | -0.03% | 103% | 102% | 0.01% | 0.02% | 0.06% | 103% | 100% | 0.00% | 0.05% | 0.10% | 101% | 99% |
| **CE7-3.2** | 0.01% | 0.17% | 0.21% | 103% | 103% | 0.02% | 0.22% | 0.20% | 99% | 103% | -0.02% | 0.17% | 0.03% | 106% | 108% |
| **CE7-3.2\*** | 0.00% | 0.26% | 0.24% | 103% | 104% | 0.01% | 0.32% | 0.26% | 99% | 103% | -0.03% | 0.39% | 0.26% | 100% | 100% |
| **CE7-3.3a** | 0.02% | 0.18% | 0.14% | 105% | 104% | 0.00% | 0.19% | 0.21% | 101% | 102% | -0.03% | 0.30% | 0.15% | 101% | 101% |
| **CE7-3.3a\*** | 0.01% | 0.22% | 0.27% | 101% | 101% | -0.01% | 0.33% | 0.36% | 101% | 103% | -0.06% | 0.50% | 0.11% | 101% | 101% |
| **CE7-3.3b** | 0.03% | 0.12% | 0.16% | 104% | 104% | 0.01% | 0.15% | 0.16% | 101% | 103% | -0.02% | 0.12% | 0.09% | 103% | 102% |
| **CE7-3.3b\*** | 0.02% | 0.22% | 0.25% | 102% | 101% | 0.00% | 0.30% | 0.29% | 101% | 103% | -0.01% | 0.30% | 0.39% | 101% | 102% |

*Table 10: Average test results for CE7-3 and low QP (2, 7, 12, 17).*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Overall** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-3.1a** | 0.01% | -0.01% | -0.01% | 101% | 100% | 0.01% | -0.01% | -0.02% | 102% | 100% | 0.01% | -0.01% | -0.01% | 99% | 98% |
| **CE7-3.1b** | 0.02% | -0.01% | 0.01% | 102% | 102% | 0.04% | -0.08% | -0.05% | 102% | 101% | 0.03% | -0.09% | -0.02% | 99% | 97% |
| **CE7-3.2** | 0.09% | 0.59% | 0.61% | 96% | 99% | 0.04% | 0.25% | 0.23% | 98% | 98% | 0.02% | 0.16% | 0.18% | 102% | 102% |
| **CE7-3.2\*** | 0.08% | 0.58% | 0.62% | 99% | 101% | 0.03% | 0.27% | 0.24% | 103% | 102% | 0.02% | 0.23% | 0.18% | 93% | 92% |
| **CE7-3.3a** | 0.10% | 0.59% | 0.61% | 99% | 100% | 0.05% | 0.23% | 0.23% | 104% | 101% | 0.03% | 0.17% | 0.17% | 94% | 94% |
| **CE7-3.3a\*** | 0.08% | 0.60% | 0.63% | 101% | 103% | 0.02% | 0.31% | 0.27% | 104% | 103% | 0.01% | 0.28% | 0.21% | 94% | 93% |
| **CE7-3.3b** | 0.12% | 0.55% | 0.61% | 101% | 103% | 0.08% | 0.17% | 0.19% | 104% | 102% | 0.06% | 0.08% | 0.13% | 93% | 94% |
| **CE7-3.3b\*** | 0.10% | 0.57% | 0.63% | 100% | 103% | 0.06% | 0.24% | 0.23% | 102% | 102% | 0.04% | 0.20% | 0.16% | 95% | 94% |

This relates to regular TC coding.

CE7-3.1 reduces number of context models, but makes calculation of context index more complicated (which is somehow reflected in the increased encoding and decoding time).

CE7-3.2 reduces the number of context models for chroma, but shows loss in particular for the low QP range.

Number of context models is not a critical issue – no need for action.

CE7-4

**CE7-4: Summary of tests**

|  |  |  |  |
| --- | --- | --- | --- |
| CE7-4.1 | S. Esenlik (Huawei) | Coding of chroma cbf’s and joint chroma residual coding flag (JVET-O0231) | C. Helmrich (HHI) |

Remarks:

* For the starred versions “\*” in the result tables, the Lagrange parameter was modified (no changes on normative aspects).

*Table 11: Average test results for CE7-4, Common Test Conditions (CTC) and low QP (2, 7, 12, 13).*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CTC** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-4.1** | 0.08% | -0.67% | -0.48% | 103% | 103% | 0.14% | -1.15% | -1.39% | 103% | 102% | 0.03% | -0.41% | -2.08% | 103% | 102% |
| **CE7-4.1\*** | 0.08% | -0.67% | -0.48% | 100% | 100% | 0.01% | -0.52% | -0.89% | 100% | 100% | -0.06% | 1.37% | -0.64% | 100% | 100% |
| **CE7-4.1+** | 0.02% | -0.10% | 0.02% | 102% | 98% | 0.02% | -0.33% | -0.74% | 101% | 97% | 0.02% | 0.42% | -1.35% | 101% | 93% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **lowQP** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec | Y | Cb | Cr | Enc | Dec |
| **CE7-4.1** | 0.04% | 0.03% | -0.01% | 101% | 99% | 0.08% | -0.07% | -0.16% | 101% | 99% | 0.05% | 0.22% | -0.40% | 101% | 99% |

Note: The version “CE7-4.1+” represents a test with lambda tuning (the one used in joint CbCr coding) done by the cross checker independently (different lambda tuning than that of the proponent).

*Table 12: Average test results for CE7-4 and HDR.*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **AI** |  |  | **wPSNR** | | | **PSNR** | | |  |  |
| DE100 | L100 | Y | Cb | Cr | Y | Cb | Cr | Enc | Dec |
| **CE7-4.1** | -1.46% | 0.13% | 0.13% | -1.01% | -4.27% | 0.11% | -0.53% | -4.08% | 100% | 100% |
| **CE7-4.1+** | -0.90% | 0.07% | 0.07% | 0.40% | -2.20% | 0.05% | 0.63% | -2.36% | 100% | 101% |
|  |  |  |  |  |  |  |  |  |  |  |
| **RA** |  |  | **wPSNR** | | | **PSNR** | | |  |  |
| DE100 | L100 | Y | Cb | Cr | Y | Cb | Cr | Enc | Dec |
| **CE7-4.1** | -1.36% | 0.07% | 0.09% | -1.33% | -5.14% | 0.08% | -0.53% | -5.14% | 100% | 100% |
| CE7-4.1+ | -0.81% | 0.04% | 0.02% | 0.41% | -3.01% | 0.03% | 0.86% | -3.49% | 100% | 102% |

Note: The DE100 and L100 data are taken from the cross checker. The version “CE7-4.1+” represents a test with lambda tuning done by the cross checker.

The method is coding 3 flags instead of two, but the number of context coded bins is not increased (reduced on average if both Cb and Cr are zero). Due to the fact that selecting both Cb and Cr to be coded is cheaper, more rate would go into chroma (which explains the slight shift of bits from luma to chroma in the results above). In the results “7-4.1+” the cross-checkers tried to align this by changing lambda in RDO. This indicates that still benefit remains (at least in RA). However, one expert mentions that some effects of that specific lambda may interfere with the QP difference table that was adopted in the last meeting. It is notes that this may also be the reason that the coding gain is lower now than it was in the last meeting.

It is also not clear if this would have benefit in case of 4:4:4 coding.

Benefit is very low, and no support expressed by other experts.

No action.

[JVET-P0046](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7835) CE7-1.1 and CE7-2.1: Improving transform skip residual coding [S.-T. Hsiang, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)

[JVET-P0047](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7836) CE7-3.1: Context reduction for sig\_coeff\_flag [S.-T. Hsiang, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0049](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7838) CE7-4.1: Coding of chroma cbf flags [S. Esenlik, B. Wang, A. M. Kotra, H. Gao, E. Alshina (Huawei)]

[JVET-P0066](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7855) CE7-3.2: Context reduction by reduced usage of local neighbourhood [Y. Chen, F. Le Léannec, T. Poirier, F. Galpin (InterDigital)]

[JVET-P0067](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7856) CE7-3.3: Context reduction for sig\_coeff\_flag, par\_level\_flag, abs\_level\_gtx\_flag [Y. Chen, F. Le Léannec, T. Poirier, F. Galpin (Intedigital), S.-T. Hsiang, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0072](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7861) CE7-1.3: Simplification of transform-skip residual coding [M. G. Sarwer, R. -L. Liao, J. Luo, Y. Ye (Alibaba)]

[JVET-P0076](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7865) CE7-2.2: QP dependent binarization in TS residual coding [M. Karczewicz, H. Wang, Y.-H. Chao, M. Coban (Qualcomm)]

[JVET-P0079](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7868) CE7: Modifications to transform-skip residual coding (CE7-1.2) [M. Karczewicz, H. Wang, Y.-H. Chao, M. Coban (Qualcomm)]

## CE8: Screen content coding tools (6)

Contributions in this category were discussed Friday 4 Oct. 1130–1300 in Track A (chaired by JRO).

[JVET-P0028](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8287) CE8: Summary Report on 4:4:4 Screen Content Coding Tools [X. Xu, Y.-C. Chao, Y.-C. Sun, J. Xu]

This contribution provides a summary report of Core Experiment 8 on 4:4:4 screen content coding tools. 5 tests have been tested in CE8 in between JVET-O and JVET-P meetings, to study and evaluate technologies related to 4:4:4 screen content coding. In this report, coding performance and complexity of these tests are reported and analyzed. In particular, test results against VTM-6.0 anchors (4:4:4 settings) are provided to show the coding efficiency and complexity trade-off of each tool. Some of the tests are also evaluated under low QPs testing conditions. Crosschecking results for the performed tests are integrated in this contribution.

|  |  |  |  |
| --- | --- | --- | --- |
| **Test** | **Tester** | **Document** | **Tool description** |
| CE8-1.1 | Y.-C. Sun  (Alibaba) | JVET-P0060 | Palette mode neighboring pixel copy |
| CE8-1.2 | W. Zhu  (ByteDance) | JVET-P0055 | Palette and IBC combination |
| CE8-1.3 | Y.-H. Chao  (Qualcomm) | JVET-P0077 | Line-based CG Palette mode |
| CE8-2.1 | T. Tsukuba,  M. Ikeda, Y. Yagasaki (Sony) | JVET-P0058 | Chroma TS support with limited maximum number of TS residual context-coded bins |
| CE8-4.1 | F. Henry (Orange)  T. Tsukuba (Sony) | JVET-P0059 | Chroma TS and BDPCM support |

Note: In addition to 4:4:4 Testing condition with normal QP range, tests of CE8-2 and CE8-4 should be performed for low QP cases (2, 7, 12, 17) for 1st 100 frames of each sequence, which are also used in CE7 tests.

Note also that one element in CE8-4.1 is the chroma support of BDPCM. The original test was withdrawn but the combination with CE8-2.1 is still tested. This was reflected in the CE description JVET-O2028 v4.

The detailed description of each tools is provided in the next section.

The followings are summary tables of the tests in this CE.

Table 3: CE8 test results with VTM-6.0+IBC=1+PLT=1+DualTree=1

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **AI Over VTM-6.0** | | | | | | **RA Over VTM-6.0** | | | | | |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | | **U** | **V** | **EncT** | **DecT** |
| TGM 1080p | CE8-1.1 | -1.03% | -1.44% | -1.53% | 103% | 101% | -0.89% | | -1.44% | -1.20% | 101% | 97% |
| CE8-1.2 | -0.33% | 0.00% | -0.04% | 127% | 102% | -0.42% | | -0.25% | -0.19% | 114% | 102% |
| CE8-1.3 | -0.95% | -0.18% | -0.09% | 107% | 100% | -0.27% | | -0.06% | 0.22% | 105% | 100% |
| CE8-2.1 | -0.74% | -0.75% | -1.51% | 109% | 100% | -0.45% | | -2.36% | -2.53% | 110% | 102% |
| CE8-4.1 | -0.61% | -1.04% | -1.54% | 117% | 98% | -0.44% | | -2.62% | -2.66% | 112% | 102% |
| TGM 720p | CE8-1.1 | 0.03% | 0.07% | 0.15% | 102% | 97% | -0.05% | | -0.41% | -0.53% | 101% | 101% |
| CE8-1.2 | 0.02% | -0.01% | -0.12% | 127% | 100% | -0.05% | | -0.15% | -0.09% | 113% | 105% |
| CE8-1.3 | -0.47% | 0.03% | 0.29% | 105% | 100% | -0.49% | | 0.35% | 0.58% | 103% | 102% |
| CE8-2.1 | 0.24% | -0.68% | -0.54% | 105% | 99% | 0.07% | | -1.25% | -1.29% | 105% | 100% |
| CE8-4.1 | 0.31% | -0.57% | -0.44% | 110% | 96% | 0.31% | | -1.28% | -1.17% | 107% | 100% |
| Animation | CE8-1.1 | 0.07% | 0.05% | 0.09% | 99% | 97% | -0.11% | | -0.27% | -0.22% | 101% | 102% |
| CE8-1.2 | 0.00% | 0.00% | 0.04% | 132% | 102% | 0.04% | | 0.01% | -0.01% | 114% | 103% |
| CE8-1.3 | -0.14% | 0.11% | 0.05% | 104% | 100% | -0.26% | | -0.16% | -0.16% | 105% | 101% |
| CE8-2.1 | -0.11% | -0.79% | -0.32% | 105% | 100% | 0.17% | | -1.46% | -0.64% | 105% | 99% |
| CE8-4.1 | 0.38% | -0.33% | 0.27% | 110% | 97% | 0.40% | | -1.21% | -0.36% | 107% | 98% |
| Mixed Content | CE8-1.1 | -0.05% | -0.06% | -0.01% | 100% | 99% | 0.05% | | -0.32% | 0.04% | 100% | 99% |
| CE8-1.2 | 0.00% | -0.01% | 0.05% | 128% | 101% | 0.00% | | 0.01% | 0.04% | 112% | 100% |
| CE8-1.3 | -0.94% | -0.37% | -0.82% | 104% | 99% | -0.63% | | -0.14% | -0.48% | 104% | 100% |
| CE8-2.1 | -0.37% | -0.88% | -1.46% | 105% | 100% | -0.20% | | -2.14% | -2.48% | 104% | 99% |
| CE8-4.1 | -0.55% | -1.11% | -1.80% | 113% | 98% | -0.10% | | -2.54% | -2.65% | 105% | 99% |
| Camera-Captured | CE8-1.1 | -0.01% | 0.05% | -0.01% | 100% | 98% | -0.02% | | 0.01% | 0.08% | 99% | 101% |
| CE8-1.2 | 0.00% | 0.06% | -0.01% | 131% | 101% | 0.00% | | 0.09% | 0.11% | 113% | 102% |
| CE8-1.3 | 0.00% | 0.02% | 0.01% | 106% | 101% | -0.02% | | 0.01% | 0.05% | 102% | 100% |
| CE8-2.1 | 0.08% | 0.26% | 0.19% | 107% | 102% | 0.00% | | 0.25% | 0.15% | 103% | 101% |
| CE8-4.1 | 0.13% | 0.66% | 0.68% | 111% | 100% | 0.06% | | 0.34% | 0.48% | 105% | 102% |

Table 4: CE8 test results with VTM-6.0+IBC=1+PLT=1+DualTree=0

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **AI Over VTM-6.0** | | | | | | **RA Over VTM-6.0** | | | | | |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | | **U** | **V** | **EncT** | **DecT** |
| TGM 1080p | CE8-1.1 | -1.66% | -1.88% | -1.95% | 102% | 102% | -1.13% | | -1.24% | -1.24% | 99% | 96% |
| CE8-1.2 | -1.31% | -1.55% | -1.69% | 124% | 103% | -0.94% | | -1.01% | -0.78% | 113% | 101% |
| CE8-1.3 | 0.03% | -0.23% | -0.16% | 103% | 99% | -0.12% | | -1.00% | -0.01% | 103% | 101% |
| CE8-2.1 | 0.46% | -1.58% | -1.69% | 115% | 100% | -0.36% | | -3.13% | -3.37% | 111% | 100% |
| CE8-4.1 | 0.71% | -1.87% | -1.95% | 121% | 98% | -0.21% | | -3.20% | -3.21% | 113% | 100% |
| TGM 720p | CE8-1.1 | 0.08% | -0.07% | -0.32% | 102% | 100% | -0.23% | | -0.20% | -0.13% | 101% | 101% |
| CE8-1.2 | -0.02% | -0.45% | -0.61% | 123% | 101% | -0.40% | | -0.80% | -0.68% | 114% | 103% |
| CE8-1.3 | -0.07% | -0.42% | 0.33% | 101% | 99% | -0.18% | | -0.01% | -0.15% | 102% | 101% |
| CE8-2.1 | 0.82% | -1.36% | -0.73% | 111% | 101% | 0.22% | | -2.38% | -1.51% | 107% | 100% |
| CE8-4.1 | 1.51% | -1.52% | -1.06% | 117% | 100% | 0.66% | | -2.81% | -1.73% | 109% | 100% |
| Animation | CE8-1.1 | 0.06% | 0.13% | 0.18% | 101% | 100% | -0.28% | | -0.25% | -0.21% | 101% | 100% |
| CE8-1.2 | 0.01% | 0.04% | 0.06% | 125% | 99% | -0.04% | | -0.08% | -0.04% | 114% | 101% |
| CE8-1.3 | 0.07% | 0.19% | 0.45% | 102% | 100% | -0.28% | | -0.21% | -0.20% | 105% | 100% |
| CE8-2.1 | 0.23% | -0.36% | 0.06% | 109% | 100% | 0.20% | | -1.21% | -0.43% | 107% | 100% |
| CE8-4.1 | 0.46% | -0.57% | -0.24% | 114% | 100% | 0.31% | | -1.36% | -0.68% | 109% | 100% |
| Mixed Content | CE8-1.1 | -0.36% | -1.04% | -1.06% | 100% | 97% | -0.28% | | -0.80% | -0.87% | 100% | 100% |
| CE8-1.2 | -0.21% | -1.02% | -0.93% | 125% | 102% | -0.31% | | -0.38% | -0.62% | 112% | 101% |
| CE8-1.3 | -0.35% | -0.57% | -0.74% | 103% | 99% | -0.32% | | -1.35% | -1.71% | 104% | 100% |
| CE8-2.1 | -0.15% | -3.69% | -4.03% | 111% | 100% | -0.91% | | -5.18% | -5.38% | 106% | 100% |
| CE8-4.1 | 0.67% | -4.04% | -4.22% | 117% | 98% | -0.52% | | -6.06% | -6.20% | 107% | 100% |
| Camera-Captured | CE8-1.1 | 0.00% | 0.00% | 0.00% | 99% | 100% | 0.00% | | 0.00% | 0.01% | 100% | 99% |
| CE8-1.2 | 0.00% | 0.00% | 0.00% | 127% | 101% | 0.00% | | 0.00% | 0.01% | 113% | 103% |
| CE8-1.3 | 0.00% | 0.00% | 0.00% | 101% | 100% | 0.00% | | -0.01% | -0.01% | 100% | 101% |
| CE8-2.1 | 0.02% | 0.45% | 0.22% | 108% | 100% | 0.04% | | 0.30% | 0.24% | 104% | 100% |
| CE8-4.1 | 0.24% | 0.31% | 0.15% | 114% | 101% | 0.08% | | 0.26% | 0.02% | 106% | 101% |

Table 5: CE8 test results with VTM-6.0+IBC=1+PLT=1+DualTree=1, LowQP

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **AI Over VTM-6.0** | | | | | | **RA Over VTM-6.0** | | | | | |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | | **U** | **V** | **EncT** | **DecT** |
| TGM 1080p | CE8-1.1 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.2 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.3 | 0.21% | -1.18% | -1.38% | 107% | 102% | 0.11% | | -0.51% | -0.45% | 102% | 101% |
| CE8-2.1 | -0.12% | -3.00% | -3.10% | 115% | 103% | -4.07% | | -6.57% | -6.85% | 112% | 97% |
| CE8-4.1 | -0.71% | -4.08% | -3.96% | 117% | 98% | -4.22% | | -7.28% | -7.56% | 113% | 97% |
| TGM 720p | CE8-1.1 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.2 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.3 | -0.67% | -0.84% | -0.82% | 104% | 101% | -0.27% | | -0.21% | -0.15% | 102% | 106% |
| CE8-2.1 | -0.07% | -2.50% | -2.49% | 112% | 102% | 0.38% | | -4.95% | -5.21% | 107% | 100% |
| CE8-4.1 | -0.57% | -3.16% | -3.03% | 117% | 101% | 0.60% | | -8.31% | -8.47% | 111% | 101% |
| Animation | CE8-1.1 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.2 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.3 | -0.65% | -0.98% | -1.00% | 103% | 100% | 0.16% | | -0.32% | -0.21% | 101% | 101% |
| CE8-2.1 | -0.24% | -3.68% | -2.48% | 108% | 101% | -2.39% | | -8.29% | -7.37% | 110% | 98% |
| CE8-4.1 | -0.36% | -4.20% | -3.00% | 114% | 99% | -2.45% | | -8.68% | -7.77% | 110% | 98% |
| Mixed Content | CE8-1.1 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.2 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.3 | -1.02% | -2.53% | -2.59% | 103% | 97% | -0.02% | | -2.80% | -3.06% | 102% | 99% |
| CE8-2.1 | 0.59% | -5.25% | -5.98% | 112% | 102% | 1.06% | | -13.79% | -14.87% | 108% | 97% |
| CE8-4.1 | 0.10% | -5.97% | -6.70% | 123% | 103% | 1.41% | | -18.67% | -19.61% | 109% | 96% |
| Camera-Captured | CE8-1.1 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.2 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.3 | 0.00% | 0.00% | 0.00% | 101% | 100% | -0.01% | | 0.02% | -0.04% | 100% | 101% |
| CE8-2.1 | 0.03% | -0.04% | 0.00% | 106% | 101% | -0.04% | | -0.08% | -0.47% | 105% | 101% |
| CE8-4.1 | 0.02% | -0.03% | 0.00% | 111% | 99% | -0.03% | | -0.09% | -0.43% | 106% | 100% |

Table 6: CE8 test results with VTM-6.0+IBC=1+PLT=1+DualTree=0, LowQP

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **AI Over VTM-6.0** | | | | | | **RA Over VTM-6.0** | | | | | |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | | **U** | **V** | **EncT** | **DecT** |
| TGM 1080p | CE8-1.1 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.2 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.3 | -1.40% | -1.96% | -1.82% | 103% | 99% | -0.28% | | -0.98% | -0.81% | 102% | 102% |
| CE8-2.1 | -4.48% | -5.32% | -5.71% | 120% | 101% | -6.03% | | -8.10% | -8.63% | 114% | 98% |
| CE8-4.1 | -4.77% | -5.67% | -6.09% | 124% | 99% | -6.40% | | -9.36% | -9.84% | 116% | 99% |
| TGM 720p | CE8-1.1 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.2 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.3 | -0.83% | -0.87% | -0.81% | 102% | 102% | -0.40% | | -0.53% | -0.56% | 101% | 108% |
| CE8-2.1 | -1.45% | -3.16% | -3.07% | 115% | 101% | -1.15% | | -6.29% | -6.77% | 109% | 99% |
| CE8-4.1 | -1.61% | -3.66% | -3.49% | 119% | 99% | -1.15% | | -9.33% | -9.98% | 111% | 99% |
| Animation | CE8-1.1 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.2 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.3 | -0.37% | -1.14% | -1.25% | 101% | 98% | 0.20% | | -0.44% | -0.44% | 101% | 99% |
| CE8-2.1 | -0.20% | -3.12% | -2.01% | 111% | 101% | -2.47% | | -8.32% | -7.30% | 110% | 98% |
| CE8-4.1 | -0.25% | -3.82% | -2.46% | 116% | 100% | -2.39% | | -8.31% | -7.66% | 112% | 98% |
| Mixed Content | CE8-1.1 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.2 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.3 | -1.04% | -1.66% | -1.79% | 102% | 98% | -0.37% | | -1.18% | -1.36% | 101% | 101% |
| CE8-2.1 | -3.38% | -6.97% | -7.83% | 117% | 99% | -1.07% | | -12.81% | -13.63% | 108% | 94% |
| CE8-4.1 | -3.56% | -7.42% | -8.39% | 122% | 98% | -1.38% | | -17.59% | -18.37% | 107% | 90% |
| Camera-Captured | CE8-1.1 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.2 |  |  |  |  |  |  | |  |  |  |  |
| CE8-1.3 | 0.00% | 0.00% | 0.00% | 100% | 99% | 0.01% | | -0.01% | 0.02% | 99% | 100% |
| CE8-2.1 | 0.03% | -0.02% | -0.01% | 107% | 99% | -0.01% | | -0.10% | -0.39% | 105% | 99% |
| CE8-4.1 | 0.03% | -0.01% | -0.02% | 112% | 100% | 0.00% | | -0.11% | -0.43% | 105% | 98% |

It is verbally reported that the base palette mode gives gives approx. 18% for TGM 1080p for the dual tree off case. For dual tree on, the gain is 16%. Dual tree off has about 28% gain for that class. It is noted that the benefit of disabling dual tree is only observed for 4:4:4 screen content. For camera captured 4:4:4, dual tree is still better. Compared to that, the additional benefit of those palette proposals targeting better compression by adding more palette options (8-1.1 and 8-1.2) is relatively low. Not sufficient benefit to take action.

8-1.3 allows handling of groups of 16 samples, such that reconstruction can already start before the palette indexes of the whole CU are decoded (escape flags are coded after the group of 16 samples, which is the same interleaving of context coded and bypass coded bins as in the current palette when Cus have size 4x4). The method also replaces the run length coding by signalling the identity or not-identity with the previous sample. It is noted that the worst case of context is not increased (it is 2 per pixel, but this is still less than for the case of transform coding, as in case of single tree all three component samples are covered, and in case of dual tree, the chroma components are coded jointly). Worst case number of context coded bins is less in palette than in residual coding for the 4:4:4 case.

It is asked why this method has benefit in compression. Proponents report that they have performed encoder optimization (RD decision) which can be implemented simpler due to the sample wise decision and would be more difficult with run length coding. The encoder run time increases by around 3% on average. Has also advantage on other classes than TGM 1080.

The method has advantages in terms of buffer saving, and better pipelining of reconstruction.

Decision: Adopt JVET-P0077.

CE8-2.1 enables transform skip and a variant of TS residual coding (with 1.75 maximum number of context coded bins) for the chroma components. In particular for RA case and low QP range, this shows gain for the screen content sequences.

It is suggested that enabling TS for chroma in case of 4:4:4 coding is useful for design consistency, in particular when RGB is encoded.

Decision: Adopt the aspect of JVET-P0058 that TS is enabled for chroma in the case of 4:4:4. This does not include the aspect of the modified bin limit in TS residual coding (which is to be further discussed in context of non-CE). The syntax shall also include an SPS flag to turn it off.

CE8-4.1 additionally enables BDPCM along with TS. This gives some additional gain for some classes of screen content. It was reported reported in the last meeting that the gain in case of RGB would be larger (JVET-O0166), whereas the CE only tested YCbCr 4:4:4 content. It is suggested during the discussion that enabling BDPCM for chroma in case of 4:4:4 coding is useful for design consistency, and would be useful in particular when RGB is encoded.

Decision: Adopt the aspect of JVET-P0059 that BDPCM is enabled for chroma in the case of 4:4:4. The syntax shall also include an SPS flag to turn it off.

[JVET-P0055](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7844) CE8-1.2: Compound Palette Mode [W. Zhu, J. Xu, L. Zhang, K. Zhang, H. Liu, Y. Wang (Bytedance)]

In this test, a combined IBC/Palette mode is tested. A special palette index indicates that the predictor for the current sample is copied from IBC prediction. Otherwise the sample is from palette predictor.

In this test, the first available merge candidate is always employed to generate the IBC prediction. Therefore, the signalling of IBC motion information could be avoided to reduce the overhead bits.

[JVET-P0058](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7847) CE8-2.1: Transform Skip for Chroma with limiting maximum number of context-coded bin in TS residual coding [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

In this test, chroma transform skip (TS) is introduced and evaluated. The motivation is to unify TS and MTS signaling between luma and chroma by relocating transform\_skip\_flag and mts\_idx into residual\_coding part. One context model is added for chroma TS. No context model and no binarization are changed for the mts\_idx.

In addition, TS residual coding is also applied when chroma TS is used. According to the meeting note (JVET-O\_Notes\_dB sec 5.8 CE:8 Screen content coding tools), there is a concern on the maximum number of context coded bins in the TS residual coding. Therefore, the maximum number of context-coded bins in TS residual coding is limited to the same maximum number of non-TS residual coding (1.75 per coefficient).

**Semantics**

transform\_skip\_flag[ x0 ][ y0 ][ cIdx ] specifies whether a transform is applied to the associated ~~luma~~ transform block or not. The array indices x0, y0 specify the location ( x0, y0 ) of the top-left luma sample of the considered transform block relative to the top-left luma sample of the picture. transform\_skip\_flag[ x0 ][ y0 ][ cIdx ] equal to 1 specifies that no transform is applied to the current ~~luma~~ transform block. The array index cIdx specifies an indicator for the colour component; it is equal to 0 for luma, equal to 1 for Cb and equal to 2 for Cr. transform\_skip\_flag[ x0 ][ y0 ][ cIdx ] equal to 0 specifies that the decision whether transform is applied to the current transform block or not depends on other syntax elements. When transform\_skip\_flag[ x0 ][ y0 ][ cIdx ] is not present, it is inferred to be equal to 0.

mts\_idx[ x0 ][ y0 ][ cIdx ] specifies which transform kernels are applied to the residual samples along the horizontal and vertical direction of the associated ~~luma~~ transform block. The array indices x0, y0 specify the location ( x0, y0 ) of the top-left luma sample of the considered transform block relative to the top-left luma sample of the picture. The array index cIdx specifies an indicator for the colour component; it is equal to 0 for luma, equal to 1 for Cb and equal to 2 for Cr.

When mts\_idx[ x0 ][ y0 ][ cIdx ] is not present, it is inferred to be equal to 0.

If ChromaArrayType is larger than 0, mts\_idx[ x0 ][ y0 ][ 1] and mts\_idx[ x0 ][ y0 ][ 2] shall be equal to 0.

[JVET-P0059](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7848) CE8-4.1: BDPCM and Transform skip for Chroma [G. Clare (bcom), F. Henry (Orange), T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

In this CE test, in addition to chroma TS support as in CE8-2.1, BDPCM is added to chroma components.

In this test the use of BDPCM and Transform skip on the chroma components is to be tested as a straightforward evolution of the current luma-only BDPCM.

If sps\_bdpcm\_enable\_flag is 1, a further syntax element **sps\_bdpcm\_chroma\_enable\_flag** is added to the SPS.

The flags have the following behaviour, as indicated in table 1

|  |  |  |
| --- | --- | --- |
| **sps\_bdpcm\_enable\_flag** | **sps\_bdpcm\_chroma\_enable\_flag** | behaviour |
| 0 | not written | BPDCM is not used in the sequence |
| 1 | 0 | BDPCM is available for luma only |
| 1 | 1 | BDPCM is available for luma and chroma |

When BDPCM is available for luma only, the current behaviour is unchanged.

When BDPCM is also available for chroma, a **bdpcm\_chroma\_flag** is sent for each chroma block. This indicates whether BDPCM is used on the chroma blocks. When it is on, BDPCM is used for both chroma components, and an additional **bdpcm\_dir\_chroma** flag is coded, indicating the prediction direction used for both chroma components.

The deblocking filter is de-activated on a border between two Block-DPCM blocks, since neither of the blocks uses the transform stage usually responsible for blocking artifacts. This deactivation happens independently for luma and chroma components. A bdpcm deblocking bugfix (ticket #295) was also applied for the test as part of these bdpcm-chroma deblocking changes.

[JVET-P0060](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7849) CE8-1.1: Palette mode with neighboring pixel copy [Y.-C. Sun, T.-S. Chang, J. Lou (Alibaba)]

Palette mode with neighboring pixel copy

In this test, the method combining palette mode and neighboring pixel copy is tested. The new combined mode is disabled for small size CUs in order to reduce implementation complexity. If a CU is coded by palette mode, a flag (intra\_palette) is first encoded to indicate whether the neighboring pixel copy combination is used. If the flag is turned on, a pred\_dir flag is then signaled indicating whether horizontal or vertical intra prediction in used. On the decoder side, the decoder first decodes a palette and an index map. A specific index (0) is reserved to indicate the sample is reconstructed from intra prediction. When decoder reconstruct the palette coded block, samples with the index, 0, are reconstructed by the horizontal or vertical nearest samples across CU boundary, and samples with other indices are reconstructed by the colors in the palette. Figure 1 shows an example.



(a) vertical intra prediction combination (b) horizontal intra prediction combination

Figure 1. An example of palette mode and horizontal/vertical intra prediction combination.

[JVET-P0077](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7866) CE8-1.3: Line-based CG Palette Mode [Y.-H. Chao, C.-H. Hung, W.-J. Chien, T. Hsieh, M. Karczewicz (Qualcomm)]

In this CE, a line-based CG palette mode, which reduces the buffer to store index values, index maps in HEVC palette mode, is tested. A palette mode coded CU is divided into multiple line segments (line coefficient group (CG)) of *m* samples based on the traverse scan mode, as shown in Figure 2. The coefficient parsing, i.e., parsing the index runs, palette index values, and quantized colors, are done sequentially for each line CG.

The parsing of the palette index run in each line CG is as follows: a context coded bin (*index\_flag*)is parsed for each sample indicating if the sample is of the same run mode as the previously scanned sample, i.e., if the previous scanned sample and the current sample are both of run type COPY\_ABOVE or if the previous scanned sample and the current sample are both of run type INDEX with the same index value. If the pixel and the previous sample are of different mode, a context coded bin is parsed indicating the run type, i.e., INDEX or COPY\_ABOVE. Same as the HEVC palette, decoder doesn’t have to parse run type if the sample is in the first row (horizontal traverse scan) or in the first column (vertical traverse scan) since the INDEX mode is used by default. Also, decoder doesn’t have to parse run type if the previously parsed run type is COPY\_ABOVE.

The index values (for index runs of INDEX mode) and quantized escape colors are bypass coded and grouped apart from encoding/parsing of context coded bins, i.e., *index\_flag* and *run\_type*, to improve throughput within each line CG.

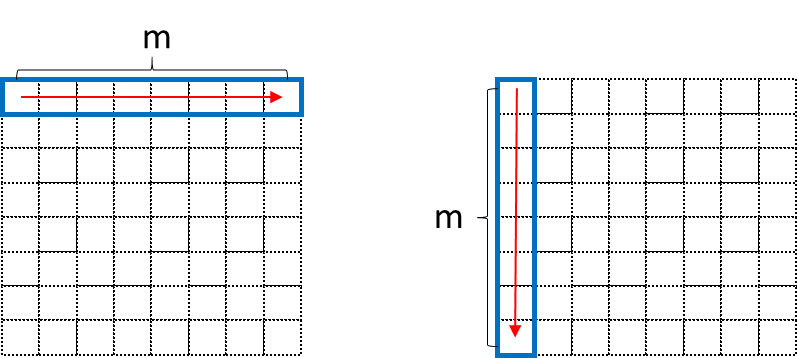


Figure 2: line CG segmentation for horizontal and vertical traverse scans

# Non-CE Technology proposals

## CE1 related – Reference picture resampling filters (12)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0119](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7908) AHG8: On reference picture resampling (RPR) [J. Chen (Futurewei)]

This contribution proposes to use the cropping window offsets in the reference sample location derivation of reference picture resampling process to avoid location misalignment of the reference sample block and the current block.

In the current spec, the scaling factor is based on the cropped picture.

It was commented that if we will

P0119 / P0241, P0381, P0590 are closely related.

[JVET-P0381](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8170) Non-CE1: A fix on reference sample offset for RPR [K. Zhang, L. Zhang, H. Liu, Z. Deng, J. Xu, Y. Wang (Bytedance)]

With RPR in VVC, a reference sample position is derived assuming that the offset between the top-left corner of the conformance window in the current picture and that in the reference picture is zero. However, the offset may be signalled to be non-zero. In this contribution, it is proposed to derive the reference sample position considering the non-zero offsets. Experimental results reportedly show that the proposed method achieves 16.91%, (PSNR1), 18.53%(PSNR2) BD-rate reductions for scaling ratio 1.5 and 14.89% (PSNR1), 15.25% (PSNR2) BD-rate reductions for scaling ratio 2.0, when the top-left corner of the conformance window in low-resolution pictures is at (64, 64).

P0119 / P0241, P0381, P0590 are closely related.

It was said that this proposal is the same as in P0119.

[JVET-P0938](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8753) Crosscheck of JVET-P0381 (Non-CE1: A fix on reference sample offset for RPR) [J. Samuelsson (Sharp)]

Reference picture resampling functionality was adopted into the draft text at the Gothenburg July 2019 meeting. It was identified during the meeting that a potential issue that required further study is how to define the scaling ratio between pictures, especially for picture sizes that are not a multiple of 8 pixels. An approach using the conformance cropping window to determine the scaling ratio was agreed to be the starting point, but it was acknowledged this may not be the right approach.

This contribution proposes to redefine the semantics of the width and height transmitted in the PPS to represent the true picture dimensions, derive decode dimensions by rounding the true dimensions with the appropriate granularity, and using the true dimensions for scaling ratio computations. It is suggested that this approach provides a simple method to represent integer scaling ratios and avoids complications with the use of the conformance window for these calculations.

The contributions proposes to change the definition of the (uncropped) picture width and height, such that rather than these being required to be a multiple of 8, they would be allowed to have finer granularity. For the internal decoding process, the decoder would basically derive the multiple of 8 by rounding up, but the extra granularity would be used for the scaling process.

With this proposal, the conformance window would again be used only for cropping.

P0119 / P0241, P0381, P0590 are closely related.

In VVC draft 6, reference picture resampling and scalability support were adopted, where scaling ratio is derived based on the conformance cropping window and picture size. In this document, it is proposed to decouple scaling ratio derivation from the conformance cropping window and to signal a scaling window in the PPS to derive scaling ratio.

This proposes to send additional window parameters on each picture that are used for scaling and positioning when referring to that picture and when decoding that picture. (The HLS of the current picture does not select the area to reference in the reference picture; that area is what was indicated with the referenced picture.)

P0119 / P0241, P0381, P0590 are closely related.

P0119 / P0241, P0381, P0590 as a group

It was concluded that even if we would like to enable a more elaborate functionality (e.g., per P0219, P0336, P0482), such as to support ROI scalability, we would like to have a default mode. These proposals are candidate approaches for that mode.

Decision: Adopt P0590.

Decision: Add an SPS-level reference\_picture\_resampling\_enabled\_flag (which was actually part of the prior proposal JVET-O0133), and constrain the picture width and height to be equal to the max values and constrain the presence flag for the new parameters to be 0 when that flag is 0.

[JVET-P0274](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8063) Non-CE1: Enabling TMVP in RPR [T.-S. Chang, Y.-C. Sun, L. Zhu, J. Lou (Alibaba)]

Currently, there is a constraint that TMVP can only be enabled if the collocated picture is the same size.

The contribution proposes to perform MV scaling when the current and reference pictures have different sizes.

In this proposal, TMVP is enabled for AMVP and SbTMVP by performing MV scaling when the current and collocated pictures have different sizes. The simulation results are summarized as follows:

* Y/Cb/Cr BD rate w/ PSNR1 and scaling ration 2.0x: -0.16%/-0.07%/-0.23%
* Y/Cb/Cr BD rate w/ PSNR2 and scaling ration 2.0x: -0.13%/-0.07%/-0.24%
* Y/Cb/Cr BD rate w/ PSNR1 and scaling ration 1.5x: -0.08%/-0.06%/0.26%
* Y/Cb/Cr BD rate w/ PSNR2 and scaling ration 1.5x: -0.07%/-0.08%/0.27%

It was commented that it is not the motion vector that is the problem with TMVP and RPR, but rather the lack of correspondence between the structures of the pictures.

[JVET-P0723](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8524) Crosscheck of JVET-P0274 (Non-CE1: Enabling TMVP in RPR) [Y.-W. Chen (Kwai Inc.)]

[JVET-P0353](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8142) CE1-related: Reference picture resampling filters [J. Luo, Y. Ye, M. Sarwer (Alibaba)]

CE1 test 3 in JVET-O2021 tests the application of a 12-tap SHM filter for reference picture down-sampling. In order to avoid an increase of complexity and memory access bandwidth, this contribution proposes to use cosine windowed sinc filters with the filter length, gain and number of phases matching those of the existing motion compensation interpolation filters (MCIF) in VVC. The simulation results reportedly show that comparing to the CE1 anchors which use existing MCIF for reference down-sampling, average BD rate deltas of PSNR1 are { -5.96%, -2.44%} for ratio 2:1 and 1.5:1, and average BD rate savings of PSNR2 are { -3.80%, -1.78%} for ratio 2:1 and 1.5:1.

In the CE, the filter for affine was not modified. In this proposal, the affine filter was modified. This probably doesn't make much of a difference, and the proponent was running tests to confirm that.

It was commented that the sequences that tend to benefit the most from affine are, at least mostly, not tested here.

The half pel position is not using the proposed filter. The proponent was running tests to confirm the effect of that. The same issue existed in the CE.

Compared to the CE1-1.1 result, for the 2x case, there is a reported benefit of about 1.5% for PSNR1 LB.

It was commented that the filter coefficients in the first and second versions were different.

There was discussion of whether it is a problem that the filter has a gain higher than 1 for some frequencies. Some participants indicated that since RPR is not applied in a cascaded manner, this should not be a problem.

A participant suggested that, regardless of what action is taken at this meeting, further study be conducted, perhaps including subjective viewing and alternative test sequences.

The SHVC filter also has a "bump".

Another participant commented that HDR testing may be desirable.

Focusing on the 2:1 case, it was commented that this filter has less aliasing than the one from the CE. The P0353 filter was submitted quite late, although the difference is only the values of the taps. Some tests for P0353 were still ongoing. The actual difference for the switching pictures is larger than what was measured here, and the difference was significant.

Decision: P0353-v5 2:1 8-tap & 4-tap filter, subject to checking for any issue in ongoing affine and half-pel tests.

For 1.5:1, stay with the CE1 result.

[JVET-P0836](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8651) Cross-check of JVET-P0353 on reference picture resampling filters [V. Seregin (Qualcomm)]

VTM6.0 supports reference picture resampling, which is being studied in CE1. In VTM6, existing sub-pel interpolation filters for motion compensation are used to resample the reference picture for inter-picture prediction. Using these conventional “all pass” interpolation filters may encounter the well-known restrictions of Nyquist–Shannon sampling theorem and cause aliasing effect if the reference picture size is larger than the current picture size. This contribution proposes to reduce the aliasing effect by switching to a different set of filter coefficients, maintaining the 8-tap filter size and the filter coefficient sum of 64, when the reference picture size exceeds the current picture size by a 2x ratio per dimension or more.

This was not cross-checked.

It was asked what method was used for the filter design, and the proponent said it was a windowed DCTIF design.

There was also a 4-tap filter for chroma that was not mentioned in the proposal.

The proponent suggested that further study be done for the filtering.

It was commented that both high QP and low QP are worth studying.

In VVC draft 6, reference picture resampling process uses existed motion compensation filters. In CE1, depending on the scaling ratio alternative fixed filter coefficients for reference picture downsampling are tested.

In this contribution, it is proposed to signal filter coefficients in APS for luma and chroma components that are used for downsampling. In slice header, an APS index is signalled to indicate which filter coefficients set is applied for downsampling. This allows to specify the desired coefficients per picture, which can be scaling ratio dependent.

It was commented that there is definitely a complexity increase (and possibly dynamic range issues) for having downloadable filters.

(Huawei)

In VVC draft 6, reference picture resampling process uses existing motion compensation filters. In CE1 and related contributions, depending on the scaling ratio, alternative fixed filter coefficients for reference picture down-sampling have been tested. In this contribution, the dynamic range of re-sampling process is analysed for different filters in CE1 and CE1-related contributions. Except, JVET-P0083, all analysed filters with predefined coefficients have dynamic range not higher than HEVC motion compensation interpolation process (so this module can be re-used for resampling with only a change of filter coefficients). But non-restricted interpolation filter coefficients allowed by syntax proposed in JVET-P0593 might result in overflow of 16 bits temporal buffer. An additional restriction to the sum of interpolation filter positive coefficients to be not greater than 96 ensures dynamic range to be the same as HEVC motion compensation interpolation. Among all analysed re-sampling filters, non-CE1 conditions demonstrate up to 6% gain.

One aspect noted was that the tests done thus far does not use all phases of the filter.

The proponent expressed some worry over filters that have a "bump" in the frequency response and encouraged further study of the filters and discussed phase effects.

A participant remarked that it may be important to remember that the filters do not directly produce the output signal; the encoder can choose a different prediction signal and can also code a residual difference.

The filter also only gets used at resolution changes, which are not likely to be frequent.

[JVET-P0382](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8171) Non-CE1: Simplified motion compensation in RPR [K. Zhang, L. Zhang, H. Liu, Z. Deng, J. Xu, N. Zhang (Bytedance)]

With RPR in VVC, the bandwidth and computational complexity demanded by motion compensation is higher when the reference picture is larger than the current picture. In this contribution, it is proposed to apply the 6-tap interpolation filters used in the affine motion compensation on a luma M × N block satisfying certain conditions when the scaling ratio is larger than 1. Two tests are conducted with different conditions as below:

Test #1: The luma block is bi-predicted.

Test #2: The luma block is bi-predicted and (M × N <= 64 || M == 4 || N== 4)

For both tests with the scaling ratio equal to 2, the required bandwidth of motion compensation is asserted to be reduced to 82%, and the required number of multiplications is asserted to be reduced to 67% in the worst case. Experimental results reportedly show that the BD-rate changes are -0.01%, 0.00% for scaling ratio 1.5 and 0.11%, 0.06% for scaling ratio 2.0 in test #1, and 0.00%, 0.00% for scaling ratio 1.5 and 0.00%, 0.00% for scaling ratio 2.0 in test #2, respectively, under the CTC for RPR.

These test results are relative to the anchor that does not use anti-alising.

A participant commented that, from an implementation perspective, it does not seem necessary to consider trying to shorten the filter to be shorter than the ordinary MC filter.

[JVET-P0661](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8459) Crosscheck of JVET-P0382 (Non-CE1: Simplified motion compensation in RPR) [J. Chen (Alibaba)]

[JVET-P0409](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8198) CE1-related: Enable PROF for RPR [J. Chen, R.-L. Liao, J. Luo, Y. Ye (Alibaba)]

TBP.

[JVET-P0655](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8453) Crosscheck of JVET-P0409 (CE1-related: Enable PROF for RPR) [K. Zhang (Bytedance)]

[JVET-P0592](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8384) AHG8/Non-CE1: Phase shifts for resampling [V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

TBP.

[JVET-P0902](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8717) Crosscheck of JVET-P0592 AHG8/Non-CE1: Phase shifts for resampling [J. Luo (Alibaba)]

## CE2 related – Gradual decoding refresh (0)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

## CE3 related – Intra prediction and mode coding (48)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

BoG (G. v. d. Auweera) to assess the proposals in this category (all topics), with emphasis of providing an overview about suggested MIP cleanups

[JVET-P0111](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7900) CE3-related: Chroma intra prediction mode mapping for 4:2:2 format [B. Wang, S. Esenlik, A. M. Kotra, H. Gao, E. Alshina (Huawei)]

[JVET-P0915](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8730) Crosscheck of JVET-P0111 on Chroma intra prediction mode mapping for 4:2:2 format [S. Iwamura (NHK)]

[JVET-P0136](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7925) Non-CE3: MIP simplification [J.-Y. Huo, H.-X. Wang, Y. Sun, Y.-Z. Ma, F.-Z. Yang (Xidian Univ.), S. Wan (NPU), Y.-F. Yu, Y. Liu (OPPO)]

[JVET-P0904](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8719) Crosscheck of JVET-P0136 (Non-CE3: MIP simplification) [X. Ma (Huawei)]

[JVET-P0150](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7939) CE3-related: Simplification of reference luma intra prediction mode derivation [Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0768](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8583) Crosscheck of JVET-P0150 (CE3-related: Simplification of reference luma intra prediction mode derivation) [Y.-W. Chen (Kwai)]

[JVET-P0177](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7966) Non-CE3: On Constraint of CCLM and CST [C.-W. Kuo, J. Li, C.S. Lim (Panasonic)]

[JVET-P0649](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8447) Crosscheck of JVET-P0177 (Non-CE3: On Constraint of CCLM and CST) [T.-S. Chang (Alibaba)]

[JVET-P0194](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7983) CE3-related: Simplified MIP with reduced memory footprint [T. Biatek, A.K. Ramasubramonian, G. Van Der Auwera, M. Karczewicz (Qualcomm)]

[JVET-P0198](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7987) Non-CE3: Enable MIP prediction for 64×N or N×64 blocks at maximum transform size 32 [Z. Zhang, K. Andersson, D. Saffar, R. Sjöberg, J. Ström, R. Yu (Ericsson)]

[JVET-P0199](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7988) Non-CE3: Align MIP matrix multiplication process [Z. Zhang, K. Andersson, D. Saffar, R. Sjöberg, J. Ström, R. Yu (Ericsson)]

[JVET-P0749](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8553) Crosscheck of JVET-P0199 (Non-CE3: Align MIP matrix multiplication process) [Y. Yasugi (Sharp)]

[JVET-P0208](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7997) Non CE3: Intra mode coding of non-MPM modes [S. Blasi, A. Seixas Dias, G. Kulupana (BBC)]

[JVET-P0919](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8734) Crosscheck of JVET-P0208 (Non CE3: Intra mode coding of non-MPM modes) [V. Rufitskiy, A. Filippov (Huawei)]

[JVET-P0265](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8054) CE3-related: CCLM with unified filter shape [D.-Y. Kim (Chips&Media), S.-C. Lim, J. Lee, J. Kang, H. Lee (ETRI)]

[JVET-P0812](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8627) Crosscheck of JVET-P0265 (CE3-related: CCLM with unified filter shape) [T. Toma, K. Abe (Panasonic)]

[JVET-P0277](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8066) Non-CE3: LFNST restriction based on MIP [A. Kumar, S. Shrestha, B. Lee (Chosun Univ.), Y. Lee, J. Park (Humax)]

[JVET-P0873](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8688) Crosscheck of JVET-P0277: Non-CE3: LFNST restriction based on MIP [J. Jung, D. Kim, G. Ko, J. Son, J. Kwak (WILUS)]

[JVET-P0289](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8078) Non-CE3: MIP simplification [Y. Yasugi, T. Ikai (Sharp)]

[JVET-P0888](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8703) Crosscheck of JVET-P0289 (Non-CE3: MIP simplification) [C.-C Kuo, C.-C. Lin (ITRI)]

[JVET-P0294](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8083) Non-CE3: Simplification of MPM derivation [D. Gwon, H. Han, H. Choi (HNU), H. Lee, J. Kang (ETRI)]

[JVET-P0822](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8637) Cross-check of JVET-P0294 (Non-CE3: Simplification of MPM derivation) [K. Choi (Samsung)]

[JVET-O0297](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6902) Non-CE3: On CCLM neighboring sample [M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

[JVET-P0763](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8578) Cross-check of JVET-P0297 (Non-CE3: On CCLM neighboring sample) [S.-C. Lim, H. Lee, J. Lee, J. Kang (ETRI)]

[JVET-P0302](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8091) Non-CE3: PDPC without clipping [A. Filippov, V. Rufitskiy (Huawei)]

[JVET-P0782](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8597) Crosscheck of JVET-P0302 (Non-CE3: PDPC without clipping) [Y. Morigami, M. Ikeda (Sony)]

[JVET-P0303](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8092) Non-CE3: Removal of leaving out operation for 4×16 and 16×4 MIP blocks [X. Li, R.-L. Liao, Y. Chen, J. Chen, J. Luo, Y. Ye (Alibaba)]

[JVET-P0751](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8555) Crosscheck of JVET-P0303 (Non-CE3: Removal of leaving out operation for 4×16 and 16×4 MIP blocks) [Y. Yasugi (Sharp)]

[JVET-P0318](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8107) Non-CE3: Context reduction for intra\_luma\_not\_planar\_flag [D. Park, Y.-U. Yoon, J. Do, J.-G. Kim (KAU), J. Lee, J. Kang (ETRI)]

[JVET-P0780](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8595) Crosscheck of JVET-P0318 (Non-CE3: Context reduction for intra\_luma\_not\_planar\_flag) [M. Ikeda (Sony)]

[JVET-P0329](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8118) CE3-related: Simplification of Planar intra prediction [B. Wang, S. Esenlik, A. M. Kotra, H. Gao, E. Alshina (Huawei)]

[JVET-P0840](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8655) Cross-check of JVET-P0329 (CE3-related: Simplification of Planar intra prediction) [M. G. Sarwer (Alibaba)]

[JVET-P0352](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8141) Non-CE6 / Non-CE3: MIP UP TO 64x64 CU’s [K. Naser, T. Poirier, F. Le Léannec, F. Galpin (InterDigital)]

See notes under JVET-P0702 – revisit in CE3 context.

[JVET-P0831](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8646) Cross-check result of JVET-P0352: Non-CE6 / Non-CE3: MIP UP TO 64x64 CU’s [Z. Zhang (Ericsson)]

[JVET-P0355](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8144) Non CE3: Simplified coding of chroma intra modes [S. Blasi, A. Seixas Dias, G. Kulupana (BBC)]

[JVET-P0633](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8430) Crosscheck of JVET-P0355 (Non CE3: Simplified coding of chroma intra modes) [?? (??)]

[JVET-P0358](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8147) Non-CE3: Improved intra mode coding simplified [G. Rath, F. Galpin, F. Urban (InterDigital)]

[JVET-P0777](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8592) Crosscheck of JVET-P0358 (Non-CE3: Improved intra mode coding simplified) [J. Choi (LGE)]

[JVET-P0369](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8158) Non-CE3: MPM flag signaling with MRL [G. Rath, F. Galpin, F. Le Léannec (InterDigital)]

[JVET-P0685](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8484) Crosscheck of JVET-P0369 (Non-CE3: MPM flag signaling with MRL) [J. Yao (Fujitsu)]

[JVET-P0374](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8163) Non-CE3: One directional Intra planar mode [H. Yang, Y. He (InterDigital)]

[JVET-P0716](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8517) Crosscheck of JVET-P0374: Non-CE3: One directional Intra planar mode [Y.-H. Chao (Qualcomm)]

[JVET-P0398](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8187) Non-CE3: MIP Cleanup [J. Pfaff, B. Stallenberger, M. Schäfer, P. Merkle, T. Hinz, P. Helle, H. Schwarz, D. Marpe, T. Wiegand]

[JVET-P0832](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8647) Cross-check result of JVET-P0398: Non-CE3: MIP cleanup [Z. Zhang (Ericsson)]

[JVET-P0401](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8190) CE3-related: MIP downsampling process with re-trained MIP matrix [Z. Zhang, K. Andersson, D. Saffar, R. Sjöberg, J. Ström, R. Yu (Ericsson)]

[JVET-P0793](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8608) Crosscheck of JVET-P0401 (CE3-related: MIP downsampling process with re-trained MIP matrix) [J. Pfaff (HHI)]

[JVET-P0418](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8207) Non-CE3: Cleanup of MRLP Line Storage [T. Hellman, M. Zhou, B. Heng (Broadcom)]

[JVET-P0500](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8290) Non-CE3: Multiple reference sample set for CCLM [P.-H. Lin, C.-Y. Teng (Foxconn)]

[JVET-P0718](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8519) Crosscheck of JVET-P0500 (Non-CE3: Multiple reference sample set for CCLM) [H.-J. Jhu (Kwai Inc.)]

[JVET-P0503](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8293) Non-CE3: Simplification of harmonization for LFNST and MIP [S. Shrestha, A. Kumar, B. Lee (Chosun Univ.), Y. Lee, J. Park (Humax)]

[JVET-P0952](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8767) Crosscheck of JVET-P0503 (Non-CE3: Simplification of harmonization for LFNST and MIP) [L. Li (Tencent)]

[JVET-P0507](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8297) Non-CE3: ISP simplifications [L. Zhao, X. Li, X. Zhao, S. Liu (Tencent)]

[JVET-P0725](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8526) Crosscheck of JVET-P0507 (Non-CE3: ISP simplifications) [Y.-W. Chen (Kwai Inc.)]

[JVET-P0509](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8299) CE3-related: Simplification for MIP matrix multiplication [L. Zhao, X. Zhao, X. Li, S. Liu (Tencent)]

[JVET-P0726](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8527) Crosscheck of JVET-P0509 (CE3-related: Simplification for MIP matrix multiplication) [Y.-W. Chen (Kwai Inc.)]

[JVET-P0511](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8301) Non-CE3: ISP extension to avoid small Chroma intra blocks [L. Zhao, X. Li, X. Zhao, S. Liu (Tencent)]

[JVET-P0922](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8737) Crosscheck of JVET-P0511 on Non-CE3: ISP extension to avoid small Chroma intra blocks [S.H. Wang (PKU), Y. Wang, X. Zheng (DJI)]

[JVET-P0535](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8325) Non-CE3: Removal of block size restriction in MIP [J. Choi, J. Heo, J. Lim, S. Kim (LGE)]

[JVET-P0791](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8606) Crosscheck of JVET-P0535 (Non-CE3: Removal of block size restriction in MIP) [J. Pfaff (HHI)]

[JVET-P0536](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8326) Non-CE3: MRL with non-MPM intra modes [J. Choi, J. Heo, J. Lim, S. Kim (LGE)]

[JVET-P0787](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8602) Crosscheck of JVET-P0536 (Non-CE3: MRL with non-MPM intra modes) [F. Urban (InterDigital)]

[JVET-P0917](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8732) Crosscheck of JVET-P0537 on local dual tree for non-4:2:0 chroma formats [S. Iwamura (NHK)]

[JVET-P0548](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8338) Non-CE3: Removal of MRL restriction [J. Heo, H. Jang, J. Choi, J. Lim, S. Kim (LGE)]

[JVET-P0961](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8776) Crosscheck of JVET-P0548 (Non-CE3: Removal of MRL restriction) [I. Zupancic (HHI)]

[JVET-P0549](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8339) Non-CE3: Interpolation filter selection for chroma intra prediction [J. Heo, J. Choi, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-P0772](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8587) Crosscheck of JVET-P0549 (Non-CE3 : Interpolation filter selection for chroma intra prediction) [Y.-W. Chen (Kwai)]

[JVET-P0550](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8340) Non-CE3: Cleanup of intra reference sample filter selection [J. Heo, J. Choi, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-P0773](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8588) Crosscheck of JVET-P0550 (Non-CE3 : Cleanup of intra reference sample filter selection) [Y.-W. Chen (Kwai)]

[JVET-P0560](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8350) Non-CE3: Simplification on MIP and MPM context model [H.-J. Jhu, T.-C. Ma, X. Xiu, Y.-W. Chen, X. Wang (Kwai Inc.)]

[JVET-P0694](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8493) Cross-check of JVET-P0560: Non-CE3: Simplification on MIP and MPM context model [H. Sun, J. Li (Panasonic)]

[JVET-P0599](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8391) Non-CE3: Cleanup of interpolation filtering for intra prediction [A. Filippov, V. Rufitskiy (Huawei)]

[JVET-P0788](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8603) Crosscheck of JVET-P0599 (Non-CE3: Cleanup of interpolation filtering for intra prediction) [S. Blasi, (BBC)]

[JVET-P0615](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8409) Non-CE3: Intra chroma mode coding cleanup [B. Ray, G. Van der Auwera, M. Karczewicz (Qualcomm)]

[JVET-P0790](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8605) Crosscheck of JVET-P0615 (Non-CE3: Intra chroma mode coding cleanup) [S. Blasi (BBC)]

[JVET-P0625](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8420) Non-CE3: simplified MIP with power-of-two offsets [T. Biatek, A.K. Ramasubramonian, G. Van Der Auwera, M. Karczewicz (Qualcomm)] [late]

[JVET-P0835](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8650) Cross-check result of JVET-P0625: Non-CE3: simplified MIP with power-of-two offset [Z. Zhang (Ericsson)]

[JVET-P0626](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8421) Non-CE3: Cleanup of reference sample padding for intra prediction [A. Filippov, V. Rufitskiy (Huawei)] [late]

[JVET-P0781](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8596) Crosscheck of JVET-P0626 (Non-CE3: Cleanup of reference sample padding for intra prediction) [Y. Morigami, M. Ikeda (Sony)]

[JVET-P0638](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8435) CE3-related: Adaptive coding subset for intra mode [M. Bhat, D. Gommelet, J.-M. Thiesse, D. Nicholson (VITEC)] [late] [miss]

[JVET-P0802](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8617) Non-CE3: PDPC spec and software mismatch [H. Yang, Y. He, H. Li (InterDigital)] [late]

[JVET-P0803](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8618) Non-CE3: Combined cleanup of MIP [J. Pfaff, B. Stallenberger, M. Schäfer, P. Merkle, T. Hinz, P. Helle, H. Schwarz, D. Marpe, T. Wiegand (HHI), T. Biatek, A. K. Ramasubramonian, G. Van der Auwera, M. Karczewicz (Qualcomm), H. Liu, L. Zhang, K. Zhang, Z. Deng, J. Xu (Bytedance), J. Choi, J. Heo, J. Lim, S. Kim (LGE), K. Naser, T. Poirier, F. Le Leannec, F. Galpin (Inter Digital)] [late]

## CE4 related – Inter prediction (107)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0089](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7878) Non-CE4: DMVR control by reference picture type [H. Huang, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-P0090](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7879) Non-CE4: 32 bits coding for abs\_mvd\_minus2 [H. Huang, M. Coban, H. Wang, V. Seregin, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-P0673](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8472) Crosscheck of JVET-P0090 (Non-CE4: 32 bits coding for abs\_mvd\_minus2) [C.-Y. Lai (MediaTek)]

[JVET-P0091](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7880) CE4-related: Simplification of PROF and BDOF [H. Huang, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-P0094](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7883) AHG16: Fix on overflow issue in PROF [H. Chen, [H. Yang (Huawei)](mailto:haitao.yang@huawei.com)]

[JVET-P0932](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8747) Crosscheck of JVET-P0094 (AHG16/Non-CE4: Fix on overflow issue in PROF) [W. Chen (InterDigital)]

[JVET-P0107](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7896) CE4-Related: Geometric Merge Mode (GEO) Simplifications [H. Gao, S. Esenlik, E. Alshina, A. M. Kotra, B. Wang (Huawei), M. Bläser, J. Sauer (RWTH Aachen Uni.)]

[JVET-P0677](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8476) Crosscheck of JVET-P0107 (CE4-related: Geometric merge mode simplifications) [Y.-L. Hsiao (MediaTek)]

[JVET-P0728](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8530) Crosscheck of JVET-P0107 on reducing number of GEO modes and removing flipping [R.-L. Liao (Alibaba)]

[JVET-P0137](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7926) Non-CE4: On coding of merge triangle index [J.-Y. Huo, H.-X. Wang, Y.-Z. Ma, F.-Z. Yang (Xidian Univ.), S. Wan (NPU), Y.-F. Yu, Y. Liu (OPPO)]

[JVET-P0905](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8720) Crosscheck of JVET-P0137 (Non-CE4: On coding of merge triangle index) [X. Ma (Huawei)]

[JVET-P0151](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7940) CE4-related: Simplification of half-pel switchable interpolation filter [Y.-L. Hsiao, C.-C. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0924](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8739) Crosscheck of JVET-P0151: CE4-related: Simplification of half-pel switchable interpolation filter [H. Gao (Huawei)]

[JVET-P0152](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7941) CE4-related: On maximum number of subblock-based merging candidates [O. Chubach, C.-C. Chen, C.-W. Hsu, C.-Y. Chen, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0153](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7942) CE4-related: Overlapped block optical flow [Y.-L. Hsiao, Y.-C. Lin, C.-C. Chen, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0784](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8599) Crosscheck of JVET-P0153 (CE4-related: Overlapped block optical flow) [H. Lee, S.-C. Lim, J. Lee, J. Kang (ETRI)]

[JVET-P0154](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7943) CE4-related: PROF prediction sample range reduction [T.-D. Chuang, Z.-Y. Lin, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0769](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8584) Crosscheck of JVET-P0154 TEST1, TEST3 (CE4-related: PROF prediction sample range reduction) [Y.-W. Chen (Kwai)]

[JVET-P0742](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8545) Crosscheck of JVET-P0254 (Issue of simplified luma mapping of LMCS) [T. Chujoh (Sharp)]

[JVET-P0155](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7944) CE4-related: An encoder switch for forcing temporal MV to zero in SbTMVP [Y.-L. Hsiao, C.-C. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0859](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8674) Crosscheck report of JVET-P0155 (CE4-related: An encoder switch for forcing temporal MV to zero in SbTMVP) [X.Xu (Tencent)]

[JVET-P0172](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7961) AHG16/Non-CE4: Prediction sample value clipping for PROF [J. Li, C. S. Lim (Panasonic)]

[JVET-P0933](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8748) Crosscheck of JVET-P0172 (AHG16/Non-CE4: Prediction sample value clipping for PROF) [W. Chen (InterDigital)]

[JVET-P0174](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7963) Non-CE4: Modifications of TPM and GEO [J. Li, C. S. Lim (Panasonic)]

[JVET-P0925](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8740) Crosscheck of JVET-P0174: Non-CE4: Modifications of TPM and GEO [H. Gao (Huawei)]

[JVET-P0175](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7964) AHG16/Non-CE4: A clean-up to merge list generation by removing shared merge list [J. Li, C. S. Lim (Panasonic)]

[JVET-P0921](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8736) Crosscheck of JVET-P0175 on AHG16/Non-CE4: A clean-up to merge list generation by removing shared merge list [S.H. Wang (PKU), Y. Wang, X. Zheng (DJI)]

[JVET-P0191](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7980) Enabling BDOF and DMVR according to reference picture types [N. Zhang, H. Liu, L. Zhang, K. Zhang, Y. Wang (Bytedance)]

[JVET-P0200](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7989) Non-CE4: Modifications on BDOF intermediate parameter derivation [D. Liu, R.Yu (Ericsson)]

[JVET-P0678](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8477) Crosscheck of JVET-P0200 (Non-CE4: Modifications on BDOF intermediate parameter derivation-Test 1) [F. Chen (Hikvision)]

[JVET-P0201](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7990) Non-CE4: Simplification on BDOF offset calculation [D. Liu, R. Yu (Ericsson)]

[JVET-P0734](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8536) Crosscheck of JVET-P0201 on simplification on BDOF offset calculation [X. Xiu (Kwai Inc.)]

[JVET-P0209](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7998) Non-CE4: On the affine AMVR [H. Huang, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-P0698](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8497) Cross-check of JVET-P0209: Non-CE4: On the affine AMVR [H. Sun, J. Li (Panasonic)]

[JVET-P0214](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8003) CE4-related: Simplification of the CIIP chroma Intra Prediction Mode [J. Park, B. Jeon (SKKU)]

[JVET-P0234](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8023) AHG-2/Non-CE4: On clarification of weightedPredFlag [T. Chujoh, T. Ikai (Sharp)]

[JVET-P0236](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8025) Non-CE4: On a simplification for triangle merge mode [T. Chujoh, E. Sasaki, T. Ikai (Sharp)]

[JVET-P0690](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8489) Crosscheck of JVET-P0236 (Non-CE4: On a simplification for triangle merge mode) [P. Bordes (InterDigital)]

[JVET-P0811](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8626) Crosscheck of JVET-P0236 (Non-CE4: On a simplification for triangle merge mode) [K. Abe (Panasonic)]

[JVET-P0237](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8026) Non-CE4: On conditions for PROF [T. Chujoh, E. Sasaki, T. Ikai (Sharp)]

[JVET-P0833](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8648) Crosscheck of JVET-P0237 (Non-CE4: On conditions for PROF) [H. Liu (Bytedance)]

[JVET-P0238](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8027) Non-CE4: On definition of motion vector range for PROF and BDOF [T. Chujoh, E. Sasaki, T. Ikai (Sharp)]

[JVET-P0248](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8037) CE4-related: Modification of GEO mode [L. Xu, X. Cao, Y. Sun, F. Chen, L. Wang (Hikvision)]

[JVET-P0729](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8531) Crosscheck of JVET-P0248 (CE4-related: On Modifications of GEO) [R.-L. Liao (Alibaba)]

[JVET-P0249](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8038) CE4-related: On simplification for CIIP with triangular partitions [Y. Sun, F. Chen, L. Wang (Hikvision)]

[JVET-P0789](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8604) Crosscheck of JVET-P0249 (CE4-related: On simplification for CIIP with triangular partitions) [S. Blasi, (BBC)]

[JVET-P0250](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8039) CE4-related: On simplification for GEO weight derivation [Y. Sun, F. Chen, L. Wang (Hikvision)]

[JVET-P0926](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8741) Crosscheck of JVET-P250: CE4-related: On simplification for GEO weight derivation [H. Gao (Huawei)]

[JVET-P0253](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8042) Non-CE4: Simplify the division process of DMVR [K. Abe, Y. Kato, T. Toma (Panasonic)]

[JVET-P0741](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8544) Crosscheck of JVET-P0253 (Non-CE4: Simplify the division process of DMVR) [H. Tsurusaki, K. Unno (KDDI)]

[JVET-P0260](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8049) CE4-related: On inheritance of half-pel interpolation filter in merge mode [S. H. Wang (PKU)]

[JVET-P0695](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8494) Cross-check of JVET-P0260: CE4-related: On inheritance of half-pel interpolation filter in merge mode [H. Sun, J. Li (Panasonic)]

[JVET-P0261](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8050) Non-CE4: On Affine Motion Vector Restriction [X. W. Meng (PKU)]

[JVET-P0860](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8675) Crosscheck report of JVET-P0261 (Non-CE4: On Affine Motion Vector Restriction) [X. Xu (Tencent)]

[JVET-P0263](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8052) Non-CE4: On PROF conditions [X. W. Meng (PKU)]

[JVET-P0679](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8478) Crosscheck of JVET-P0263 (Non-CE4: On PROF conditions) [F. Chen (Hikvision)]

[JVET-P0264](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8053) CE4-related: Simplification of GEO using angles with power-of-two tangents [K. Reuzé, C.-C Chen, H. Huang, W.-J Chien, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0722](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8523) Crosscheck of JVET-P0264 (CE4-related: Simplification of GEO using angles with power-of-two tangents) [H.-J. Jhu (Kwai Inc.)]

[JVET-P0278](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8067) Non-CE4: HMVP buffer update for TPM block [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-P0660](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8458) Crosscheck of JVET-P0278 (Non-CE4: HMVP buffer update for TPM block) [N. Zhang (Bytedance)]

[JVET-P0275](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8064) Non-CE4/AHG17: On slice-level syntax for TPM and GEO [A. Filippov, V. Rufitskiy (Huawei)]

Move to non-CE4.

[JVET-P0753](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8557) Crosscheck of JVET-P0275 (Non-CE4/AHG17: On slice-level syntax for TPM and GEO) and JVET-P0320 (Non-CE4/AHG17: On slice-level syntax for BDOF and DMVR) [K. Unno (KDDI)]

Move to non-CE4.

[JVET-P0829](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8644) Cross-check result of JVET-P0275 (Non-CE4/AHG17: On slice-level syntax for TPM and GEO) [K. Kawamura, S. Naito (KDDI)]

[JVET-P0320](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8109) Non-CE4/AHG17: On slice-level syntax for BDOF and DMVR [A. Filippov, V. Rufitskiy (Huawei)]

Move to non-CE4.

[JVET-P0830](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8645) Cross-check result of JVET-P0320 (Non-CE4/AHG17: On slice-level syntax for BDOF and DMVR) [K. Kawamura, S. Naito (KDDI)]

[JVET-P0279](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8068) Non-CE4: Interaction between PROF and other tools [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-P0869](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8684) Crosscheck of JVET-P0279 (Non-CE4: Interaction between PROF and other tools) [T. Chujoh (Sharp)]

[JVET-P0280](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8069) Non-CE4: Fix the behavior between BCW and WP [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-P0281](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8070) Non-CE4: Corrections on parameter calculation for PROF and BDOF [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-P0934](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8749) Crosscheck of JVET-P0281 (Non-CE4: Corrections on parameter calculation for PROF and BDOF) [W. Chen (InterDigital)]

[JVET-P0282](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8071) Non-CE4: Block size alignment between PROF and BDOF [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-P0870](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8685) Crosscheck of JVET-P0282 (Non-CE4: Block size alignment between PROF and BDOF) [T. Chujoh (Sharp)]

[JVET-P0285](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8074) Non-CE4: Intra prediction mode of CIIP selection using left adjacent coded block [D. Jiang, J. Lin, F. Zeng, C. Fang (Dahua)]

[JVET-P0286](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8075) Non-CE4: Intra prediction mode of CIIP selection using left and above adjacent coded block [D. Jiang, J. Lin, F. Zeng, C. Fang (Dahua)]

[JVET-P0287](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8076) Non-CE4: Modified MVD derivation method for bidirectional MMVD using the magnitude of MV [D. Jiang, J. Lin, F. Zeng, C. Fang (Dahua)]

[JVET-P0288](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8077) Non-CE4: Modified MVD derivation method for bidirectional MMVD using the magnitude of MV and POC distance [D. Jiang, J. Lin, F. Zeng, C. Fang (Dahua)]

[JVET-P0291](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8080) AHG17: MMVD and CIIP parameters in PPS or slice header [Y. Yasugi, E. Sasaki, T. Ikai (Sharp)] [late]

This proposes moving some control from the SPS to lower levels.

[JVET-P0304](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8093) CE4-related: Simplification of blending weights and motion field storage in geometric merge mode [R.-L. Liao, J. Chen, Y. Ye, J. Luo (Alibaba)]

[JVET-P0305](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8094) CE4-related: Unification of triangle partition mode and geometric merge mode [R.-L. Liao, J. Chen, Y. Ye, J. Luo (Alibaba)]

[JVET-P0309](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8098) Non-CE4: Improved signaling method for merge modes [F. Chen, L. Wang (Hikvision)]

[JVET-P0880](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8695) Crosscheck of JVET-P0309: Non-CE4: Improved signaling method for merge modes [X. W. Meng (PKU)]

[JVET-P0310](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8099) Non-CE4: On simplification of PROF and BDOF [F. Chen, L. Wang (Hikvision)

[JVET-P0945](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8760) Crosscheck of JVET-P0310 (Non-CE4: On Simplification of PROF and BDOF) [K. Unno (KDDI)]

[JVET-P0311](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8100) Non-CE4: On enabling condition of BDOF and DMVR [F. Chen, L. Wang (Hikvision)]

[JVET-P0750](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8554) Crosscheck of JVET-P0311 (Non-CE4: On Enabling Condition of BDOF and DMVR) [D. Liu, R. Yu (Ericsson)]

[JVET-P0312](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8101) Non-CE4: On condition of SMVD [F. Chen, L. Wang (Hikvision)]

[JVET-P0752](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8556) Crosscheck of JVET-P0312 (Non-CE4: On Condition of SMVD) [D. Liu, R. Yu (Ericsson)]

[JVET-P0314](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8103) Non-CE4: Harmonization of PROF, BDOF and DMVR syntax [X.W. Meng (PKU), X. Zheng (DJI), S.S. Wang, S.W. Ma (PKU)]

[JVET-P0317](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8106) Non-CE4: BCW clean-up for weight signaling [D. Park, Y.-U. Yoon, [J. Do](mailto:jhdo@kau.kr), J.-G. Kim (KAU), J. Lee, J. Kang (ETRI)]

[JVET-P0675](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8474) Crosscheck of JVET-P0317 (Non-CE4: BCW cleanup for weight signalling) [Y.-L. Hsiao (MediaTek)]

[JVET-P0322](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8111) Non-CE4: CIIP size restriction [G. Ko, D. Kim, J. Jung, J. Son, J. Kwak (WILUS)]

[JVET-P0325](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8114) Non-CE4: Construction of spatial merge candidates [Z. Wang, Y. Yan, J. Luo (Alibaba)]

[JVET-P0954](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8769) Crosscheck of JVET-P0325 (Non-CE4: Construction of spatial merge candidates) [H. Liu (Bytedance)]

[JVET-P0340](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8129) Non-CE4: Unification of merge interpolation filter (triangle and pairwise-average) [P. Bordes, A. Robert, F. Le Léannec, F. Galpin (InterDigital)]

[JVET-P0658](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8456) Crosscheck of JVET-P0340 (Non-CE4: Unification of merge interpolation filter (triangle and pairwise-average)) [Y. Wang (Bytedance)]

[JVET-P0341](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8130) Non-CE4: Coding of interpolation filter index in non-merge inter mode [P. Bordes, F. Galpin, F. Le Léannec, E. François (InterDigital)]

[JVET-P0744](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8547) Crosscheck of JVET-P0341 (Non-CE4: Coding of interpolation filter index in non-merge inter mode) [T. Chujoh (Sharp)]

[JVET-P0384](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8173) Non-CE4: Flexible MMVD candidates [F. Galpin, F. Le Léannec, A. Robert (InterDigital)] [late]

[JVET-P0857](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8672) Crosscheck of JVET-P0384 (non-CE4 flexible MMVD candidates) [L. Pham Van, G. Van der Auwera (Qualcomm)]

[JVET-P0385](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8174) Non-CE4: MV rounding in sbTMVP [K. Zhang, L. Zhang, H. Liu, Z. Deng, N. Zhang, Y. Wang (Bytedance)]

[JVET-P0874](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8689) Crosscheck of JVET-P0385 "Non-CE4: MV rounding in sbTMVP" [G. Li (Tencent)]

[JVET-P0387](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8176) Non-CE4: Flexible CIIP mode [F. Galpin, F. Le Léannec, A. Robert, K. Naser (InterDigital)] [late]

[JVET-P0408](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8197) CE4-related: On PROF on/off control [J. Chen, R.-L. Liao, J. Luo, Y. Ye (Alibaba)]

[JVET-P0413](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8202) CE4-related: Clipping for PROF [W. Chen, Y. He (InterDigital)]

[JVET-P0697](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8496) Cross-check of JVET-P0413: CE4-related: Clipping for PROF [H. Sun, J. Li (Panasonic)]

[JVET-P0414](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8203) Non-CE4: Simplification of SIF [W. Chen, Y. He (InterDigital)]

[JVET-P0871](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8686) Crosscheck of JVET-P0414 (Non-CE4: Simplification of SIF) [H. Chen (Huawei)]

[JVET-P0415](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8204) Non-CE4: Unification of DMVR and BDOF enabling conditions [W. Chen, Y. He (InterDigital)]

[JVET-P0817](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8632) Crosscheck of JVET-P0415 (Non-CE4: Unification of DMVR and BDOF enabling conditions) [N. Park (LGE)]

[JVET-P0416](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8205) Non-CE4: Using integer MV in CIIP [W. Chen, Y. He (InterDigital)]

[JVET-P0755](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8559) Crosscheck of JVET-P0416 on using integer MV in CIIP [X. Xiu (Kwai Inc.)]

[JVET-P0434](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8223) Non-CE4: Enabling conditions of PROF [Z. Deng, L. Zhang, K. Zhang, H. Liu, N. Zhang, K. Fan (Bytedance)]

[JVET-P0439](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8228) Non-CE4: Motion pruning with alternative half-pel interpolation filter flag [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

[JVET-P0828](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8643) Crosscheck of JVET-P0439 (Non-CE4 Motion pruning with alternative half-pel interpolation filter flag) [A. Robert (InterDigital)]

[JVET-P0440](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8229) Non-CE4: On inheritance of alternative half-pel interpolation filter flag in MMVD [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

[JVET-P0646](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8444) Cross-check of JVET-P0440 (Non-CE4: On inheritance of alternative half-pel interpolation filter flag in MMVD) [K. Zhang (Bytedance)]

[JVET-P0442](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8231) Non-CE4: Unified AMVR signalling [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

[JVET-P0910](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8725) Cross-check of JVET-P0442 (Non-CE4: Unified AMVR signaling) [J. Nam (LGE)]

[JVET-P0443](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8232) Non-CE4: On DMVR early termination [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

[JVET-P0735](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8537) Crosscheck of JVET-P0443 on DMVR early termination [X. Xiu (Kwai Inc.)]

[JVET-P0444](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8233) Non-CE4: On DMVR without padding [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

[JVET-P0736](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8538) Crosscheck of JVET-P0444 on DMVR without padding [X. Xiu (Kwai Inc.)]

[JVET-P0445](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8234) Non-CE4: Encoder optimization for subblock-based merge candidate search [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

[JVET-P0714](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8515) Cross-check of JVET-P0445: Non-CE4: Encoder optimization for subblock-based merge candidate search [J. Zhao (LGE)]

[JVET-P0449](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8238) CE4-related: Thin Partition Mode [K. Panusopone, S. Hong, L. Wang (Nokia)]

[JVET-P0779](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8594) Cross-check of JVET-P0449 (CE-4 related: Thin Partition Mode) [M. Zhou (Broadcom)]

[JVET-P0461](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8250) Non-CE4: Usage of half-pel switchable interpolation filter for pairwise candidate [N. Zhang, H. Liu, L. Zhang, K. Zhang, Y. Wang (Bytedance)]

[JVET-P0490](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8279) Non-CE4: Cleanup of half-pel switchable interpolation filter [H. Liu, N. Zhang, L. Zhang, K. Zhang, Z. Deng, J. Xu (Bytedance)]

[JVET-P0867](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8682) Crosscheck of JVET-P0490 (Non-CE4: Cleanup of half-pel switchable interpolation filter) [N. Hu (Qualcomm)]

[JVET-P0491](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8280) CE4-related: On MVD derivation in PROF [H. Liu, L. Zhang, K. Zhang, Y. Wang, J. Xu, Y. Wang (Bytedance)]

[JVET-P0745](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8548) Crosscheck of JVET-P0491 (CE4-related: On MVD derivation in PROF) [T. Chujoh (Sharp)]

[JVET-P0496](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8285) Non-CE4: Switchable interpolation filter in TPM [Y. Wang, L. Zhang, H. Liu, K. Zhang, N. Zhang, Y. Wang (Bytedance)]

[JVET-P0689](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8488) Crosscheck of JVET-P0496 (Non-CE4: Switchable interpolation filter for TPM) [P. Bordes (InterDigital)]

[JVET-P0498](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8288) Non-CE4: On weight derivation process in CIIP [N. Zhang, H. Liu, L. Zhang, [K. Zhang](mailto:zhangkai.video@bytedance.com), Y. Wang (Bytedance)

[JVET-P0818](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8633) Crosscheck of JVET-P0498 (Non-CE4: On weight derivation process in CIIP) [N. Park (LGE)]

[JVET-P0499](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8289) Non-CE4: Removal of MVD scaling process in MMVD [N. Zhang, H. Liu, L. Zhang, K. Zhang, Y. Wang (Bytedance)]

[JVET-P0645](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8442) Cross-check of JVET-P0499: Non-CE4: Removal of MVD scaling process in MMVD [J. Zhao (LGE)]

[JVET-P0512](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8302) Non-CE4: SIMD support for motion compensated prediction at high internal bit-depth [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-P0940](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8755) Crosscheck of JVET-P0512 on SIMD support for motion compensated prediction at high internal bit-depth [?? (??)]

[JVET-P0513](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8303) Non-CE4: Extending switchable interpolation filter to affine mode [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-P0875](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8690) Crosscheck of JVET-P0513 "Non-CE4: Extending switchable interpolation filter to affine mode" [G. Li (Tencent)]

[JVET-P0518](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8308) AHG16/Non-CE4: Addressing 16-bit multiplication overflow issue of the PROF [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-P0935](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8750) Crosscheck of JVET-P0518 (AHG16/Non-CE4: Addressing 16-bit multiplication overflow issue of the PROF) [W. Chen (InterDigital)]

[JVET-P0519](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8309) Non-CE4: On SAD threshold for BDOF early termination [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-P0524](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8314) On high-level control flags of BDOF and PROF [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-P0530](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8320) Non-CE4: Alignment of luma and chroma weight calculation for TPM blending [Z. Deng, L. Zhang, K. Zhang, H. Liu, Y. Wang (Bytedance)]

[JVET-P0936](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8751) Crosscheck of JVET-P0530 (Non-CE4: Alignment of luma and chroma weight calculation for TPM blending) [W. Chen (InterDigital)]

[JVET-P0532](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8322) CE4-related: Modified hpelIfIdx derivation for half-pel interpolation filter [Y. Kidani, K. Kawamura, K. Unno, S. Naito (KDDI)]

[JVET-P0911](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8726) Cross-check of JVET-P0532 (CE4-related: Modified hpelIfIdx derivation for half-pel interpolation filter) [J. Nam (LGE)]

[JVET-P0533](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8323) CE4-related: Motion vector rounding in enabled hpelIfIdx [Y. Kidani, K. Kawamura, K. Unno, S. Naito (KDDI)]

[JVET-P0912](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8727) Cross-check of JVET-P0533 (CE4-related: Motion vector rounding in enabled hpelIfIdx) [J. Nam (LGE)]

[JVET-P0541](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8331) Non-CE4: Context modeling for inter prediction mode [J. Nam, H. Jang, N. Park, J. Lim, S. Kim (LGE)]

[JVET-P0876](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8691) Crosscheck of JVET-P0541 "Non-CE4: Context modeling for inter prediction mode" [G. Li (Tencent)]

[JVET-P0542](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8332) Non-CE4: Cleanup on alternative half-pel interpolation filter [J. Nam, H. Jang, N. Park, J. Lim, S. Kim (LGE)]

[JVET-P0947](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8762) Crosscheck of JVET-P0542 (Non-CE4: Cleanup on alternative half-pel interpolation filter) [Y. Kidani, K. Unno, (KDDI)]

[JVET-P0544](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8334) Non-CE4: A slice header flag disabling PROF [K. Unno, K. Kawamura, S. Naito (KDDI)]

[JVET-P0546](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8336) Non-CE4: An applying condition of BDOF [K. Unno, K. Kawamura, S. Naito (KDDI)]

[JVET-P0810](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8625) Crosscheck of JVET-P0546 (Non-CE4: An applying condition of BDOF) [K. Abe (Panasonic)]

[JVET-P0572](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8362) AHG17/Non-CE4: Restrict integer-pel fetch for BDOF and RPOF for subpicture [H. Jang, J. Nam, N. Park, S. Paluri, S. Kim, J. Lim (LGE)]

[JVET-P0583](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8374) CE4-related: On the SBT in CE4-1.1 [H. Huang, T. Hsieh, V. Seregin, K. Reuze, C.-C. Chen, H.E. Egilmez, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-P0595](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8387) Non-CE4: Neighboring locations for CIIP [G. Ko, D. Kim, J. Jung, J. Son, J. Kwak (WILUS)]

[JVET-P0598](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8390) CE4-related: Harmonized CU-level Condition Check in BDOF and DMVR [C.-C. Chen, H. Huang, K. Reuzé, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-P0600](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8392) CE4-related: Support large rotation and flipping in affine and PROF [A. Aminlou (Nokia)]

[JVET-P0664](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8462) Cross-check of JVET-P0600: CE4-related: Support large rotation and flipping in affine and PROF [Y. He (InterDigital)]

[JVET-P0601](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8393) CE4-related: Support slice level disabling for PROF [K. Kondo, M. Ikeda (Sony)] [late]

[JVET-P0604](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8397) Non-CE4: Motion field storage optimization for the line buffer [T. Solovyev, S. Ikonin, A. Karabutov, R. Chernyak (Huawei)]

[JVET-P0605](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8398) Non-CE4: On triangular merge list size signalling [T. Solovyev, S. Ikonin, A. Karabutov, R. Chernyak (Huawei)]

[JVET-P0617](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8411) Non-CE4: On TPM merge mode in the presence of weighted prediction [A. Filippov, V. Rufitskiy (Huawei)] [late] [miss]

[JVET-P0620](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8414) Non-CE4: Flexible SBT mode [F. Galpin, F. Le Léannec, A. Robert, K. Naser, E. François (InterDigital)] [late]

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[JVET-P0621](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8415) Non-CE4: On motion information comparison [A. Robert, F. Le Léannec, F. Galpin, T. Poirier (InterDigital)] [late]

[JVET-P0879](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8694) Crosscheck of JVET-P0621 "Non-CE4: On motion information comparison" [G. Li (Tencent)]

[JVET-P0629](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8426) CE4-related: CIIP Simplification [J. Y. Lee (Sejong Univ.), W. Lim, G. Bang (ETRI)] [late]

[JVET-P0821](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8636) Cross-check of JVET-P0629 (CE4-related: CIIP Simplification) [K. Choi (Samsung)]

[JVET-P0653](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8451) Non-CE4: On BDOF and PROF parameter derivation [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai)] [late]

[JVET-P0937](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8752) Crosscheck of JVET-P0653 (Non-CE4: On BDOF and PROF parameter derivation) [W. Chen (InterDigital)]

[JVET-P0654](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8452) Non-CE4: Unified BDOF and DMVR early termination threshold [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai)] [late]

[JVET-P0964](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8779) Crosscheck of JVET-P0654: Non-CE4: Unified BDOF and DMVR early termination threshold [H. Gao (Huawei)]

[JVET-P0663](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8461) CE4-1.14 related: Block size limitation of enabling TPM and GEO [Z. Deng, L. Zhang, H. Liu, K. Zhang, Y. Wang (Bytedance)] [late]

[JVET-P0785](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8600) Crosscheck of JVET-P0663 (CE4-1.14 related: Block size limitation of enabling TPM and GEO) [T.-H. Li, C.-Y. Teng (Foxconn)]

[JVET-P0746](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8549) CE4-related: Combination of JVET-P0264 and JVET-P0304 on GEO simplification [K. Reuzé, C.-C. Chen, H. Huang, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm), R.-L. Liao, J. Chen, Y. Ye, J. Luo (Alibaba)] [late]

[JVET-P0856](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8671) Non-CE4: On switchable interpolation filter and bi-prediction weight indices cleanup [T. Solovyev, S. Ikonin, A. Karabutov, R. Chernyak (Huawei)] [late] [miss]

[JVET-P0884](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8699) Simplified GEO without multiplication and minimum blending mask storage (harmonization of JVET-P0107, JVET-P0264 and JVET-P0304) [H. Gao, S. Esenlik, E. Alshina, A. M. Kotra, B. Wang (Huawei), M. Bläser, J. Sauer (RWTH Aachen)] [late]

[JVET-P0895](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8710) Crosscheck of JVET-P0884 (Simplified GEO without multiplication and minimum blending mask storage (harmonization of JVET-P0107, JVET-P0264 and JVET-P0304)) [Y.-L. Hsiao (MediaTek)]

[JVET-P0885](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8700) Simplified GEO without multiplication and minimum blending mask storage (harmonization of JVET-P0107, JVET-P0264 and JVET-P0304) [K. Reuzé, C.-C Chen, H. Huang, W.-J Chien, V. Seregin, M. Karczewicz (Qualcomm), R.-L Liao, J. Chen, Y. Ye, J. Luo (Alibaba), M. Bläser, J. Sauer (RWTH Aachen Uni.)] [late]

## CE5 related – Loop filtering (72)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0043](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7832) AHG16/Non-CE5: A cleanup for de-blocking in the affine and TPM mode [[B. Heng](mailto:brian.heng@broadcom.com), M. Zhou (Broadcom)]

[JVET-P0656](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8454) Crosscheck of JVET-P0043 (AHG16/Non-CE5: A cleanup for de-blocking in the affine and TPM mode) [J. Xu (Bytedance)]

[JVET-P0053](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7842) AHG16/Non-CE5: A cleanup for the ALF sample padding [M. Zhou (Broadcom)]

[JVET-P0086](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7875) AHG16/Non-CE5: Deblocking boundary strength fix for Affine and TPM [A. M. Kotra, S. Esenlik, H. Gao, B. Wang, E. Alshina (Huawei)]

[JVET-P0844](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8659) Crosscheck of JVET-P0086 (AHG16/Non-CE5: Deblocking boundary strength fix for Affine and TPM) [C.-M. Tsai (MediaTek)]

[JVET-P0087](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7876) Non-CE5: Deblocking boundary strength modification for triangle and affine mode [K. Misra, F. Bossen, A. Segall (Sharp Labs of America)]

[JVET-P0845](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8660) Crosscheck of JVET-P0087 (Non-CE5: Deblocking boundary strength modification for triangle and affine mode) [C.-M. Tsai (MediaTek)]

[JVET-P0105](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7894) Non-CE5: Modified Chroma QP derivation for deblocking filter [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)]

[JVET-P0846](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8661) Crosscheck of JVET-P0105 (Non-CE5: Modified Chroma QP derivation for deblocking filter) [C.-M. Tsai (MediaTek)]

[JVET-P0106](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7895) AHG16/CE5-Related: Simplifications for Cross Component Adaptive Loop Filter [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)]

[JVET-P0847](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8662) Crosscheck of JVET-P0106 (AHG16/CE5-related: Simplifications for cross component adaptive loop filter) [C.-M. Tsai (MediaTek)]

[JVET-P0109](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7898) AHG18/Non-CE5: Boundary strength fix for coding units using BCW [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)]

[JVET-P0848](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8663) Crosscheck of JVET-P0109 (AHG18/Non-CE5: Boundary strength fix for coding units using BCW) [C.-M. Tsai (MediaTek)]

[JVET-P0121](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7910) On adaptive loop filter [J. Chen, Hendry (Futurewei)]

[JVET-P0156](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7945) CE5-related: ALF padding process when raster scan slices are used [C.-Y. Lai, C.-Y. Chen, T.-D. Chuang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek), A. M. Kotra, S. Esenlik, H. Gao, B. Wang, E. Alshina (Huawei)]

[JVET-P0157](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7946) CE5-related: Align ALF padding processes at picture and subpicture boundaries [C.-Y. Lai, O. Chubach, L. Chen, C.-Y. Chen, T.-D. Chuang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0158](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7947) CE5-related: Align ALF virtual boundary processes in the bottom CTU rows of one picture and one subpicture [C.-Y. Lai, O. Chubach, L. Chen, C.-Y. Chen, T.-D. Chuang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0159](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7948) CE5-related: DMVR deblocking by inheriting neighbouring boundary strength values [C.-M. Tsai, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0948](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8763) Crosscheck of JVET-P0159 (CE5-related: DMVR deblocking by inheriting neighbouring boundary strength values) [A. M. Kotra (Huawei)]

[JVET-P0160](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7949) CE5-related: Unification of deblocking processes for transform block and prediction block boundaries [C.-M. Tsai, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0792](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8607) Crosscheck of JVET-P0160 (CE5-related: Unification of deblocking processes for transform block and prediction block boundaries) [Y. Han, N. Hu (Qualcomm) ]

[JVET-P0161](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7950) CE5-related: Deblocking considering prediction weights in BCW and TPM [C.-M. Tsai, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0927](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8742) Crosscheck report of JVET-P0161 [K. Misra (Sharp Labs of America)]

[JVET-P0162](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7951) CE5-related: Simplified ALF syntax with removal of alf\_ctb\_use\_first\_aps\_flag [Y.-L. Hsiao, C.-C. Chen, O. Chubach, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0748](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8552) Cross-check of JVET-P0162 (CE5-related: Simplified ALF syntax with removal of alf\_ctb\_use\_first\_aps\_flag) [K. Andersson (Ericsson)]

[JVET-P0163](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7952) CE5-related: SAO encoder-only improvements [C.-Y. Lai, C.-Y. Chen, T.-D. Chuang, O. Chubach, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0820](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8635) Cross-check of JVET-P0163 (CE5-related: SAO encoder-only improvements) [K. Choi, W. Choi, K. P. Choi (Samsung)]

[JVET-P0164](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7953) CE5-related: Simplified ALF syntax regarding to alf\_luma\_coeff\_signalled\_flag and alf\_luma\_coeff\_flag [C.-Y. Lai, C.-Y. Chen, T.-D. Chuang, O. Chubach, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0946](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8761) Crosscheck of JVET-P0164 (CE5-related: Simplified ALF syntax regarding to alf\_luma\_coeff\_signalled\_flag and alf\_luma\_coeff\_flag) [A. M. Kotra (Huawei)]

[JVET-P0165](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7954) CE5-related: Simplified CCALF [O. Chubach, C.-Y. Lai, C.-Y. Chen, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0923](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8738) Crosscheck report of JVET-P0165 [K. Misra (Sharp Labs of America)]

[JVET-P0173](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7962) AHG16/Non-CE5: Cross component ALF simplification [J. Li, C. S. Lim (Panasonic)]

[JVET-P0852](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8667) Crosscheck of JVET-P0173 (AHG16/Non-CE5: Cross component ALF simplification) [K. Fan (??)]

[JVET-P0178](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7967) CE5-related: Unification of CCALF and ALF [C.-W. Kuo, J. Li, C.S. Lim (Panasonic)]

[JVET-P0717](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8518) Crosscheck of JVET-P0178 (CE5-related: Unification of CCALF and ALF) [H.-J. Jhu (Kwai Inc.)]

[JVET-P0179](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7968) Non-CE5: ALF as a post-filter [H.-B. Teo, H.-W. Sun, C.-S. Lim (Panasonic)]

[JVET-P0180](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7969) Non-CE5: Cleanup of ALF syntax elements [H. Liu, L. Zhang, K. Zhang, N. Zhang, Y. Wang, Y. Wang (Bytedance)]

[JVET-P0672](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8471) Crosscheck of JVET-P0180 (Non-CE5: Cleanup of ALF syntax elements) [C.-Y. Lai (MediaTek)]

[JVET-P0192](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7981) CE5-related: Reducing the number of luma filters in ALF [O. Chubach, C.-Y. Chen, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0767](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8582) Crosscheck of JVET-P0192 (CE5-related: Reducing the number of luma filters in ALF) [Y.-W. Chen (Kwai)]

[JVET-P0195](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7984) Non-CE5: Unified strong deblocking filter for luma and chroma [Y. Ahn, D. Sim (Digital Insights)]

[JVET-P0760](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8575) Cross-check of JVET-P0195 (Non-CE5: Unified strong deblocking filter for luma and chroma) [S.-C. Lim, H. Lee, J. Lee, J. Kang (ETRI)]

[JVET-P0246](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8035) AHG17/Non-CE5: on loop filter processing for subpicture treated as a picture

See 6.19.1.1 for the disposition of the HLS aspects of this contribution.

TBP for the low-level signal processing aspects.

[JVET-P0247](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8036) Non-CE5: Intra deblocking coefficients for weak filters [L.-H. Xu, J.-Q. Zhu, K. Kazui (Fujitsu)]

[JVET-P0251](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8040) CE5-related: Simplified CCALF [Y. Zhao, H. Yang (Huawei)]

[JVET-P0849](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8664) Crosscheck of JVET-P0251 (CE5-related: Simplified CCALF with 6 filter coefficients) [C.-M. Tsai (MediaTek)]

[JVET-P0892](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8707) Cross-check of JVET-P0251 (Simplified CCALF with 6 filter coefficients) [P. Onno (Canon)]

[JVET-P0255](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8044) CE5-related: Bilateral filter with SAO band offset [K. Abe, T. Toma (Panasonic)]

[JVET-P0868](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8683) Crosscheck of JVET-P0255: CE5-related: Bilateral filter with SAO band offset [J. Ström (Ericsson)]

[JVET-P0262](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8051) AHG16/Non-CE5: Deblocking boundary design cleanup for affine and TPM mode [X. W. Meng (PKU)]

[JVET-P0950](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8765) Crosscheck of JVET-P0262 (AHG16/Non-CE5: Deblocking boundary design cleanup for affine and TPM mode) [H. Liu (Bytedance)]

[JVET-P0269](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8058) AHG18 / non-CE5: Deblocking for TPM and BCW

[JVET-P0862](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8677) Crosscheck report of JVET-P0269 (AHG18 / non-CE5: Deblocking for TPM and BCW) [X. Xu (Tencent)]

[JVET-P0290](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8079) CE5-related: Clipping of intermediate value in CC-ALF [Y. Yasugi, T. Ikai (Sharp)]

[JVET-P0668](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8466) Crosscheck of JVET-P0290 (CE5-related: Clipping of intermediate value in CC-ALF) [A. Nalci (Qualcomm)]

[JVET-P0299](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8088) CE5-related: Interaction between Bilateral Filter and Cross-Component Adaptive Loop Filter [C. Hollmann, J. Ström (Ericsson)]

[JVET-P0710](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8511) Cross check report of JVET-P0299 [K. Misra (Sharp Labs of America)]

[JVET-P0306](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8095) Non CE5: DMVR internal edge deblocking without using refined MVs [J. R. Arumugam, S. Kotecha, S. Ramamurthy (Ittiam)]

[JVET-P0743](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8546) Crosscheck of JVET-P0306 (Non CE5: DMVR internal edge deblocking without using refined MVs) [T. Chujoh (Sharp)]

[JVET-P0330](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8119) Non-CE5: CC-ALF filtering simplification [J. Taquet, P. Onno, C. Gisquet, G. Laroche (Canon)]

[JVET-P0962](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8777) Crosscheck report of JVET-P0330 [K. Misra (Sharp Labs of America)]

[JVET-P0331](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8120) Non-CE5: CC-ALF design simplification [J. Taquet, P. Onno, C. Gisquet, G. Laroche (Canon)]

[JVET-P0963](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8778) Crosscheck report of JVET-P0331 [K. Misra (Sharp Labs of America)]

[JVET-P0332](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8121) AHG17/Non-CE5: On parsability of alternative ALF Chroma filter signaling [J. Taquet, P. Onno, C. Gisquet, G. Laroche (Canon)]

[JVET-P0801](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8616) Crosscheck of JVET-P0332: AHG17/Non-CE5: On parsability of alternative ALF Chroma filter signaling [S. Esenlik (Huawei)]

[JVET-P0333](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8122) On SAO performance [P. Onno, G. Laroche (Canon)]

[JVET-P0372](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8161) CE5-related: Joint chroma cross-component adaptive loop filtering [H. Yang, Y. He, H. Li (InterDigital)]

[JVET-P0704](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8505) Crosscheck of JVET-P0372 on joint chroma cross-component adaptive loop filtering [X. Li (Tencent)]

[JVET-P0386](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8175) Non-CE8/Non-CE5: Deblocking for IBC blocks [H. Gao, S. Esenlik, E. Alshina, A. M. Kotra, B. Wang (Huawei)]

[JVET-P0864](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8679) Crosscheck report of JVET-P0386 (Non-CE8/Non-CE5: Deblocking for IBC blocks) [X. Xu (Tencent)]

[JVET-P0411](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8200) Non-CE5: Fixes for long luma deblocking filter decision [K. Andersson, J. Enhorn (Ericsson)]

[JVET-P0412](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8201) CE5-related: On further modification of Hadamard filter from CE5-3.2 [S. Ikonin, V. Stepin, A. Karabutov, S. Nikolaeva (Huawei)]

[JVET-P0423](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8212) Non-CE5: Modified boundary strength derivation [W. Zhu, L. Zhang, J. Xu (Bytedance)]

[JVET-P0635](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8432) Crosscheck of JVET-P0423 (Non-CE5: Modified boundary strength derivation) [T.-H. Li, C.-Y. Teng (Foxconn)]

[JVET-P0441](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8230) Non-CE5: On deblocking on affine internal prediction sub-block edges [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

[JVET-P0944](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8759) Crosscheck of JVET-P0441 (Non-CE5: On deblocking on affine internal prediction sub-block edges) [K. Unno (KDDI)]

[JVET-P0452](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8241) Non-CE5/AHG17: Low-delay ALF syntax [K. Sühring, R. Skupin, Y. Sanchez, T. Schierl (HHI)]

[JVET-P0468](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8257) CE5-Related: Reducing multiplier count in CC-ALF [K. Misra, F. Bossen, A. Segall (Sharp Labs of America)]

[JVET-P0470](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8259) Non-CE5: Simplification of Cross Component Adaptive Loop Filter [[X. Li](mailto:xlxiangli@tencent.com), X. Zhao, L. Zhao, Y. Du, S. Liu (Tencent)]

[JVET-P0738](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8540) Crosscheck report of JVET-P0470 [K. Misra (Sharp Labs of America)]

[JVET-P0492](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8281) Non-CE5: Fixes of ALF sample padding [H. Liu, L. Zhang, K. Zhang, Y. Wang, J. Xu, Y. Wang (Bytedance)]

[JVET-P0504](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8294) CE5-related: Harmonization of Hadamard filter, SAO and ALF [V. Stepin, S. Ikonin, A. Karabutov (Huawei)]

[JVET-P0505](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8295) Non-CE5: On non-linear ALF clipping values [Y. Du, X. Zhao, X. Li, S. Liu (Tencent)]

[JVET-P0708](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8509) Crosscheck of JVET-P0505 (Non-CE5: On non-linear ALF clipping values) [H. Yang (InterDigital)]

[JVET-P0534](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8324) AhG16/Non-CE5: On deblocking at ALF virtual boundaries [Z. Deng, L. Zhang, K. Zhang, H. Liu, H.-C. Chuang (Bytedance)]

[JVET-P0727](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8528) Crosscheck of JVET-P0534 (AhG16/Non-CE5: On deblocking at ALF virtual boundaries) [Y.-W. Chen (Kwai Inc.)]

[JVET-P0539](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8329) Non-CE5: A chroma deblocking clean-up [J. Xu, L. Zhang, W. Zhu, K. Zhang, H. Liu (Bytedance)]

[JVET-P0543](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8333) CE5-related: Cleanup on cross-component adaptive loop filter [J. Nam, J. Choi, J. Lim, S. Kim (LGE)]

[JVET-P0893](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8708) Cross-check of JVET-P0543 (Cleanup on cross-component adaptive loop filter) [P. Onno (Canon)]

[JVET-P0547](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8337) Non-CE5: Deblocking filter at PROF sub-block boundary [K. Unno, K. Kawamura, S. Naito (KDDI)]

[JVET-P0877](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8692) Crosscheck of JVET-P0547 "Non-CE5: Deblocking filter at PROF sub-block boundary" [G. Li (Tencent)]

[JVET-P0551](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8341) AHG16/Non-CE5: On ALF boundary padding [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0552](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8342) AHG12/Non-CE5: Extending slice boundary processing for adaptive loop filter for raster scanned slices [N. Hu, V. Seregin, M. Coban, A. K. Ramasubramonian, M. Karczewicz (Qualcomm)]

[JVET-P0553](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8343) Non-CE5: Using truncated binary codes for ALF filter indices [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0953](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8768) Crosscheck of JVET-P0553 (Non-CE5: Using truncated binary codes for ALF filter indices) [H. Liu (Bytedance)]

[JVET-P0554](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8344) Non-CE5: Clean up of coefficient coding of adaptive loop filter [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0555](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8345) CE5-related: Dynamic range reduction for coefficients of cross component adaptive loop filter [N. Hu, J. Dong, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0850](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8665) Crosscheck of JVET-P0555 (CE5-related: Dynamic range reduction for coefficients of cross component adaptive loop filter) [C.-M. Tsai (MediaTek)]

[JVET-P0556](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8346) CE5-related: Temporal buffer removal for cross component adaptive loop filter [N. Hu, J. Dong, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0941](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8756) Cross-check of JVET-P0556 (CE5-related: Temporal buffer removal for cross component adaptive loop filter) [S.-C. Lim, H. Lee, J. Lee, J. Kang (ETRI) ]

[JVET-P0557](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8347) CE5-related: Multiplication removal for cross component adaptive loop filter [N. Hu, J. Dong, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0703](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8504) Crosscheck of JVET-P0557 on Multiplication removal for cross component adaptive loop filter [X. Li (Tencent)]

[JVET-P0967](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8782) Crosscheck report of JVET-P0557 Method 2 [K. Misra (Sharp Labs of America)]

[JVET-P0558](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8348) CE5-related: Reduced filter shape for cross component adaptive loop filter [N. Hu, J. Dong, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0674](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8473) Crosscheck of JVET-P0558 (CE5-related: Reduced filter shape for cross component adaptive loop filter) [C.-Y. Lai (MediaTek)]

[JVET-P0570](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8360) AHG10/Non-CE5: Performance of encoder-side deblocking optimization in VTM-6.0 [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0571](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8361) CE5/CE8: Deblocking Filter for BDPCM coded block [H. Jang, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-P0851](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8666) Crosscheck of JVET-P0571 (CE5/CE8: Deblocking filter for BDPCM coded block) [C.-M. Tsai (MediaTek)]

[JVET-P0851](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8666) Crosscheck of JVET-P0571 (CE5/CE8: Deblocking filter for BDPCM coded block) [C.-M. Tsai (MediaTek)]

[JVET-P0586](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8378) [AHG18][Non-CE5] Proposed cleanup of deblocking filter process [S. Iwamura, S. Nemoto, A. Ichigaya (NHK), K. Andersson, R. Yu, J. Enhorn (Ericsson)]

[JVET-P0700](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8499) Crosscheck of JVET-P0586 Aspect #1 ([AHG18][Non-CE5] Proposed cleanup of deblocking filter process) [Z. Deng (Bytedance)]

[JVET-P0783](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8598) Crosscheck of JVET-P0586 (Aspect 3 of [AHG18][Non-CE5] Proposed cleanup of deblocking filter process) [K. Kondo, M. Ikeda (Sony)]

[JVET-P0815](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8630) Crosscheck of JVET-P0586 (Non-CE5: Proposed cleanup of deblocking filter process) [K. Kazui (Fujitsu)]

[JVET-P0602](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8394) [AHG18][non-CE5] Boundary strength derivation for CUs with TPM [S. Iwamura, S. Nemoto, A. Ichigaya (NHK)]

[JVET-P0611](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8405) Non-CE5/AHG-11: Boundary strength harmonization for BDPCM, TS, Palette and IBC [B. Ray, G. Van der Auwera, M. Karczewicz (Qualcomm)]

[JVET-P0613](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8407) Non-CE5: On the average calculation for luma adaptive deblocking filter [B. Ray, D. Rusanovskyy, G. Van der Auwera, M. Karczewicz (Qualcomm)]

[JVET-P0863](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8678) Crosscheck of JVET-P0613: Non-CE5: On the average calculation for luma adaptive deblocking filter [K. Naser (InterDigital)]

[JVET-P0614](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8408) Non-CE5: On the gridsize for virtual boundaries [B. Ray, G. Van der Auwera, M. Karczewicz (Qualcomm)]

[JVET-P0665](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8463) Non-CE5: Spec fix for ALF filter and transpose index calculation [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)] [late]

[JVET-P0666](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8464) Non-CE5: Combination of JVET-P0470 and JVET-P0557 on simplification of CC-ALF [X. Li., X. Zhao, L. Zhao, X. Du, S. Liu (Tencent), N. Hu, J. Dong, V. Seregin, M. Karczewicz (Qualcomm)] [late]

[JVET-P0709](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8510) Crosscheck of JVET-P0666 (Non-CE5: Combination of JVET-P0470 and JVET-P0557 on simplification of CC-ALF) [H. Yang (InterDigital)]

[JVET-P0688](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8487) Non-CE5: Intra deblocking coefficients for weak filters [L. Xu, J. Zhu, K. Kazui (Fujitsu)] [late]

[JVET-P0837](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8652) Crosscheck of JVET-0688 on Intra deblocking coefficients for weak filters [S. Iwamura (NHK)]

[JVET-P0739](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8541) CE5-related: Combination of CCALF methods in JVET-P0165, JVET-P0556, and JVET-P0557 [O. Chubach, C.-Y. Lai, C.-Y. Chen, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek), N. Hu, J. Dong, V. Seregin, M. Karczewicz (Qualcomm)] [late] [miss]

[JVET-P0949](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8764) Crosscheck of JVET-P0739 (CE5-related: Combination of CCALF methods in JVET-P0165, JVET-P0556, and JVET-P0557) [H. Liu (Bytedance)]

[JVET-P0740](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8542) CE5-related: Combination of JVET-P0086 and JVET-P0161 for TPM deblocking [C.-M. Tsai, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek), A. M. Kotra, S. Esenlik, H. Gao, B. Wang, E. Alshina (Huawei)] [late] [miss]

[JVET-P0918](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8733) Crosscheck of JVET-P0740 (CE5-related: Combination of JVET-P0086 and JVET-P0161 on deblocking boundary strength fix for TPM and affine mode) [H. Jang (LGE)]

## CE6 related – Transforms and transform signalling (40)

Contributions in this category were discussed Friday 4 Oct. 1400–XXXX in Track A (chaired by JRO).

[JVET-P0166](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7955) CE6-related: Transform selection with intra prediction mode for implicit MTS [M.-S. Chiang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

This contribution proposes that for an intra luma coding block, the intra prediction mode is used to select the primary transform when explicit multi-transform set (MTS) is disabled and implicit MTS is enabled. The current design is to use the transform block width and height to decide the transform types for implicit MTS. Two variations are proposed. Compared to VTM6.0 with explicit MTS disabled and implicit MTS enabled, the results are summarized as follows.

Variation 1: intra prediction mode with an even number uses DST-VII

AI: BD-rates = -0.06% (Y), -0.13% (Cb), -0.11% (Cr); EncT=99%; DecT=100%

RA: BD-rates = -0.05% (Y), -0.14% (Cb), -0.03% (Cr); EncT=100%; DecT=101%

LB: BD-rates = -0.05% (Y), -0.19% (Cb), -0.02% (Cr); EncT=99%; DecT=101%

Variation 2: intra prediction mode under specified conditions uses DST-VII

AI: BD-rates = -0.04% (Y), 0.11% (Cb), 0.13% (Cr)

RA: BD-rates = 0.00% (Y), 0.02% (Cb), 0.06% (Cr)

LB: BD-rates = 0.0X% (Y), 0.0X% (Cb), 0.0X% (Cr)

The main aspect of the proposal is to replace explicit MTS with implicit MTS in CTC, plus a modification of implicit MTS that gives the coding gain above versus the current implicit method.

Compared to CTC (explicit MTS), loss of 0.02%/0.03% for RA/AI

No obvious benefit.

[JVET-P0928](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8743) Crosscheck of JVET-P0166 (CE6-related: Transform selection with intra prediction mode for implicit MTS) [S. Blasi (BBC)]

[JVET-P0929](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8744) Crosscheck of JVET-P0166 (CE6-related: Transform selection with intra prediction mode for implicit MTS) [C.-C Lin (ITRI)]

[JVET-P0196](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7985) CE6-related: Latency reduction for LFNST signalling [J. Lainema (Nokia)]

In VTM-6, LFNST is signalled at the end of the CU and signalling depends on transform block level data from all components present in a CU. This is reportedly causing latency in both encoder and decoder as, for example, knowing if LFNST is available for the luma component depends on chroma transform coefficients.

It is proposed to remove this “backwards” dependency by signalling LFNST indexes in the TU level. In the proposed approach, LFNST indexes for luma and LFNST indexes for TUs in single-tree coding mode are signalled in the luma TB. In the case of separate chroma tree mode, the chroma LFNST index is signalled in the first coded chroma TB in a TU. LFNST indexes are signalled after the last coefficient position syntax, which allows the last coefficient position based LFNST availability rule of VTM-6 to be applied using the last coefficient position of the current TB. In addition, signalling of the MTS index is proposed to be moved after LFNST index to handle all transform type signalling in a single place.

The proposed change is reported to have BD-rate impacts of -0.11 % and -0.07 % in AI and RA configurations, respectively. Encoder and decoder runtimes are reportedly not affected with respect to those of VTM-6.

Currently, signalling of LFNST depends on last coeff. Positions, including chroma. It was expressed in the discussion that the proposal has interesting aspects, but it includes various changes, and the benefit is not obvious if all these are needed. More information is requested on the particular benefit e.g. of making changes of MTS signalling. It is asserted that the benefit in compresson mainly comes due to making MTS signalling dependent on LFNST.

It is also asked if there is a significant latency issue. It was expressed that for certain implementations it would be desirable to decouple the LFNST from the chroma information.

LGE is currently cross-checking. One expert points out that there may be misalignment between spec and software – cross-checkers should investigate this.

Several experts expressed support that this proposal has beneficial aspects.

Further study in CE.

[JVET-P0197](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7986) CE6-related: LFNST transform mapping [J. Lainema (Nokia) , M.-S. Chiang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

This document proposes to change the mapping of LFNST indexes to transform matrices. Two methods are tested. Method 1 is described as follows. For LFNST index 1, the proposed approach selects transform index 1 for even and 2 for odd numbered intra prediction modes. For LFNST index 2 the selection is inverted and thus transform index 1 is selected for odd and 2 for even intra prediction modes. In addition, context coding for the second bin of the lfnstIdx syntax element is re-introduced. Method 2 is similar to method 1 but uses different mapping methods for the intra prediction modes <= 34 and intra prediction modes > 34.

It is asserted that for CTC conditions the coding efficiency is practically unaffected, but a low complexity encoder can operate at 90 % encoder runtime with +0.13%~+0.14 % bitrate impact under AI conditions and at 97 % encoder runtime with +0.11 % bitrate impact under RA conditions. This is reported to be a significantly lower BD-rate penalty than what was achieved with the comparable encoder approaches in CE6-1, where the best performing encoder side approach had +0.46 %~+0.48% impact on BD-rate for AI and +0.27 % for RA.The proposal allows still selecting the two NST types, but depending on intra mode parity the signalling is toggled. Furthermore, a context coded bin is added. A fast encoder could always select the same type and would go to the solution of CE6-1. The benefit in encoding runtime versus compression loss is still the same (slightly worse) as for CE6-1. The signalling becomes more complicated.

NO action.

Similar approaches: 215, 349/350, 568

[JVET-P0215](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8004) CE6 related: Harmonization of CE6-1.1 and two-mode LFNST [X. Zhao, X. Li, S. Liu (Tencent)]

Identical to JVET-P0197 – no action.

[JVET-P0216](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8005) Non-CE6: Simplified SBT mode coding [J. Park, B. Jeon (SKKU)]

[JVET-P0806](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8621) Crosscheck of JVET-P0216 (Non-CE6: Simplified SBT mode coding) [L. Pham Van, G. Van der Auwera (Qualcomm)]

[JVET-P0259](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8048) Non-CE6: On LFNST reduced kernels [J. Gan, C. Rosewarne (Canon)]

In the current design, the Low-frequency Non-separable Transform (LFNST) requires 8KB of memory to store the transform matrices. This contribution proposes to reduce the LFNST 16x48 matrices to 16x36 by removing primary transform coefficients that correspond to columns of low magnitude weights in the 16x48 matrices. It is reported that the proposed method achieves 18.75% table size reduction with 0.04% loss in All Intra configuration in CTC.

The powerpoint deck has some additional information.

It is asserted that the occupation of the LFNST matrices with low-weight matrices is due to the mode sets with directional orientation.

Interesting information about properties of LFNST.

As saving of ROM memory is not highly relevant. No reason to change the existing design.

[JVET-P0886](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8701) Crosscheck of JVET-P0259 (Non-CE6: On LFNST reduced kernels) [H. E. Egilmez (Qualcomm)]

[JVET-P0266](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8055) Non-CE6: LFNST signalling [C. Rosewarne, J. Gan (Canon)]

VVC uses a CU-level signalling of LFNST, sent after the residual when last positions of the TBs indicate all significant coefficients are subject to secondary transformation. When chroma separate tree (CST) is disabled in I slices, and in P or B slices, this results in the signalling applying both to luma and chroma TBs of a CU. This contribution proposes separate luma and chroma control of LFNST when CST is not in use. Coding performance results of this are AI: x.xx%, x.xx%, x.xx%, in Y, Cb, and Cr components, respectively.

Separate signalling for luma and chroma. No obvious benefit from the results, very slow encoder.

No need for action.

[JVET-P0271](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8060) Non-CE6: Context modelling for LFNST index coding [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

In this document a bugfix for the configuration parameter MTSIntraMaxCand is proposed, which by itself is claimed to have no impact on the CTC. Furthermore, it is proposed to set the CTC value of the parameter for AI and RA to from currently 3 to 1, avoiding testing transform combinations which are reportedly rarely used. A minor BD-rate impact on the CTC results is reported, namely 0.00% (Y), 0.00% (U), 0.01% (V) for AI and 0.01% (Y), 0.01% (U), -0.01% (V) for RA.

The mismatch between SW and text is already resolved (ticket issued). Proposal to reduce the number of context variables of bin 0 from 2 to 1, removes dependency on tree type.

Very small loss (0.01% in RA) unless retraining matrices, and the complexity advantage appears negligible. No action.

[JVET-P0771](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8586) Crosscheck of JVETP0271 (Non-CE6: Context modeling for LFNST index coding) [Y.-W. Chen (Kwai)]

[JVET-P0273](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8062) Non-CE6: On MTSIntraMaxCand [C. Hollmann, D. Saffar, J. Ström (Ericsson)]

In this document a bugfix for the configuration parameter MTSIntraMaxCand is proposed, which by itself is claimed to have no impact on the CTC. Furthermore, it is proposed to set the CTC value of the parameter for AI and RA to from currently 3 to 1, avoiding testing transform combinations which are reportedly rarely used. A minor BD-rate impact on the CTC results is reported, namely 0.00% (Y), 0.00% (U), 0.01% (V) for AI and 0.01% (Y), 0.01% (U), -0.01% (V) for RA.

“Bugfix” is the current disabling of MTSIntraMaxCandidate when LFNST is enabled.

This only applies to software and configuration files.

If LFNST is used, currently the software overwrites this parameter by a value of 4. Would be better to hve it configurable.

Decision(SW/CTC): It is agreed to apply the suggested bugfix (make the number of candidates configurable), but set the value to 4 in CTC (i.e. keeping CTC unchanged).

[JVET-P0930](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8745) Crosscheck of JVET-P0273 (Non-CE6: On MTSIntraMaxCand) [Y. Wang (Bytedance)]

[JVET-P0276](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8065) Non-CE6: On Supporting 64x64 Chroma Transform Unit with Composite VPDU [W. Cai, J. Zhu, J. Yao, K. Kazui (Fujitsu)]

This contribution proposes to support the maximum transform unit size of chroma components in 4:2:0 format up to 64x64 by introducing composite VPDU concept. For CTUs coded in dual tree in I slices, a flag is used to indicate whether a 64x64 chroma block is split into 4 32x32 blocks or not. If a 64x64 chroma block is not split, i.e. chroma CU size is 64x64, its TU size is also 64x64. CCLM is disabled for 64x64 chroma CU. For inter CU, when inter CU size in luma samples is larger than 64x64 (i.e. 128x128, 128x64 or 64x128), the size of transform unit of chroma components is up to 64x64. Otherwise, the maximum transform unit size of chroma is 32x32. By sharing transform core and internal buffer between luma TU and chroma TU, there is no extra hardware cost on decoder pipeline except scheduling mechanic (controller) of pipeline. The simulation results show -0.01%(Y), -0.20%(Cb), and -0.29%(Cr)BD-rates for AI configuration and -0.00%(Y), -0.17%(Cb), and -0.22%(Cr)BD-rates for RA configuration respectively on top of VTM-6.0.

The benefit in compression is low, and the proposal makes the VPDU concept more complicated. Also unclear how it would work with IBC, DMVR, etc.

No action.

[JVET-P0786](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8601) Crosscheck of JVET-P0276 (Non-CE6:On Supporting 64x64 Chroma Transform Unit with Composite VPDU) [F. Urban (InterDigital)]

[JVET-P0301](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8090) Non-CE6: Decoding process of implicit TU partitioning [G. Ko, D. Kim, J. Jung, J. Son, J. Kwak (WILUS)]

This contribution proposes to change the decoding process related to the implicit TU partitioning. The configurable maximum transform size has been adopted and the transform tree syntax related to the implicit TU partitioning has changed accordingly. Meanwhile, the corresponding decoding process has remained unchanged. Therefore, there exists a case that the processing order of partitioned transform blocks is different in the syntax and the decoding process. It is proposed to make a change on the decoding process of the implicit TU partitioning to follow the syntax. The proposed change has no impact on VTM.

It is reported that the sequence of block processing for case of implicit partuitioning is different in the syntax and decoding process description of the spec text. Decoder software implements the sequence as in the syntax part of the spec.

Decision(BF/text/ed.): Editors to check and align as necessary.

[JVET-P0313](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8102) Non-CE6: Simplification of LFNST LUT [S. Shrestha, A. Kumar, B. Lee (Chosun Univ.), Y. Lee, J. Park (Humax)]

In VTM-6.0, four LFNST transform kernel sets with kernel sizes and are defined. One of the LFNST transform kernel set (lfnstTrSetIdx) among four transform sets is selected based on predModeIntra. In this contribution, a LFNST LUT is newly defined to save the total memory size of LFNST LUT by removing the LUT for WAIP. In our proposed method, lfnstTrSetIdx for MIP and WAIP is decided to 0 and 1, respectively and lfnstTrSetIdx for predModeIntra from 67 to 94 is removed in the proposed LFNST LUT. The proposed LFNST LUT can save 28 bytes out of 96 bytes of memory size of LFNST LUT. The experimental results show Y: 0.00%, U: 0.00%, V: 0.00%, EncT: 99, DecT: 106% for AI and Y: 0.00%, U: 0.00%, V: 0.00%, EncT: 100%, DecT: 100% for RA.

The saving of memory is not significant, and instead two conditional checks are introduced.

Benefit not obvious – no action.

[JVET-P0951](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8766) Crosscheck of JVET-P0313 (Non-CE6: Simplification of LFNST LUT) [J. Heo (LGE)]

[JVET-P0342](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8131) CE6-related: LFNST applied to ISP mode [F. Le Léannec, K. Naser, F. Galpin (InterDigital)]

Intra sub-partition (ISP) is the only intra coding mode where LFNST is not applied in VTM-6. This contribution proposes to unify the VVC design by allowing LFNST in coding units coded in ISP mode. As for MIP, LFNST is allowed for CU size greater or equal to 16 in width and height. The proposed extended used of LFNST brings coding gain in every class of the JVET RA CTC. It reportedly brings -0.02% average gain in RA, with unchanged coding and decoding time. No change in AI performance is observed. A second tested method allows the LFNST/ISP combination if the CU size is such that the ISP splitting leads to TU size at least equal to 4x4. It is shown that it improves the BD-rate performances of the first method.

From the results given (0.02% gain in RA for 2% enc time increase) no need for action.

Similar contribution: JVET-P0392

[JVET-P0906](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8721) Cross-check of JVET-P0342 (CE6-related: LFNST applied to ISP mode) [S. De-Luxán-Hernández (HHI)]

[JVET-P0346](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8135) Non-CE6: SPS Clean-up of SBT [K. Naser, T. Poirier, F. Le Léannec, F. Galpin (InterDigital)]

Sub-Block Transform (SBT) is controlled by an SPS parameter (sps\_sbt\_enabled\_flag) to activate/deactivate it. If activated, another SPS parameter (sps\_sbt\_max\_size\_64\_flag) is coded to indicate if max SBT size is 64 or 32. However, due to the adoption of JVET-O0545, max SBT size is restricted to the maximum allowable transform size. Therefore, if the maximum transform size is set to 32, maximum SBT size is restricted to 32 regardless of the SPS parameter sps\_sbt\_max\_size\_64\_flag. This contribution proposes to code sps\_sbt\_max\_size\_64\_flag only if the maximum transform size is 64, otherwise max SBT size is inferred to be zero.

P0405 aspect 2 proposes the same.

P0391 aspect 1 proposes the same.

Decision: Adopt JVET-P0346.

[JVET-P0349](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8138) CE6 Related: MIP Adaptation On Top of CE6-1.1d [K. Naser, F. Galpin, T. Poirier, Y. Chen (InterDigital)]

Makes an additional dependency on selecting transform type when MIP is used (based on even/odd MIP mode). Additional benefit is average 0.01%, more (0.04%) for class A1.

No action.

[JVET-P0350](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8139) CE6 Related: Modified LFNST Index Coding For Fast Encoder Implementation [K. Naser, F. Galpin, T. Poirier, Y. Chen (InterDigital)]

Identical to JVET-P0197 in one version, and the second version makes an additional dependency on selecting transform type when MIP is used. The latter gives on average 0.01% compression benefit – no action.

Proponents announce that they are currently running simulations by changing the LFNST type flag to context coded (it had been also context coded in an earlier version), and having a fast encoder select always one type, such that the flag would cost almost nothing. Revisit after results are available.

[JVET-P0882](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8697) Crosscheck of JVET-P0350 (CE6-related: Modified LFNST Index Coding For Fast Encoder Implementation) [J. Lainema (Nokia)]

[JVET-P0354](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8143) Non-CE6: LFNST Up to 64x64 CU’s [K. Naser, T. Poirier, F. Le Léannec, F. Galpin (InterDigital)]

During the last JVET meeting, LFNST was restricted to CU’s not larger than the maximum TU size in order to solve the VPDU issue. However, due to the adoption of JVET-O0545, the maximum transform size changes between 64x64 and 32x32 depending on the SPS flag sps\_max\_luma\_transform\_size\_64\_flagsps\_sbt\_max\_size\_64\_flag. Despite no VPDU issue, LFNST is restricted to 32x32 when sps\_max\_luma\_transform\_size\_64\_flagsps\_sbt\_max\_size\_64\_flag is set to zero according to the current specification. This contribution proposes to remove this restriction and allow LFNST up to 64x64 regardless sps\_max\_luma\_transform\_size\_64\_flagsps\_sbt\_max\_size\_64\_flag, where TU tiling is performed when CU size is larger than TU. It is reported that the -0.04% AI luma gain is achieved.

This only applies to non-CTC case when max TU size is set to 32. Conceptually similar to the combination of ISP and LFNST, where LFNST is signalled at CU level but applied to several TUs in that CU.

The gain is small, and would require additional checks in the syntax. No need for action.

[JVET-P0872](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8687) Crosscheck of JVET-P0354: Non-CE6: LFNST Up to 64x64 CU’s [J. Jung, D. Kim, G. Ko, J. Son, J. Kwak (WILUS)]

[JVET-P0376](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8165) Non-CE6: Refined LFNST restriction with MIP [H. Yang, Y. He (InterDigital)]

In VTM-6.0, LFNST (low-frequency non-separable transform) is allowed to be used together with MIP (Matrix weighted intra prediction) for large coding blocks (i.e. min(width, height) ≥ 16). In this proposal, we propose to always disallow LFNST with MIP for inter slices. Simulation result shows +0.02% Y BD-rate change of RA, with similar encoding and decoding time.

Several experts expressed that there is no issue in terms of complexity. No reason imposing specific restrictions.

[JVET-P0682](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8481) Crosscheck of JVET-P0376: Refined LFNST restriction with MIP [X. Zhao (Tencent)]

[JVET-P0379](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8168) Non-CE6: Unified zero-out range for 4x4 LFNST [K. Fan, L. Zhang, K. Zhang, Y. Wang (Bytedance)]

The current LFNST design defines the zero-out range according to transform block sizes. In this contribution, a unification of the zero-out ranges for 4×4 LFNST is proposed. With the proposed method, it is asserted that the computational complexity of LFNST could be saved by 50% for 4×N and N×4 blocks. Meanwhile, the on-chip memory size required by 4×4 LFNST is reported to be reduced by 50%. Experimental results reportedly show that the BD-rate changes are negligible, i.e., 0.03%, 0.01% for AI and RA configurations, respectively. For the low QP settings according to CE6 test conditions, the coding loss is reported to be 0.03% for AI configuration.

Does not change the worst case of complexity (which is for 4x4 blocks).

The memory saving for storing matrices is not a big deal (ROM), see notes under CE6-2.

The benefit in terms of hardware implementation appears minor, better keep design unmodified.

[JVET-P0696](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8495) Cross-check of JVET-P0379: Non-CE6: A unified zero-out range for 4x4 LFNST [H. Sun, J. Li (Panasonic)]

[JVET-P0391](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8180) Non-CE6: A clean-up of SPS maximum SBT size signaling [M. G. Sarwer, R. L. Liao, J. Luo, Y. Ye (Alibaba)]

In VVC6, when sps\_sbt\_enabled\_flag = 1, sps\_sbt\_max\_size\_64\_flag is signalled regardless of the value of maximum transform block size specified by sps\_max\_luma\_transform\_size\_64\_flag. This contribution proposes to signal sps\_sbt\_max\_size\_64\_flag only if the maximum transform block size is 64. If the maximum transform block size is 32, sps\_sbt\_max\_size\_64\_flag is inferred to be 0. As an alternative approach, this contribution also proposes to remove the maximum SBT size signaling and maximum SBT size is inferred to be equal to maximum transform block size.

First aspect: Same as P0346

Second aspect: In CTC, currently the SBT flag is set to maximum 32 for classes C and D. This is mainly for encoder complexity, as larger SBT would hardly be used. As the purpose is different from the max transform size, better keep both.

From the discussion: The name of the SBT transform size flag may be misleading. Its purpose is rather restricting usage of SBT for CU >32

[JVET-P0392](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8181) Non-CE6: Combination of ISP and LFNST [S. De-Luxán-Hernández, V. George, G. Venugopal, J. Brandenburg, B. Bross, H. Schwarz, D. Marpe, T. Wiegand (HHI), M. Koo, M. Salehifar, J. Lim, S. Kim (LGE)]

In VTM-6.0 LFNST and ISP are mutually exclusive. This contribution proposes to remove this restriction. In case of ISP, the LFNST index is also signalled at the CU-Level and applied to all ISP TUs. The results of two different encoder configurations, Test 1 and 2, are presented. Test 1 obtains a gain of 0.19% and 111% and 100% encoder and decoder run-times respectively for AI. In the case of RA, the gain is 0.12% and 102% and 101% encoder and decoder run-times respectively. Test 2, which applies a fast encoder search, obtains a a gain of 0.10% and 101% and 99% encoder and decoder run-times respectively for AI. In the case of RA, the gain is 0.10% and 101% and 101% encoder and decoder run-times respectively.

It is further reported that the gain of ISP (based on tool-off test) increases when combined with LFNST. This seems to indicate that the two tools have a positive synergy.

LFNST is not changed.

The modifications are straightforward in terms of checking for ISP block sizes instead of cu sizes.

Signalled at CU level, coding and syntax not changed.

Question is raised how it would combine with JVET-P0196, which is studied in CE.

Study in CE along with JVET-P0196.

[JVET-P0854](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8669) Cross-check of JVET-P0392 (Non-CE6: Combination of ISP and LFNST) [F. Le Leannec (InterDigital)]

[JVET-P0405](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8194) Non-CE6: Cleanups of maximum transform size related syntax elements [Z. Deng, L. Zhang, K. Zhang, H. Liu, Y. Wang (Bytedance)]

In current VVC, the maximum transform size is signalled regardless the size of maximum CTU size. In addition, the maximum SBT size is signalled regardless the size of maximum transform sizes. This contribution proposes to conditionally signal the maximum transform size and maximum SBT size. More specifically, two aspects are proposed as follows:

Aspect #1: **sps\_max\_luma\_transform\_size\_64\_flag** is signalled only when the CTU size is larger than or equal to 64.

Aspect #2: **sps\_sbt\_max\_size\_64\_flag** is signalled only when the maximum transform size is equal to 64.

Aspect 2: Same as P0346. It also simplifies the spec, as currenly it is necessary to enforce the SBT transform to size 32 when the flag is signalling 64

Aspect1: Saving 1 bit in SPS for very specific cases is irrelevant, and it would require another parsing condition. No obvious benefit.

[JVET-P0430](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8219) AHG17: High level syntax cleanup on the syntax elements of transform skip [Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

The proposal is summarized as follows:

1. Replace ue(v) with u(2) for the binarization of the syntax element log2\_transform\_skip\_max\_size\_minus2

2. Infer sps\_transform\_skip\_enabled\_flag to be 0 when MinCbLog2SizeY is larger than 5. Add a requirement of conformance that log2\_transform\_skip\_max\_size\_minus2 shall be larger than or equal to log2\_min\_luma\_coding\_block\_size\_minus2.

The ue(v) signalling was inherited from RExt syntax. There is no obvious benefit replacing it with fixed length code.The issues mentioned under 2 are not critical, as there will be no problem in block-level decoding, since a TS flag would never appear (unless it would an illegal bitstream).

The aspect of moving the signalling from PPS to SPS needs to be further discussed (see notes under JVET-P0486) – revisit on that

[JVET-P0493](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8282) CE6-related: Further simplification with new LFNST transform basis [?? (??)] [late]

(include abstract)

It is asserted that saving of memory for LFNST matrices is not a real problem (ROM, fixed table). No reason to change the existing design.

[JVET-P0887](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8702) Crosscheck of JVET-P0493 (CE6-related: Further simplification with new LFNST transform basis) [H. E. Egilmez (Qualcomm)]

[JVET-P0495](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8284) Non-CE6: On implicit MTS [Y. Wang, H. Liu, L. Zhang, K. Zhang, Z. Deng, Y. Wang (Bytedance)]

In the current design of VVC, implicit MTS may be applied on ISP-coded blocks, SBT-coded blocks and normal-intra coded blocks with different rules. Implicit MTS is controlled together for all the three cases. When sps\_mts\_enabled\_flag is equal to 0, only DCT2 can be used in all the three cases, which is inflexible and deteriorates the coding performance of ISP and SBT. In this contribution, two aspects are proposed to control implicit MTS in three cases separately. Two flags are signalled in SPS to indicate whether non-DCT2 transform kernels are allowed for ISP and SBT, respectively. Simulation results reportedly show BD-rate changes of -0.37%/-0.35%/-0.34% in AI/RA/LB configurations on average, compared to VTM-6.0 with MTS disabled.

It is mentioned that JVET-P0569 method 3 is a superset.

Comparison is not CTC

More clarity needed what is desirable:

* Encoders might want only using DCT2 -> MTS enabled flag manages that
* If MTS enabled:
  + Using implicit MTS only for SBT and ISP, without using for anything else
  + Select separately for inter and intra
    - Not using MTS
    - Using implicit for all blocks (in case of inter only for SBT)
    - Using explicit for blocks that are not SBT or ISP

The solution of P0501 plus an additional “DCT only” flag of P0569 could achieve this:

“If !DCTonly {syntax of 501}”

Proponents of 495, 501, 569 should provide a table that indicates to what extent the different possible syntax states provide which level of flexibility – revisit

[JVET-P0691](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8490) Crosscheck of JVET-P0495: Non-CE6: On implicit MTS [C. Hollmann (Ericsson)]

[JVET-P0501](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8291) Non-CE6: Cleanup on MTS related HLS [X. Zhao, X. Li, S. Liu (Tencent)]

In VVC Draft 6, there are three MTS related coding tools, including intra implicit MTS, intra explicit MTS and inter explicit MTS, and the enabling/disabling of these three tools are controlled by SPS flags. According to VVC Draft 6, in order to enable inter explicit MTS for inter prediction residuals, either implicit or explicit MTS must be enabled for intra prediction residuals, which is not necessary. In this contribution, it is proposed to decouple the HLS controlling of intra (either implicit or explicit) MTS and inter explicit MTS, such that intra MTS and inter explicit MTS can be enabled/disabled individually.

It is agreed that this is a useful change, allowing configuring MTS more independently for intra and inter cases. Proposals JVET-P0569 and JVET-P0495 target similar issues.

[JVET-P0527](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8317) Non-CE6: On context model for coding last NZ position [T.-C. Ma, Y.-W. Chen, X. Xiu, H.-J. Jhu, X. Wang (Kwai Inc.)]

This contribution is proposed to align the context model selection of last non-zero coefficient position coding with the size of zero-out TUs. The proposed modification reduces 10 context models.

The result of test shows that the coding loss is 0.02%, 0.03%, 0.02XXX% for All Intra, RA, and LDB, respectively.

The further reduction of context models does not appear important.

[JVET-P0758](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8562) Crosscheck of JVET-P0527 (Non-CE6: On context model for coding last NZ position) [T. Tsukuba (Sony)]

[JVET-P0538](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8328) Non-CE6: Transform skip with fixed transform shift [J. Xu, L. Zhang, W. Zhu, K. Zhang, H. Liu, Z. Deng (Bytedance)]

In the current VVC design, a transform shift is applied to simulate transform process for all blocks even for a transform skip coded block. In this contribution, two methods are proposed. Method 1 is to have a fixed shifting to fit the 16-bit range. Method 2 is to remove such a transform simulation for transform skip blocks. It is asserted that computational complexity reduction is achieved. No BD-rate changes under the CTC are observed. For low QPs (2, 7, 12, 17), some minor BD-rate changes are reported.

The deviation is due to the fact that the current method of VVC invokes a right shift (block size dependent) in dequantization which introduces a kind of rounding error that cannot be compensated by the subsequent left shift. This effect becomes noticeable only at very low QPs.

The proposed methods solve this issue and by tendency have (marginally) better performance, in most cases bit-wise equal. Method 2 which is basically performing “transquant-bypass with quantization/scaling”

JVET-P0272 and JVET-P0515 are targeting the same issue

JVET-P0272 and JVET-P0515 are identical to method 2 at decoder, but have a modified encoder in terms of RD optimization. The additional gain is not high (0.1% in TGM and class F in AI for JVET-P0515)

Proponents of the three contributions to come together, and provide text, software and a recommendation of possible changes to the encoder. Revisit.

[JVET-P0759](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8563) Crosscheck of JVET-P0538 (Non-CE6: Transform skip with fixed transform shift) [T. Tsukuba (Sony)]

[JVET-P0540](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8330) Non-CE6: Disabling MTS for 64xN and Nx64 CUs [J. Jung, D. Kim, G. Ko, J. Son, J. Kwak (WILUS)]

[JVET-P0680](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8479) Crosscheck of JVET-P0540: Disabling MTS for 64xN and Nx64 CUs [X. Zhao (Tencent)]

[JVET-P0545](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8335) CE6-2.3-related: further reduced 8x8 LFNST matrices [K. Fan, L. Zhang, K. Zhang, Y. Wang (Bytedance)]

[JVET-P0898](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8713) Crosscheck of JVET-P0545: CE6-2.3-related: Reduced 8×8 matrices for LFNST [T. Zhou (Sharp)]

[JVET-P0566](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8356) CE6-related: On LFNST Support Patterns [H. E. Egilmez, A. Said, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0931](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8746) Crosscheck of JVET-P0566 (CE6-related: On LFNST Support Patterns) [J. Gan (Canon)]

[JVET-P0567](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8357) CE6-related: Optimized LFNST matrices for CE6-2.1 [H. E. Egilmez, A. Said, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0897](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8712) Crosscheck of JVET-P0567: CE6-related: Optimized LFNST matrices for CE6-2.1 [T. Zhou (Sharp)]

[JVET-P0568](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8358) CE6-related: An LFNST Index Signaling with Bin Prediction [H. E. Egilmez, V. Seregin, A. Nalci, A. Said, M. Karczewicz (Qualcomm)]

Identical to JVET-P0197, with a different signalling method – no action.

[JVET-P0883](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8698) Crosscheck of JVET-P0568 (CE6-related: An LFNST Index Signaling with Bin Prediction) [J. Lainema (Nokia)]

[JVET-P0569](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8359) AHG17/Non-CE6: High-level syntax for MTS and Implicit Transform Derivations [H. E. Egilmez, V. Seregin, M. Karczewicz (Qualcomm)]

This document proposes modifications for SPS-level signaling of MTS-related flags in order to remove unnecessary dependencies between explicitly signalled and implicitly defined transform selection.

The current design has following issues:

1) Explicit MTS flags **sps\_explicit\_mts\_intra\_enabled\_flag** and **sps\_explicit\_mts\_inter\_enabled\_flag** can enable implicit MTS derivation even though it is set to be disabled (i.e., VTM-6.0 configuration is set to MTSImplicit = 0). For example, when only inter MTS is enabled and implicit MTS is disabled (i.e., when VTM-6.0 configurations are MTS=2 and MTSImplicit = 0), VTM-6.0 enables implicit transform for intra blocks. In other words, the implicit MTS derivation for intra can depend on inter MTS flag.

2) Flags **sps\_explicit\_mts\_intra\_enabled\_flag**, **sps\_explicit\_mts\_inter\_enabled\_flag** and **sps\_mts\_enabled\_flag** can modify the transform derivation for SBT and ISP, which is counter-intuitive. If all these three flags are disabled, only DCT-2 transform can be used in all TUs. On top of this, if only inter MTS flag is enabled, then ISP uses a combination of DCT-2 and DST-7. In other words, transform derivation on ISP (which is an intra coding tool) can depend on inter MTS flag. Similarly, transform derivation for SBT (which is an inter coding tool) can depend on Intra MTS flag.

[JVET-P0634](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8431) Non-CE6: Removal of LFNST for 4x4, 4xN and Nx4 blocks [H. E. Egilmez, T. Hsieh, V. Seregin, M. Karczewicz (Qualcomm)] [late]

[JVET-P0637](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8434) CE6-related: On measuring reconstruction error of LFNST matrices [X. Zhao (Tencent)] [late]

[JVET-P0640](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8437) Non-CE6: High Level Syntax Flag for SBT Transform Selection [K. Naser, F. Le Léannec, M. Kerdranvat, T. Poirier (InterDigital)] [late]

[JVET-P0699](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8498) Non-CE6 / Non-CE3: On ISP and Maximum Transform Size [K. Naser, T. Poirier, T. Urban, G. Rath (InterDigital)] [late]

[JVET-P0702](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8502) Non-CE6 / Non-CE3: Combined Test of JVET-P0352 and JVET-P0354 [K. Naser, T. Poirier, F. Le Léannec, F. Galpin (InterDigital)] [late]

This contribution provides the results of combining JVET-P0352 and JVET-P0352. When the maximum transform size is set to 32 (sps\_max\_luma\_transform\_size\_64\_flag is zero), JVET-P0352 proposes to allow MIP for CU’s up to 64x64 by TU tiling and then performing MIP. Similarly, JVET-P0352 proposes allowing LFNST for CU’s up to 64x64 by TU tiling and performing LFNST on each of the tile. The combination of the two tools is reported to provide 0.06% luma gain in AI condition when sps\_max\_luma\_transform\_size\_64\_flag is zero in both test and anchor. It is also reported that the coding gain in luma of class A1 is 0.20% and 0.42% in AI and RA conditions.

The reported gain is under non-CTC condition, restricting max transform size to 32

Was discussed in context of CE6, where it was identified that JVET-P0352 may have some interesting aspects that would better be discussed in context of other MIP in CE3. The point is that unlike normal intra prediction, in case of switching max transform size to 32, MIP would be disallowed for a 64x64 CU, whereas other intra modes would be applied on 32x32 transform blocks. It is suggested in P0352 that MIP should also be applied per 32x32 transform block in such case.

[JVET-P0747](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8550) Crosscheck of JVET-P0702 (Non-CE6 / Non-CE3: Combined Test of JVET-P0352 and JVET-P0354) [T. Biatek (Qualcomm)]

[JVET-P0814](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8629) Non-CE6: On LFNST kernels [M. Koo, M. Salehifar, J. Lim, S. Kim (LGE)] [late]

[JVET-P0965](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8780) Crosscheck of JVET-P0814 (Non-CE6: On LFNST kernels) [G. Ko, D. Kim, J. Jung, J. Son, J. Kwak (WILUS)]

[JVET-P0878](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8693) CE6-related: Optimized LFNST matrices for VTM-6.0 [H. E. Egilmez, A. Said, V. Seregin, M. Karczewicz (Qualcomm)] [late]

[JVET-P0210](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7999) Non-CE8: Transform skip for chroma block in the single tree [J. Park, B. Jeon (SKKU)]

[JVET-P0681](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8480) Crosscheck of JVET-P0210: Transform skip for chroma block in the single tree [X. Zhao (Tencent)]

## CE7 related – Quantization and coefficient coding (24)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0042](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7831) Non-CE7: A cleanup for inter\_pred\_idc coding [B. Heng, M. Zhou (Broadcom)]

[JVET-P0713](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8514) Crosscheck of JVET-P0042 (Non-CE7: A cleanup for inter\_pred\_idc coding) [K. Panusopone (Nokia)]

[JVET-P0050](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7839) AHG16/Non-CE7: A study of bin to bit ratio for VTM6.0 [M. Zhou (Broadcom)]

[JVET-P0169](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7958) CE7-related: Further context reduction for sig\_coeff\_flag [S.-T. Hsiang, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0942](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8757) Crosscheck of JVET-P0169: CE7-related: Further context reduction for sig\_coeff\_flag [C. Auyeung, X. Li (Tencent)]

[JVET-P0170](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7959) CE7-related: Simplification of coding transform coefficient levels [S.-T. Hsiang, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0966](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8781) Crosscheck of JVET-P0170: CE7-related: on Simplification of coding transform coefficient level [M. Sosulnikov, M. Sychev (Huawei)]

[JVET-P0270](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8059) Non-CE7: Modified signalling method of cu\_cbf and tu\_cbf\_luma [D. -J. Won, J. -M. Ha, J. -H. Moon (Sejong university)]

[JVET-P0762](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8577) Cross-check of JVET-P0270 (Non-CE7: Modified signaling method of cu\_cbf and tu\_cbf\_luma) [S.-C. Lim, H. Lee, J. Lee, J. Kang (ETRI)]

[JVET-P0272](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8061) On Scaling of Transform Skip [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

[JVET-P0809](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8624) Crosscheck of JVET-P0272 (On Scaling for Transform Skip) [J. Xu (Bytedance)]

[JVET-P0298](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8087) CE7-related: Unification of CCB check method and bypass coding between two residual coding modes [Y. Kato, K. Abe, T. Toma (Panasonic)]

[JVET-P0705](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8506) Crosscheck of JVET-P0298 (CE7-related: Unification of CCB check method and bypass coding between two residual coding modes) [H. Yang (InterDigital)]

[JVET-P0319](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8108) CE7-related: Re-position GT3 flag into the first coding pass in TS residual coding [Y. Chen, F. Le Léannec, T. Poirier, F. Galpin (InterDigital)]

[JVET-P0631](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8428) Crosscheck of JVET-P0319: Re-position GT3 flag into the first coding pass in TS residual coding [Y.-H. Chao (Qualcomm)]

[JVET-P0360](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8149) On chroma CBFs and transform units [A. K. Ramasubramonian, G. Van der Auwera, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0370](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8159) Non-CE7: Signaling of coded\_sub\_block\_flag [M. G. Sarwer, R. L. Liao, J. Luo, Y. Ye (Alibaba)]

[JVET-P0853](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8668) Cross-check of JVET-P0370 (Non-CE7: Signaling of coded\_sub\_block\_flag) [F. Le Leannec (InterDigital)]

[JVET-P0373](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8162) CE7-related: Decouple level mapping from transform skip residual coding [M. G. Sarwer, R. L. Liao, J. Luo, Y. Ye (Alibaba)]

[JVET-P0756](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8560) Crosscheck of JVET-P0373 (CE7-related: Decouple level mapping from transform skip residual coding) [T. Tsukuba (Sony)]

[JVET-P0397](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8186) CE7-related: Simplified two-pass transform-skip residual coding [M. G. Sarwer, R. L. Liao, J. Luo, Y. Ye (Alibaba)]

[JVET-P0692](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8491) Crosscheck of JVET-P0397 (CE7-related: Simplified two-pass transform-skip residual coding) [S.-T. Hsiang (MediaTek)]

[JVET-P0402](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8191) CE7-related: Unification of CCB count method between transform residual and transform skip residual coding [Y. Chen, F. Le Léannec, T. Poirier, K. Naser (InterDigital)]

[JVET-P0632](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8429) Crosscheck of JVET-P0402: Unification of CCB count method between transform residual and transform skip residual coding [Y.-H. Chao (Qualcomm)]

[JVET-P0422](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8211) Non-CE7: Unified neighbouring block selection in context and MV/mode derivation [W. Zhu, L. Zhang, J. Xu (Bytedance)]

[JVET-P0648](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8446) Crosscheck of JVET-P0422 (Non-CE7: Unified neighbouring block selection in context and MV/mode derivation) [H. Dou, L. Xu (Intel)]

[JVET-P0435](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8224) CE7-related: Modifications to transform skip significant flag coding [C. Auyeung, X. Li, X. Zhao, S. Liu (Tencent)]

[JVET-P0437](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8226) CE7-related: Modifications to transform skip coefficient sign flag coding [C. Auyeung, X. Li, X. Zhao, S. Liu (Tencent)]

[JVET-P0447](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8236) CE7-related: Rice parameter range extension in residual coding with transform skip [C. Auyeung, X. Li, X. Zhao, S. Liu (Tencent)]

[JVET-P0451](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8240) CE7-related: Combination of JVET-P0435, JVET-P0437, and JVET-P0447 for residual coding at 1.75 bins/coefficient [C. Auyeung, X. Li, X. Zhao, S. Liu (Tencent)]

[JVET-P0823](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8638) Crosscheck of JVET-P0451, JVET-P0435, JVET-P0437, and JVET-P0447: Modifications to the context modelling for residual coding [T. Nguyen (HHI)]

[JVET-P0465](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8254) Non-CE7: Rice parameter derivation for coefficient level coding [J. Choi, J. Heo, S. Yoo, J. Choi, J. Lim, S. Kim (LGE)]

[JVET-P0960](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8775) Cross-check of JVET-P0465 (Non-CE7: Rice parameter derivation for coefficient level coding) [Y. Chen (InterDigital)]

[JVET-P0488](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8277) Non-CE7: On updating a variable for context model selection [S. Yoo, J. Choi, J. Lim, S. Kim (LGE)]

[JVET-P0907](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8722) Cross-check of JVET-P0488 (Non-CE7: On updating a variable for context model selection) [F. Le Léannec (InterDigital)]

[JVET-P0508](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8298) CE7-related: unification for joint chroma residue coding modes [L. Zhao, X. Li, X. Zhao, S. Liu (Tencent)]

[JVET-P0881](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8696) Crosscheck of JVET-P0508 (CE7-related: unification for joint chroma residue coding modes) [J. Lainema (Nokia)]

[JVET-P0585](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8377) CE7-related: Alignment of number of context coded bins per coefficients for TS residual coding and transform coefficient coding [M. Coban, M. Karczewicz (Qualcomm)]

[JVET-P0587](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8379) CE7-related: Simplifying the derivation process of ctxInc for residual coding [S.-T. Hsiang, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0619](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8413) Non-CE7: State-dependent Binarization for Transform Coefficient Levels [H. Schwarz, A. Henkel, D. Marpe, T. Wiegand] [late]

[JVET-P0901](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8716) Crosscheck of JVET-P0619 (Non-CE7: State-dependent Binarization for Transform Coefficient Levels) [M. Coban (Qualcomm)]

## CE8 related – Screen content coding tools (36)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0230](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8019) CE8-1.2-related: Compound palette mode with signalled merge index [W. Zhu, J. Xu, L. Zhang (Bytedance)]

[JVET-P0889](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8704) Cross-check of JVET-P0230 (CE8-1.2-related: Compound palette mode with signalled merge index) [Y.-C. Sun (Alibaba)]

[JVET-P0283](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8072) Non-CE8: Modified DM mode selection under IBC mode using left block [D. Jiang, J. Lin, F. Zeng, C. Fang (Dahua)] [late]

Initial version rejected: requested authors not referring to CTC as other test set is used.

[JVET-P0284](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8073) Non-CE8: Modified DM mode selection under IBC mode using left and above block [D. Jiang, J. Lin, F. Zeng, C. Fang (Dahua)] [late]

Initial version rejected: requested authors not referring to CTC as other test set is used.

[JVET-P0375](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8164) Non-CE8: Palette mode CU size restriction [H. Yang, Y. He (InterDigital)]

[JVET-P0797](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8612) Crosscheck of JVET-P0375: Non-CE8: Palette mode CU size restriction [W. Zhu (Bytedance)]

[JVET-P0399](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8188) Non-CE8: On escape sample coding [W. Zhu, J. Xu, L. Zhang (Bytedance)]

[JVET-P0706](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8507) Crosscheck of JVET-P0399 (Non-CE8: On escape sample coding) [H. Yang (InterDigital)]

[JVET-P0400](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8189) AhG16/Non-CE8: Removal of shared merge list [Y. Wang, L. Zhang, H. Liu, K. Zhang, J. Xu, Y. Wang (Bytedance)]

[JVET-P0662](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8460) Crosscheck of JVET-P0400 (AhG16/Non-CE8: Removal of shared merge list) [J. Chen (Alibaba)]

[JVET-P0421](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8210) Non-CE8: Palette mode with 8-bit entries [W. Zhu, J. Xu, L. Zhang, H.-C. Chuang (Bytedance)]

[JVET-P0644](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8441) Cross-check of JVET-P0421: Non-CE8: Palette mode with 8-bit entries [J. Zhao (LGE)]

[JVET-P0424](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8213) Non-CE8: Resetting predictor palette at CTU row [W. Zhu, L. Zhang, J. Xu (Bytedance)]

[JVET-P0425](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8214) CE8-related: On index adjustment in palette mode [W. Zhu, J. Xu, L. Zhang (Bytedance)]

[JVET-P0732](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8534) Crosscheck of JVET-P0425 on index adjustment in palette mode [X. Xiu (Kwai Inc.)]

[JVET-P0454](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8243) Non-CE8: Constraints on IBC reference block locations [X. Xu, X. Li, S. Liu (Tencent)]

[JVET-P0733](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8535) Crosscheck of JVET-P0454 on constraints on IBC reference block locations [X. Xiu (Kwai Inc.)]

[JVET-P0455](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8244) Non-CE8: IBC slice level on/off [X. Xu, X. Li, S. Liu (Tencent)]

[JVET-P0913](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8728) Crosscheck of JVET-P0455 (Non-CE8: IBC slice level on/off) [H. Jang (LGE)]

[JVET-P0456](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8245) Non-CE8: IBC chroma mode with dual-tree [X. Xu, X. Li, S. Liu (Tencent)]

[JVET-P0838](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8653) Cross-check of JVET-P0456 (Non-CE8: IBC chroma mode with dual-tree) [M. G. Sarwer (Alibaba)]

[JVET-P0457](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8246) Non-CE8: On IBC merge list size signaling [X. Xu, X. Li, S. Liu (Tencent)]

[JVET-P0676](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8475) Crosscheck of JVET-P0457 (Non-CE8: On IBC merge list size signalling) [Y.-L. Hsiao (MediaTek)]

[JVET-P0460](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8249) Non-CE8: Minimum QP for Palette Escape Coding [J. Zhao, S. Paluri, S. Kim (LGE)]

[JVET-P0798](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8613) Crosscheck of JVET-P0460: Non-CE8: Minimum QP for Palette Escape Coding [W. Zhu (Bytedance)]

[JVET-P0472](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8261) Non-CE8: Palette Coding Encoder Improvement [J. Zhao, S. Yoo, S. Kim (LGE)]

[JVET-P0719](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8520) Crosscheck of JVET-P0472 (Non-CE8: Palette Coding Encoder Improvement) [H.-J. Jhu (Kwai Inc.)]

[JVET-P0473](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8262) Non-CE8: Implicit block partitioning in palette mode [Y.-H. Chao, T. Hsieh, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0724](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8525) Crosscheck of JVET-P0473 (Non-CE8: Implicit block partitioning in palette mode) [Y.-W. Chen (Kwai Inc.)]

[JVET-P0474](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8263) Non-CE8: Minimum QP for escape mode in palette [Y.-H. Chao, H. Wang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0795](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8610) Cross-check of JVET-P0474: Non-CE8: Minimum QP for escape mode in palette [J. Zhao (LGE)]

[JVET-P0475](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8264) Non-CE8: Simplification of palette predictor update for small CUs [Y.-H. Chao, T. Hsieh, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0707](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8508) Crosscheck of JVET-P0475 (Non-CE8: Simplification of palette predictor update for small CUs) [H. Yang (InterDigital)]

[JVET-P0476](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8265) Non-CE8: Palette mode and prediction mode signaling [Y.-H. Chao, C.-H. Hung, W.-J Chien, M. Karczewicz (Qualcomm)]

[JVET-P0843](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8658) Crosscheck of JVET-P0476 (Non-CE8: Palette mode and prediction mode signalling) [Y.-W. Chen (Kwai Inc.)]

[JVET-P0479](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8268) CE8-related: Restriction on context coded bins in palette [C.-H. Hung, Y.-H. Chao, M. Karczewicz (Qualcomm)]

[JVET-P0799](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8614) Crosscheck of JVET-P0479: CE8-related: Restriction on context coded bins in palette [W. Zhu (Bytedance)]

[JVET-P0483](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8272) Non-CE8: Quantization in palette escape mode [M. Karczewicz, H. Wang, Y.-H. Chao, M. Coban (Qualcomm)]

[JVET-P0720](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8521) Crosscheck of JVET-P0483 (Non-CE8: Quantization in palette escape mode) [H.-J. Jhu (Kwai Inc.)]

[JVET-P0486](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8275) CE8-related: Alignment of maximum transform-skip size with maximum transform block size [M. G. Sarwer, R. L. Liao, J. Luo, Y. Ye (Alibaba)]

Discussed in context of CE6 (Fri 4 Oct. 1930)

Regarding the signalling of the maximum transform skip size, it is asserted that the current signalling in VVC draft 6 allows too much flexibility, which is not only unnecessary but also burdens hardware verification and conformance testing. Therefore, this contribution proposes to either remove it and set it to the same value as the maximum TB size, or to move it from PPS to SPS and to signal just as an SPS flag indicating either 32 or 64 in the same way as the maximum TB size signalling.

In VVC draft 6, the maximum transform skip (TS) block size and maximum BDPCM block size are 32x32, whereas the maximum transform block (TB) size is 64x64. This contribution proposes to align the maximum TS and BDPCM block size with maximum TB size. In the proposed method, the maximum TS block size can be up to 64x64. For larger TS and BDPCM blocks (i.e. size > 32), it is proposed to split them into 32x32 residual unit (RU). This way, the existing VVC6 TS residual coefficient scanning method can be reused, and a decoder never has to scan residual blocks larger than 32x32. It is reported that the BD-rate impact of the proposed method is -0.02% (AI), -0.13% (RA), -0.20% (LB) for the SCC sequences under CTC test conditions.

In terms of compression, no significant benefit.

As transform skip is targeting other content than regular transform, it is desirable to configure it separately. Encoders might also want to restrict its usage to small blocks only for lower complexity.

It is asserted that the current flexibility of TS is desirable.

Revisit in context of CE8 related: Which amount of picture adaptivity is needed for TS, or can that be signalled at SPS?

[JVET-P0866](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8681) Crosscheck report of JVET-P0486 (CE8-related: Alignment of maximum transform-skip size with maximum transform block size) [X. Xu (Tencent)]

[JVET-P0487](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8276) Non-CE8: Binarization of palette escape value [S. Yoo, J. Zhao, J. Nam, J. Choi, S. Kim, J. Lim (LGE)] [late]

Initial version rejected as “placeholder”.

[JVET-P0943](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8758) Crosscheck of JVET-P0487 (CE8-related: Binarization of palette escape value) [K. Unno, K. Kawamura (KDDI)]

[JVET-P0959](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8774) Crosscheck of JVET-P0487: Non-CE8 : Binarization of palette escape value [Y.-H. Chao (Qualcomm)]

[JVET-P0515](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8305) Non-CE8: Quantization unification for palette escape and transform skip [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-P0715](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8516) Crosscheck of JVET-P0515: Non-CE8: Quantization unification for palette escape and transform skip [Y.-H. Chao (Qualcomm)]

[JVET-P0516](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8306) Non-CE8: On palette mode signaling binarization [Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-P0630](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8427) Crosscheck of JVET-P0516: On palette mode signalling binarization [Y.-H. Chao (Qualcomm)]

[JVET-P0522](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8312) Non-CE8: On palette mode syntax [Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-P0650](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8448) Crosscheck of JVET-P0522 (Non-CE8: On palette mode syntax) [T.-S. Chang (Alibaba)]

[JVET-P0523](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8313) Non-CE8: Context coded bin constraint for palette mode signaling [Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-P0651](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8449) Crosscheck of JVET-P0523 (Non-CE8: Context coded bin constraint for palette mode signaling) [T.-S. Chang (Alibaba)]

[JVET-P0526](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8316) Non-CE8: Palette encoder improvements [H.-J. Jhu, Y.-W. Chen, X. Xiu, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-P0796](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8611) Cross-check of JVET-P0526: Non-CE8: Palette encoder improvements [J. Zhao (LGE)]

[JVET-P0529](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8319) Non-CE8: QP dependent binarization for palette escape [H.-J. Jhu, Y.-W. Chen, X. Xiu, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-P0652](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8450) Crosscheck of JVET-P0529 (Non-CE8: QP dependent binarization for palette escape) [T.-S. Chang (Alibaba)]

[JVET-P0562](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8352) Non-CE8: Transform skip residual coding simplification [Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-P0642](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8439) Crosscheck of JVET-P0562 (Non-CE8: Transform skip residual coding simplification) [L. Zhao (Tencent)]

[JVET-P0565](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8355) CE8-related: Cross-component residual prediction for 4:4:4 format [K. Kawamura, S. Naito (KDDI)]

[JVET-P0957](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8772) Crosscheck of JVET-P0565 : CE8-related: Cross-component residual prediction for 4:4:4 format [S. Yoo, J. Lim (LGE)]

[JVET-P0573](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8363) AHG17/Non-CE8: Support parallel decoding based on initialization for palette predictor at CTU row [H. Jang, N. Park, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-P0643](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8440) Crosscheck of JVET-P0573: AHG17/NonCE8: Support parallel decoding based on initialization for palette predictor at CTU row [W. Zhu (Bytedance)]

[JVET-P0577](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8367) AHG17/Non-CE8: APS support for palette predictor entry initialization [H. Jang, S. Paluri, S. Yoo, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-P0670](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8468) Non-CE8: On num\_palette\_indices\_minus1 [W. Zhu, L. Zhang, J. Xu (Bytedance)] [late]

[JVET-P0731](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8533) Crosscheck of JVET-P0670 (Non-CE8: On num\_palette\_indices\_minus1) [H. Yang (InterDigital)]

[JVET-P0900](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8715) Non-CE8: Simplification of chroma BDPCM Syntax for single-tree [C.-C Kuo, [C.-C Lin](mailto:JackLin@itri.com), C.-L Lin (ITRI)] [late]

## Quantization control (23)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0093](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7882) Fix on value ranges of cu\_qp\_delta\_subdiv and cu\_chroma\_qp\_offset\_subdiv [E. Sasaki, T. Chujoh, T. Ikai (Sharp)]

[JVET-P0110](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7899) AHG15: Quantization matrices with single identifier and enhanced prediction [P. de Lagrange, F. Leléannec, E. François, K. Naser (InterDigital)]

[JVET-P0754](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8558) Crosscheck of JVET-P0110 (AHG15: Quantization matrices with single identifier and enhanced prediction) [J. Le Tanou (MediaKind)]

[JVET-P0167](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7956) CE7-related: Improved coding of user defined quantization matrices [O. Chubach, C.-Y. Lai, C.-Y. Chen, T.-D. Chuang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0813](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8628) Crosscheck of JVET-P0167 (CE7-related: Improved coding of user defined quantization matrices) [T. Toma, K. Abe (Panasonic)]

[JVET-P0168](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7957) CE7-related: Removing 2x2 chroma quantization matrices [O. Chubach, C.-Y. Lai, C.-Y. Chen, T.-D. Chuang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek), H. Jang, J. Nam, S. Paluri, S. Kim, J. Lim (LGE)]

[JVET-P0256](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8045) AHG15: 16x16 base scaling matrix for 64x64 TU [T. Toma, K. Abe (Panasonic)]

[JVET-P0909](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8724) Crosscheck of JVET-P0256 (AHG15: 16x16 base scaling matrix for 64x64 TU) [O. Chubach (MediaTek)]

[JVET-P0257](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8046) AHG15: VTM decoder speed-up for handling scaling matrices [T. Toma, K. Abe (Panasonic)]

[JVET-P0761](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8576) Cross-check of JVET-P0257 (AHG15: VTM decoder speed-up for handling scaling matrices) [S.-C. Lim, H. Lee, J. Lee, J. Kang (ETRI)]

[JVET-P0267](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8056) Quantization group subdivision level signalling [C. Rosewarne, J. Gan (Canon)]

[JVET-P0292](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8081) AHG15: Scaling process for LFNST case [T. Hashimoto, E. Sasaki, T. Ikai (Sharp)]

[JVET-P0657](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8455) Crosscheck of JVET-P0292 (AHG15: Scaling process for LFNST case) [Y. Wang (Bytedance)]

[JVET-P0293](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8082) AHG15: Signalling scaling matrix for LFNST case [T. Hashimoto, E. Sasaki, T. Ikai (Sharp)]

[JVET-P0321](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8110) AHG15: Signaling of chroma QP mapping table [Z. Wang, Y. Ye, J. Luo (Alibaba)]

[JVET-P0324](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8113) AHG15: Quantization matrix selection based on block area [P. de Lagrange, P. Bordes, K. Naser, E. François (InterDigital)]

[JVET-P0335](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8124) AHG15: Chroma QP mapping table for HDR [T. Lu, F. Pu, P. Yin, M. Sean, W. Husak, T. Chen (Dolby)]

[JVET-P0623](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8418) Crosscheck report of JVET-P0335 on Chroma QP mapping table for HDR [E. François (InterDigital)]

[JVET-P0339](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8128) AHG15: Signalling of CU level chroma QP offset [Z. Wang, Y. Ye, J. Luo (Alibaba)

[JVET-P0361](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8150) On chroma quantization groups [A. K. Ramasubramonian, G. Van der Auwera, W.-J. Chien, H. Huang, Y. Han, B. Ray, M. Karczewicz (Qualcomm)]

[JVET-P0365](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8154) AHG15: Scaling matrices for LFNST-coded blocks [A. K. Ramasubramonian, G. Van der Auwera, V. Seregin, H. E. Egilmez, M. Karczewicz (Qualcomm)]

[JVET-P0371](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8160) AHG7/AHG15: signalling of corrective values for chroma residual scaling [E. François, F. Galpin, K. Naser, P. de Lagrange (InterDigital)]

[JVET-P0711](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8512) Crosscheck of JVET-P0371 (AHG7/AHG15: signalling of corrective values for chroma residual scaling) [T. Lu (Dolby)]

[JVET-P0407](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8196) AHG15: cu\_qp\_delta\_subdiv and cu\_chroma\_qp\_offset\_subdiv syntax dependency removal [J. Chen, R.-L. Liao, J. Luo, Y. Ye (Alibaba)]

[JVET-P0410](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8199) AHG15: chroma QP mapping table syntax variant with less bits [P. de Lagrange, P. Bordes, K. Naser, E. François (InterDigital)]

[JVET-P0426](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8215) AHG17/AHG15: On quantization control parameters signalling [R. Chernyak (Huawei)]

[JVET-P0667](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8465) AHG17/AHG15: Comments on aspect 1 of JVET-P0426 [B. Ray, A. K. Ramasubramonian, G. Van der Auwera, M. Karczewicz (Qualcomm)] [late]

[JVET-P0436](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8225) AHG15: On CU Adaptive Chroma QP Offset Signalling [J. Zhao, S. Paluri, S. Kim (LGE)]

[JVET-P0608](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8401) [AHG15] On scaling list for JCCR [S. Iwamura, S. Nemoto, A. Ichigaya (NHK), P. de Lagrange, F. Le Leannec, E. François (InterDigital)]

[JVET-P0469](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8258) AHG15: efficient coding of qp\_out\_val [F. Bossen, A. Segall (Sharp)]

[JVET-P0730](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8532) AHG15: default quantization matrix [P. de Lagrange, E. François (InterDigital)] [late]

## Entropy coding (4)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0300](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8089) High throughput CABAC mode for VVC [H. Kirchhoffer, D. Marpe, B. Bross, T. Nguyen, C. Rudat, H. Schwarz, T. Wiegand (HHI)]

[JVET-P0395](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8184) CABAC zero word thresholds [A. Browne, S. Keating, K. Sharman (Sony)]

[JVET-P0396](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8185) Switching between CABAC context coded bins and bypass coded bins [A. Browne, S. Keating, K. Sharman (Sony)]

[JVET-P0603](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8395) CABAC zero word signalling [M. Coban, A. Ramasubramonian, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0939](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8754) Report of CABAC skip mode results on VTM-6.0 [K. Abe, T. Toma (Panasonic)] [late]

## Partitioning (14)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0406](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8195) Non-CE3: Generalization of SCIPU for different YUV formats [L. Pham Van, G. Van der Auwera, V. Seregin, H. Huang, A. K. Ramasubramonian, M. Karczewicz (Qualcomm)]

[JVET-P0701](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8500) Crosscheck of JVET-P0406 (Non-CE3: Generalization of SCIPU for different YUV formats) [Z. Deng (Bytedance)]

[JVET-P0484](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8273) Non-CE3: Signalling unification of prediction mode and SCIPU mode [L. Pham Van, G. Van der Auwera, A. K. Ramasubramonian, H. Huang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-P0537](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8327) Non-CE3: Cleanups on local dual tree for non-4:2:0 chroma formats [Z. Deng, J. Xu, L. Zhang, K. Zhang, H. Liu, Y. Wang (Bytedance)]

[JVET-P0596](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8388) Non-CE3: Removal of chroma 2xN blocks in CIIP mode [L. Pham Van, G. Van der Auwera, A. K. Ramasubramonian, T Hsieh, V. Seregin, M. Karczewicz (Qualcomm)] [late]

Initial version rejected as “placeholder”

[JVET-P0641](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8438) Non-CE3: Combination of JVET-P0596 and JVET-P0531 on removal of 2xN chroma intra blocks [L. Pham Van, G. Van der Auwera, T. Hsieh, A. K. Ramasubramonian, V. Seregin, M. Karczewicz (Qualcomm), Z. Deng, L. Zhang, K. Zhang, H. Liu, Y. Wang (Bytedance)] [late]

[JVET-P0778](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8593) Crosscheck of JVET-P0641 (Non-CE3: Combination of JVET-P0596 and JVET-P0531 on removal of 2xN chroma intra blocks) [[J. Choi (LGE)](mailto:jangwon84.choi@lge.com)]

[JVET-P0063](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7852) AHG16: Fix on local dual tree [Y. Zhao, H. Yang (Huawei), Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0766](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8581) Crosscheck of JVET-P0063 (AHG16: Fix on local dual tree) [C. Rosewarne (Canon)]

[JVET-P0188](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7977) On MinCU constraint [T. Suzuki (Sony)]

[JVET-P0343](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8132) Flexible maximum MTT hierarchy depth [F. Le Léannec, F. Galpin, T. Poirier (InterDigital)]

[JVET-P0839](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8654) Cross-check of JVET-P0343 (AHG17: Flexible maximum MTT hierarchy depth) [M. G. Sarwer (Alibaba)]

[JVET-P0344](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8133) Overriding qtbtt\_dual\_tree\_flag [F. Le Léannec, K. Naser, F. Galpin, T. Poirier (InterDigital)]

[JVET-P0347](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8136) Comments on maximum MTT Depth and MinCbSize [T. Poirier, F. Le Léannec, F. Urban, F. Galpin (InterDigital)]

[JVET-P0348](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8137) On BT/TT flag signalling [T. Poirier, F. Le Léannec, F. Urban, F. Galpin (InterDigital)]

[JVET-P0890](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8705) Crosscheck of JVET-P0348 (AhG17: On BT/TT flag signalling) [S.-T. Hsiang (MediaTek)]

[JVET-P0419](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8208) AHG16/AHG17: Simplification of CU Splitting Controls [T. Hellman, W. Wan, M. Zhou, B. Heng (Broadcom)]

[JVET-P0429](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8218) AHG17: On log2\_min\_luma\_coding\_block\_size\_minus2 [Y.-J. Chang, V. Seregin, M. Coban, A. Ramasubramonian, M. Karczewicz (Qualcomm)]

[JVET-P0506](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8296) On max QT/BT/TT size signaling [Y. Du, X. Li, X. Zhao, B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-P0764](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8579) Crosscheck of JVET-P0506: AHG17: On max QT/BT/TT size signaling [J. Jung, D. Kim, G. Ko, J. Son, J. Kwak (WILUS)]

[JVET-P0575](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8365) Non-CE: to support SCIPU with local dual tree for various color format [H. Jang, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-P0908](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8723) Crosscheck of JVET-P0575 (NonCE: to support SCIPU with local dual tree for various color format) [T. Ikai (Sharp)]

[JVET-P0578](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8368) Interaction between dual tree and minimum CU size [T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0580](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8371) On signalling CTU size in SPS [Y. Du, B. Choi, X. Li, X. Zhao, S. Wenger, S. Liu (Tencent)]

[JVET-P0582](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8373) AhG16: On dynamic internal bit depth [Y. Du, X. Zhao, X. Li, L. Zhao, S. Liu (Tencent)]

[JVET-P0865](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8680) Crosscheck of JVET-P0582: AhG16: On dynamic internal bit depth [K. Naser (InterDigital)]

[JVET-P0624](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8419) AHG16: Bugfix for local dual tree [L. Zhao, X. Li, X. Zhao, S. Liu (Tencent)] [late]

[JVET-P0737](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8539) Crosscheck of JVET-P0624 on Bugfix for local dual tree [X. Xiu (Kwai Inc.)]

## Chroma sampling and chroma formats (1)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0517](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8307) Support of adaptive color transform for 444 video coding in VVC [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-P0683](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8482) Crosscheck of JVET-P0517: Support of adaptive color transform for 444 video coding in VVC [X. Zhao (Tencent)]

## Lossless and near lossless coding (24)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0082](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7871) AHG18: BDPCM for Lossless [A. Nalci, H. Wang, H. E. Egilmez, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-P0807](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8622) Crosscheck of JVET-P0082 Proposal#4 and #5 (AHG18: BDPCM for Lossless) [T. Tsukuba (Sony)]

[JVET-P0896](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8711) Crosscheck of JVET-P0082 (AHG18: BDPCM for lossless) [Z.-Y. Lin (MediaTek)]

[JVET-P0147](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7936) AHG18: BDPCM in lossless coding [Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0775](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8590) Crosscheck of JVET-P0147, TEST1, TEST2 (AHG18: BDPCM in lossless coding) [Y.-W. Chen (Kwai)]

[JVET-P0148](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7937) AHG18: Disabling dependent quantization in lossless coding [Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek), T.-C. Ma, Y.-W. Chen, X. Xiu, H.-j. Jhu, X. Wang (Kwai)]

[JVET-P0659](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8457) Crosscheck of JVET-P0148 (AHG18: Disabling dependent quantization in lossless coding) [N. Zhang (Bytedance)]

[JVET-P0149](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7938) AHG18: Disabling LMCS for lossless coding [Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0176](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7965) AHG18: Lossless coding support related to cross-component ALF [J. Li, C. S. Lim (Panasonic)]

[JVET-P0258](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8047) AHG18: Disabling Dependent Quantization for Lossless [A. Nalci, H. Wang, H. E. Egilmez, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-P0827](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8642) Crosscheck of JVET-P0258: AHG18: Disabling Dependent Quantization for Lossless [T.Poirier (Interdigital)]

[JVET-P0327](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8116) AHG18: Configurable Maximum Transform Size for Mixed Lossy and Lossless Coding [A. Nalci, H.E. Egilmez, H. Wang, Y.-H. Chao, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-P0816](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8631) Cross-check of JVET-P0327: AHG18: Configurable Maximum Transform Size for Mixed Lossy and Lossless Coding [H. Sun, J. Li (Panasonic)]

[JVET-P0463](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8252) AHG18: Residual coding method for lossless mode [M. G. Sarwer, R. L. Liao, J. Luo, Y. Ye (Alibaba)]

[JVET-P0914](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8729) Crosscheck of JVET-P0463 (AHG18: Residual coding method for lossless mode) [H. Jang (LGE)]

[JVET-P0466](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8255) AHG18: Residual coding for lossless video coding [J. Choi, H. Jang, J. Heo, S. Yoo, J. Lim, S. Kim (LGE)]

[JVET-P0824](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8639) Crosscheck of JVET-P0466: Test #3, #4, and #5 [T. Nguyen (HHI)]

[JVET-P0467](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8256) AHG18: Rice parameter extension [J. Choi, H. Jang, J. Heo, S. Yoo, J. Lim, S. Kim (LGE)]

[JVET-P0774](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8589) Crosscheck of JVET-P467, TEST2, TEST4 (AHG18: Rice parameter extension) [Y.-W. Chen (Kwai)]

[JVET-P0477](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8266) AHG18: On Last Position Signaling for Lossless [A. Nalci, H. E. Egilmez, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-P0826](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8641) Crosscheck of JVET-P0477: Last coding for lossless [T. Nguyen (HHI)]

[JVET-P0485](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8274) AHG18: Performance of CE7-1.2d and CE7-2.2 on lossless coding [Y.-H. Chao, A. Nalci, H. Wang, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-P0956](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8771) Crosscheck of JVET-P0485 (AHG18: Performance of CE7-1.2d and CE7-2.2 on lossless coding) [J. Choi, J. Lim (LGE)]

[JVET-P0502](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8292) AHG18: Interaction between lossless coding and max transform size [X. Zhao, X. Li, S. Liu (Tencent)]

[JVET-P0514](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8304) AHG18: Enable lossless coding for VVC [T.-C. Ma, Y.-W. Chen, X. Xiu, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-P0916](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8731) Crosscheck of JVET-P0514 (AHG18: Enable lossless coding for VVC) [H. Jang (LGE)]

[JVET-P0521](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8311) AHG18: Disabling DMVR and BDOF for lossless coding [T.-C. Ma, Y.-W. Chen, X. Xiu, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-P0955](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8770) Cross-check of JVET-P0521 (AHG18: Disabling DMVR and BDOF for lossless coding) [J. Choi, J. Lim (LGE)]

[JVET-P0525](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8315) AHG18: Residual coding selection signaling for lossless VVC [T.-C. Ma, Y.-W. Chen, X. Xiu, H.-J. Jhu, X. Wang (Kwai Inc.), Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S. Lei (MediaTek)]

[JVET-P0757](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8561) Crosscheck of JVET-P0525 Test2 (AHG18: Residual coding selection signaling for lossless VVC) [T. Tsukuba (Sony)]

[JVET-P0804](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8619) Crosscheck of JVET-P0525 (AHG18: Residual coding selection signaling for lossless VVC) [J. Heo (LGE)]

[JVET-P0858](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8673) Crosscheck of JVET-P0525 (AHG18: Residual coding selection signaling for lossless VVC) [L. Zhao (Tencent)]

[JVET-P0528](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8318) AHG18: On residual scanning order for lossless coding [T.-C. Ma, Y.-W. Chen, X. Xiu, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-P0671](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8470) Crosscheck of JVET-P0528 (AHG18: On residual scanning order for lossless coding) [Z.-Y. Lin (MediaTek)]

[JVET-P0559](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8349) AHG18: Rice parameter derivation for coefficient level coding in lossless [M. Karczewicz, H. Wang, Y.-H. Chao, M. Coban (Qualcomm)]

[JVET-P0825](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8640) Crosscheck of JVET-P0559: Rice parameter derivation for lossless [T. Nguyen (HHI)]

[JVET-P0574](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8364) AHG18: BDPCM residual coding for lossless coding [H. Jang, J. Choi, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-P0841](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8656) Cross-check of JVET-P0574 (AHG18: BDPCM residual coding for lossless coding) [M. G. Sarwer (Alibaba)]

[JVET-P0576](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8366) AHG18: on low level coding for lossless [H. Jang, J. Choi, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-P0776](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8591) Crosscheck of JVET-P0576 (AHG18: on low level coding for lossless) [Y.-W. Chen (Kwai)]

[JVET-P0834](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8649) Cross-check result of JVET-P0576: AHG18: on low level coding tool for lossless coding (mipTuTiling) [Z. Zhang (Ericsson)]

[JVET-P0584](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8375) AHG18: BDPCM for luma and chroma in lossless coding [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

[JVET-P0770](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8585) Crosscheck of JVET-P0584 (AHG18: BDPCM for luma and chroma in lossless coding) [Y.-W. Chen (Kwai)]

[JVET-P0606](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8399) AHG18: Enabling lossless coding with minimal impact on VVC design [[B. Bross](mailto:benjamin.bross@hhi.fraunhofer.de), T. Nguyen, H. Schwarz, D. Marpe, T. Wiegand (HHI), M. Karczewicz, Y.-H. Chao, H. Wang, M. Coban (Qualcomm)]

[JVET-P0684](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8483) Crosscheck of JVET-P0606: Enabling lossless coding with minimal impact on VVC design [L. Zhao, X. Zhao (Tencent)]

[JVET-P0607](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8400) AHG18: Two Stage Residual Coding for Lossless [B. Bross, T. Nguyen, H. Schwarz, D. Marpe, T. Wiegand (HHI)] [late]

[JVET-P0721](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8522) Crosscheck of JVET-P0607: AHG18: Two Stage Residual Coding for Lossless [Y.-H. Chao (Qualcomm)]

[JVET-P0612](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8406) AHG18: Non-Lossless Coding Tools in VVC [?? (??)] [late] [miss]

## Miscellaneous coding tools (6)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0254](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8043) Issue of simplified luma mapping of LMCS [K. Abe, T. Toma (Panasonic)]

[JVET-P0383](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8172) Non-CE: JCCR and LMCS interaction [K. Fan, L. Zhang, K. Zhang, Y. Wang (Bytedance)]

[JVET-P0712](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8513) Crosscheck of JVET-P0383 (Non-CE3: JCCR and LMCS interaction) [T. Lu (Dolby)]

[JVET-P0394](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8183) AHG13: Luma Clipping instead of LMCS [S. Keating, K. Sharman, A. Browne (Sony)]

[JVET-P0417](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8206) AHG13: Removal of ISP [T. Hellman, B. Heng, W. Wan (Broadcom)]

[JVET-P0561](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8351) AHG16: Context restriction on CTU boundary for line buffer reduction [H.-J. Jhu, Y.-W. Chen, X. Xiu, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-P0636](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8433) Crosscheck of JVET-P0561 (AHG16: Context restriction on CTU boundary for line buffer reduction) [T.-H. Li, C.-Y. Teng (Foxconn)]

## Neural networks (1)

[JVET-P0489](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8278) AHG9: Multiple Convolution Neural Networks for Sequence-Independent Processing [H. Yin, R. Yang, X. Fang, Z. Gao, R. Yang (Intel)] [late]

## 360 degree video (2)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0315](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8104) Modified 360Lib for more flexible cube face arrangements [J. Sauer, M. Bläser (RWTH Aachen)

[JVET-P0669](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8467) AHG6: Wrap-around motion vector prediction at the picture boundary [M. Lee, J. Lee, J. Park, D. Sim, S.-J. Oh (KWU), W. Lim, G. Bang (ETRI)] [late]

## High level tool control (0)

## AHG17: General high-level syntax (47)

### NAL unit header (2)

[JVET-P0362](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8151) AHG17: NAL unit header extension to extend the number of layers [R. Sjöberg, M. Pettersson, M. Damghanian (Ericsson)]

[JVET-P0363](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8152) AHG17: On NAL unit type table [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

### PTL definition and signalling (2)

[JVET-P0217](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8006) On Profile, Tier, Level Syntax Structure [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

[JVET-P0478](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8267) AHG17: On (sub)profiles signalling in the DPS [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)] [late]

### Cross-RAP referencing and external reference pictures (2)

[JVET-P0114](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7903) AHG17: On external decoding refresh (EDR) [Y.-K. Wang, Hendry, J. Chen (Futurewei), H. Yu, L. Yu (ZJU)]

Discussed 0900 Wednesday (GJS & JRO)

This contribution proposes a design for support of random accessing a bitstream from inter-coded pictures without a recovery period. This technique is referred to as external decoding refresh (EDR) or cross RAP referencing (CRR). Using this technique, random access point (RAP) pictures can be coded as inter-predicted pictures typically using only one or two earlier pictures in the bitstream for inter prediction reference(s), thus reportedly achieving higher coding efficiency than coding of the RAP pictures as IRAP pictures.

When random accessing from such inter-coded RAP pictures, the reference pictures would not be available in the bitstream starting from the RAP, but need to be provided through an external means, e.g., in a separate file format track or a separate dynamic adaptive streaming over HTTP (DASH) representation. The externally-provided pictures are referred to as external pictures, and such RAP pictures are referred to as external decoding refresh (EDR) pictures.

The proposed design is summarized as follows:

1. A new NAL unit type (EDR\_NUT) is defined for EDR pictures.
2. An EDR picture may start a CVS (hence may also start a bitstream).
3. External pictures are provided in the form of coded pictures, and there is no change to the RPL syntax, semantics, and derivation process.
4. The general decoding process is updated to specify the decoding process of a bitstream starting from an EDR picture (i.e., when random accessing from an EDR picture) with externally-provided reference pictures.
5. Two alternative options regarding POC handling are proposed.
   1. In the first option, POC signalling and derivation are kept unchanged, while POC values are restricted as follows: For each EDR picture, let listOfPictures be the list of pictures that consists of all the pictures referred to by all entries in RefPicList[ 0 ] and all entries in RefPicList[ 1 ] of the EDR picture and the EDR picture itself, listed in increasing decoding order of these pictures. It is a requirement of bitstream conformance that the difference between the PicOrderCntVal values of any two of these pictures that are consecutive in the list shall be greater than −MaxPicOrderCntLsb / 2 and less than MaxPicOrderCntLsb / 2.
   2. In the second option, the POC MSB values of the external pictures except for the first external picture as well as the POC MSB value of the EDR picture itself are signalled in the slice headers, while the above constraint on POC values are not imposed.

The proposed detailed spec text changes are attached.

The "external" pictures are provided as *coded* pictures, and the decoder decodes them when performing random access.

It was asked why the decoder would need awareness of what happened. It was suggested that the system could handle the construction of a bitstream that appears to a decoder as an ordinary bitstream but was constructed by putting the coded AUs together in the right order before the inter-coded "RAP" AU. In this case, the encoder would need to be responsible for making sure that the POC MSBs have the necessary relationship to retain the MSBs tracking correctly and satisfy our constraint on the relationship of the POC of the current picture relative to its reference pictures. This seemed adequate without a need for special syntax or other handling in the decoding process spec. (We are not responsible for the format of the data within a server before the construction of the bitstream that is fed to a decoder.)

So no action seemed necessary.

[JVET-P0211](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8000) AHG17: On cross-RAP referencing [M. M. Hannuksela (Nokia)]

Discussed 0900 Wednesday (GJS & JRO)

JVET-P0212 proposes enabling the use of a single decoder instance and the single-layer VVC decoding process for decoding multiple independent layers. The decoding is performed as if all NAL units resided in a single layer only.

This contribution is asserted to achieve the functionality of cross-RAP referencing using the multiple independent layers functionality as proposed in the following ingredients of JVET-P0212:

1. A VPS flag to indicate that there is one and only one picture per each POC value among all independent layers and that the independent layers can be decoded as if there were in the same layer.
2. "Collective" HRD parameters can be signalled for the bitstream that contains multiple independent layers.
3. Possibility to control by external means that the entire bitstream is decoded as if it were a single-layer bitstream. Otherwise, the current layer-wise operation of VVC is carried out.

It is proposed to support the cross-RAP referencing functionality in VVC by adopting the above-listed aspects 1 to 3 of JVET-P0212.

The proponent indicated that this seems conceptually aligned with what had been agreed in discussion of P0114. As with P0114, POC relationships would need to be handled appropriately in the "encoder".

No further change seemed needed for the PTL signalling relative to the plan agreed earlier in the meeting (i.e., PTL indicates total capability needed for an operation point).

The remaining element of the proposal to consider was a high-level flag (associated with an OLS) that would indicate that every AU in the OLS contains only one picture.

A participant brought up the idea of combining this with multiple layers of a different type, e.g., having two spatial layers in which each spatial layer acts like the proposed scheme. The proponent suggested adjusting the semantics of the flag to indicate that every AU in the OLS contains only one *output* picture.

Another case brought up is multiview. In such a case, more than one view is output for an AU, but each view could be coded separately in the described manner.

Underlying the described case is the notion of using layers to deliver a functionality that can be provided with single-layer coding. The spirit of what is experienced by a decoder is basically single-layer operation.

Further study is encouraged to determine whether the single layer approach can be fully adequate for the envisioned functionality, or could be made adequate with some small adjustment, or if such a layering approach is needed instead.

[JVET-P0326](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8115) AHG17: External reference picture [P. Bordes, D. Doyen, F. Galpin, M. Kerdranvat (InterDigital)]

It is proposed to signal in the reference-picture-list-struct whether some reference pictures are provided by an external means not specified in the Specification. It is also proposed to signal in the reference-picture-list-struct whether the motion information associated with one reference picture is zero (default) or not.

Two distinctions between this proposal and P0114 are:

* The externally provide picture is provided in *decoded* form
* That picture may not come from a VVC bitstream, and thus may not have the syntax elements and motion data and other properties (e.g., a POC, a layer ID, a temporal ID, a NUT) that we ordinarily have available for a referenc picture.

The proposal includes proposal of a flag for whether motion data is available for the externally provided reference picture or not.

It was commented that SHVC conformance testing data was never provided for the similar functionality there.

If provided, such a capability would need to be optional in some way – e.g., made an optional feature of any profile or given a different profile.

A participant commented that this could provide an opportunity for externally specified operations (e.g., disparity compensation) to be applied to pictures that are then fed back into the ordinary VVC decoding process.

It was agreed that this functionality should be deferred for future study for consideration as part of some possible v2 (or v3) extension project (but not included in v1).

### Reference picture list signalling and constraints (8)

[JVET-P0123](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7912) AHG17: RPL constraints for RASL and RADL pictures [Hendry, Y.-K. Wang (Futurewei)]

[JVET-P0134](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7923) AHG17: On long-term reference picture signalling [X. Ma, H. Yang (Huawei)]

[JVET-P0135](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7924) AHG8/AHG17: On inter-layer reference picture signalling [X. Ma, H. Yang (Huawei)]

[JVET-P0182](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7971) AHG8/AHG17: On Reference Picture List and Inter-Layer Prediction [S. Deshpande (Sharp)]

[JVET-P0221](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8010) AHG8: On signaling interlayer reference picture list [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-P0235](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8024) AHG17: A bugfix of SPS flags and reference picture list structure [T. Chujoh, E. Sasaki, T. Ikai (Sharp)]

[JVET-P0356](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8145) AHG17: Bitstream constraints on RPL and GDR [R. Sjöberg, M. Pettersson, M. Damghanian (Ericsson)]

[JVET-P0589](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8381) AHG8: On inter-layer reference picture index range [V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

### AUD, picture header, slice header parameters signalling (10)

[JVET-P0687](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8486) AHG17: A summary of HLS proposals on access unit delimiter, picture header, and slice header parameters signalling [Hendry (Futurewei)] [late]

Discussed Wednesday 2030 (GJS & JRO)

This contribution provides a summary of high-level syntax proposals submitted to this JVET meeting related to access unit delimiter, picture header, and slice header parameters signalling. A list of design questions is provided to help structure the review of the proposals.

The contributions in this category can be classified into two sub-categories:

* AUD and Picture Header
* Modifications to constant slice header paramater signalling (related to constant\_slice\_header\_params\_enabled\_flag)

**General questions:**

1. Do we want to avoid signalling syntax elements in slice header that are constrained to have same values for all slices of a picture?

If yes. Where to signal them? AUD? New NAL Picture Header? Use the constant slice header params signalling in PPS?

1. For constant slice header parameters, should some of the syntax elements be in PPS? or in AUD? or in Picture Header, if exists?

***On AUD and Picture Header.***

1. Do we want to have Picture Header?

Proposing yes. JVET-P0095, JVET-P0120, JVET-P0239

Why? JVET-P0092 & JVET-P0120: AUD is AU specific. An AU may contain multiple pictures.

JVET-P0120: Order of AUD is supposed to the first NAL unit in an AU. If AUD preceeds SPS & PPS, some picture-level syntax elements in SH cannot be moved to AUD. Having PH is asserted would solve this problem.

Decision: Yes, after considering the quantity of syntax elements that would go there, we should have a picture header.

1. If yes, what to signal in PH?
   1. Move some signalling from PPS to PH

JVET-P0095: Subpicture Id mapping, if it is not signalled in the SPS and not signaled in the PPS, to avoid needing to send a PPS for this

Decision: Allow the mapping in the PH when it is not in the SPS. If present, it overrides what is in the PPS. If not in the PPS and not in the SPS, then is shall be in the PH. As detailed below:

SPS syntax:

fancy\_weird\_stuff\_allowed\_flag

if( fancy\_weird\_stuff\_allowed\_flag ) {

sending\_details\_in\_sps\_flag /\* infer 0 if not present \*/

if ( sending\_details\_in\_sps\_flag )

Details

}

PPS syntax:

sending\_details\_in\_pps\_flag

if (sending\_details\_in\_pps\_flag)

Details

constraint: If fancy\_weird\_stuff\_allowed\_flag is 0 or sending\_details\_in\_sps\_flag is 1, sending\_details\_in\_pps\_flag shall be equal to 0.

PH syntax:

if ( fancy\_weird\_stuff\_allowed\_flag && !sending\_details\_in\_sps\_flag ) {

sending\_details\_in\_ph\_flag

if(sending\_details\_in\_ph\_flag)

Details

}

* 1. Signal syntax element both in PPS and PH. Present in PH if not present in PPS

JVET-P0095: Tile/Brick/Rect Slice signalling

Deferred to after considering GDR needs.

* 1. Move some signalling from SH to PH

Preliminary decision:

* + 1. JVET-P0095, P0120: no\_output\_of\_prior\_pics\_flag
    2. JVET-P0120, P0239: slice\_pic\_parameter\_set\_id, non\_reference\_picture\_flag, colour\_plane\_id, slice\_pic\_order\_cnt\_lsb, recovery\_poc\_cnt, pic\_output\_flag, slice\_temporal\_mvp\_enabled\_flag.

Comment: Think more about slice\_pic\_order\_cnt\_lsb as a loss detection mechanism

* + 1. JVET-P0239: slice\_lmcs\_aps\_id and slice\_scaling\_list\_aps\_id
    2. JVET-P0239 move some syntax elements that are currently not constrained to be the same for all slices of a picture, but asserted having no / minimal benefit and coding loss to transmitting them in every slice header as their anticipated usage would change at the picture level. 18 such syntax elements are identified in the contribution. (In the CTC, about half of these don't even change across different pictures.)

It was commented that this could affect the ability to merge slices from different encoders. However, others commented that encoding for such applications would already be customized to this use case (and possibly only coming from one common encoder or encoders from only one company).

* + - 1. six\_minus\_max\_num\_merge\_cand
      2. five\_minus\_max\_num\_subblock\_merge\_cand
      3. slice\_fpel\_mmvd\_enabled\_flag
      4. slice\_disable\_bdof\_dmvr\_flag
      5. max\_num\_merge\_cand\_minus\_max\_num\_triangle\_cand
      6. slice\_six\_minus\_max\_num\_ibc\_merge\_cand
      7. partition\_constraints\_override\_flag
      8. slice\_log2\_diff\_min\_qt\_min\_cb\_luma
      9. slice\_max\_mtt\_hierarchy\_depth\_luma
      10. slice\_log2\_diff\_max\_bt\_min\_qt\_luma
      11. slice\_log2\_diff\_max\_tt\_min\_qt\_luma
      12. slice\_log2\_diff\_min\_qt\_min\_cb\_chroma (only needed for I slices)
      13. slice\_max\_mtt\_hierarchy\_depth\_chroma (only needed for I slices)
      14. slice\_log2\_diff\_max\_bt\_min\_qt\_chroma (only needed for I slices)
      15. slice\_log2\_diff\_max\_tt\_min\_qt\_chroma (only needed for I slices)
      16. mvd\_l1\_zero\_flag (only needed for B slices)
      17. dep\_quant\_enabled\_flag
      18. sign\_data\_hiding\_enabled\_flag
  1. Signal some syntax element that are not constrained to be the same for all slices of a picture both in PH and SH. Present in SH if not present in PH
     1. JVET-P0120: RPL, joint cb/cr sign flag, SAO, ALF, LMCS, Scaling list

Preliminary decision:

joint cb/cr sign flag should be in the PH and never be in the SH

RPL, SAO, ALF, LMCS, deblocking (4 syntax elements in July output doc) should possible to put in SH (as override if also in higher layer), also possible in PH and in SPS (for each of these five categories, if it's in the PH, then it's not in the SH)

Scaling list control should never be in the SH

* 1. New syntax elements:
     1. JVET-P0095: A flag to specify whether associated picture contains mixed NAL unit types (i.e, mixed\_nalu\_types\_in\_pic\_flag). See JVET-P0124, JVET-P0146, and JVET-P0222.

Revisit after section 6.19.1.3.

* + 1. JVET-P0120: Picture type (whether picture is IDR, CRA, GDR, contains only I-slices, only P- and I- slices, any type of slices)

Revisit after determining handling/need of AUD.

Discussion continued Track B Thursday 3 October 1115 (GJS).

1. If yes, what is property of PH?
   1. JVET-P0095, JVET-P0120, JVET-P0239: Mandating one PH one picture

Decision:

PH comes before the VCL NAL units for the picture; the SPS and PPS must precede it. APSs do not need to precede it but may. SEI messages for the picture follow it.

Do not allow PH to be "out of band" (and it should be in Type I category of HRD).

Allow repetitions; not more PHs than slices; not after the last VCL NAL unit.

* 1. JVET-P0120: Specifies layer Id, temporal Id, order of PH in access unit, etc.

Decision: Layer Id and temporal Id are those of the picture.

* 1. Is it VCL or non-VCL?

Decision: Non-VCL

* + 1. JVET-P0095, JVET-P0120: PH is a non-VCL NAL unit.
    2. JVET-P0239: PH is a VCL NAL unit.

1. Do we want to keep AUD?

Proposing no: JVET-P0095, JVET-P0120

Decision: Optional AUD (restore language of boundary detection). See also next item.

1. Do we want to keep mandating the presence of AUD?

Proposing no:

JVET-P0218. Signal single\_slice\_in\_pic\_flag in SPS. When single\_slice\_in\_pic\_flag is equal to 1, AUD is not mandated to be present. single\_slice\_in\_pic\_flag can be used to condition the presence of other syntax elements such as num\_bricks\_in\_slice\_minus1.

JVET-P0367: Signal a flag aud\_in\_next\_access\_unit\_present\_flag in AUD to specify whether the AUD is required to be present for next AU.

JVET-P0480: AUD is mandated only when there are more than 1 subpicture. Signal first\_slice\_in\_sub\_pic\_flag in SH. This flag can be used for detecting first slice of each picture when there is only one subpicture in a picture.

Conclusion: See above item 5 (AUD optional).

1. Do we want to signal more syntax elements in AUD?
   1. JVET-P0218: Optionally moves PPS Id, non\_reference\_picture\_flag, colour\_plane\_id, slice\_pic\_order\_cnt\_lsb, and pic\_output\_flag to AUD, if present. Create a syntax structure pic\_header(). NOTE: pic\_header is not in its own NAL unit.
   2. JVET-P0146: Signal syntax elements which specifies types of subpictures of a picture (non-IRAP, IDR, CRA). This would allow a picture to contain mixed subpicture types.
   3. JVET-P0222: Signal rap\_type and au\_order\_cnt. Syntax element rap\_type specifies which specifies whether the coded pictures in the access unit contain non-IRAP NAL unit only, IRAP NAL unit only, or both IRAP and non-IRAP.

Comments: JVET-P0146 and first aspect of JVET-P0222 suggest to allow mixed of IRAP and non-IRAP in a picture. They should be discussed together with JVET-P0095 and JVET-P0124.

No action.

1. AUD properties:

Decision: Adopt points a and c below.

* 1. JVET-P0218: The AUD shall have nuh\_layer\_id value equal to vps\_layer\_id[ 0 ].
  2. JVET-P0380: The AUD shall have nuh\_layer\_id value equal to 0.
  3. JVET-P0218: The AUD shall have TemporalId equal to the TemporalId of the access unit containing the NAL unit

***On signalling constant slice header params.***

1. Some bugs are asserted to be present in the signalling of syntax element when constant\_slice\_header\_params\_enabled\_flag? Revisit this deferred aspect.
   1. JVET-P0152:
      1. Update semantics of pps\_five-minus\_max\_mun\_subblock\_merge\_cand\_plus1 to incorporate the value of sps\_affine\_enabled\_flag.

Comment: The proposed changes seem to be more appropriate to be expressed as constraints.

* + 1. Update the inference of the value five\_minus\_max\_num\_subblock\_merge\_cand in SH when it is not present taking into account the proposed change above.
  1. JVET-P0427 proposal 1: Condition the signalling of pps\_max\_num\_merge\_cand\_minus\_max\_num\_triangle\_cand\_plus1 on the value of pps\_six\_minus\_max\_num\_merge\_cand\_plus1
  2. JVET-P0427 proposal 2: Update the range value of pps\_max\_num\_merge\_cand\_minus\_max\_triangle\_cand\_plus1 to not depend on the value of MaxNumMergeCand
  3. JVET-P0427 proposal 3: MaxNumTriangleMergeCand is inferred to be equal to 2 in slice header if MaxNumMergeCand is equal to 2 without signaling in either PPS or slice headers
  4. JVET-P0605: proposed to modify pps\_max\_num\_merge\_cand\_minus\_max\_num\_triangle\_cand\_minus1 to pps\_max\_num\_merge\_cand\_minus\_max\_num\_triangle\_cand\_plus1

This has been addressed by editor between last meeting and this meeting. The update is reflected in JVET-P0113

1. Adding more syntax element to be signalled in PPS when constant\_slice\_header\_params\_enabled\_flag is equal to 1:
   1. JVET-P0334 proposal / modification 1
   2. JVET-P0368
   3. JVET-P0428 proposal 1

Discussed Thursday Track B 1300 (GJS).

With us now having a PH, it was suggested for this to be a matter of indicating whether something is in the PPS or the PH. Whereas previously this mechanism would be saving one instance of each syntax element per slice, it would now be saving only one instance per picture header. Decision: This aspect agreed in principle.

Revisit/further discussion for the specifics.

1. Improvement for signalling mechanism of constant slice header params:
   1. JVET-P0334 proposal 2 & 3:
      1. Instead of signalling 1 set of constant slice header params in PPS, allow signalling up to 7 sets of constant slice header params in PPS. In SH, signal index of the set to be used.
      2. When the number of constant slice header params set in PPS is equal to 0, signal the syntax elements in SH
   2. JVET-P0428 proposal 2: signal conformance\_constant\_params\_enabled\_flag in SH to specify if the slice uses the constant syntax elements signalled in PPS or not. This allow constant slice params to be present in the PPS but also present in SH (i.e., when the value of conformance\_constant\_params\_enabled\_flag is equal to 0)

[JVET-P0480](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8269) AHG17: On simplification of subpicture design [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)] [late]

The first\_slice\_in\_sub\_pic\_flag part of this contribution belongs to this category. For other aspects see section 6.19.1.1.

[JVET-P0095](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7884) AHG12/AHG17: On signalling of picture-specific syntax elements in access unit delimiter [M. M. Hannuksela (Nokia)]

[JVET-P0120](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7909) AHG17: On access unit delimiter [Hendry, Y.-K. Wang (Futurewei)]

[JVET-P0218](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8007) AHG8/AHG17: On Access Unit Delimiter and Picture Detection [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

[JVET-P0222](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8011) AHG17: On signaling parameters in AUD [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-P0239](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8028) AHG17: HLS Cleanup [W. Wan, T. Hellman, B. Heng (Broadcom)]

[JVET-P0334](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8123) AHG17: On constant slice header parameter set in PPS [B. Wang, S. Esenlik, A. M. Kotra, H. Gao, E. Alshina (Huawei)]

[JVET-P0367](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8156) AHG17: On AUD signaling [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

[JVET-P0368](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8157) AHG17: On selectively signal slice header parameters in PPS [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

[JVET-P0427](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8216) AHG17: Bugfixes on constant slice header parameters [Y.-J. Chang, V. Seregin, M. Coban, A. Ramasubramonian, M. Karczewicz (Qualcomm)]

[JVET-P0428](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8217) AHG17: Improvement on signaling of constant slice header parameters [Y.-J. Chang, [V. Seregin](mailto:vseregin@qti.qualcomm.com), M. Coban, M. Karczewicz (Qualcomm)]

### Miscellaneous HLS topics (11)

[JVET-P0122](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7911) AHG17: On adaptation parameter set [Hendry, J. Chen, Y.-K. Wang (Futurewei)]

[JVET-P0359](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8148) AHG17: An STSA\_NUT restriction on PPS and APS availability [R. Sjöberg, M. Pettersson, M. Damghanian (Ericsson)]

[JVET-P0184](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7973) AHG8/AHG17: On Decoding Process for Unavailable Reference Pictures and Reference Picture List Construction [S. Deshpande (Sharp)]

[JVET-P0243](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8032) AHG17: HLS simplification W. Wan, T. Hellman, B. Heng (Broadcom)]

[JVET-P0244](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8033) AHG17: Miscellaneous HLS corrections [W. Wan, T. Hellman (Broadcom)]

[JVET-P0316](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8105) Coding of 360° video in non-compact cube layout using uncoded areas [J. Sauer, M. Bläser (RWTH Aachen)]

[JVET-P0366](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8155) AHG17: Signalling absence of NAL unit types in DPS [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

[JVET-P0420](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8209) AHG8/AHG17: Reduction of overlapping between POC LSB and Temporal ID [M. Sychev (Huawei)]

[JVET-P0438](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8227) AHG17: On Constraints for ALF APS [J. Chen, Hendry (Futurewei)]

[JVET-P0497](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8286) AHG17: On LMCS Signalling [Y.-C. Yang, C.-Y. Teng, P.-H. Lin (Foxconn)]

[JVET-P0800](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8615) Crosscheck of JVET-P0497: AHG17: On LMCS Signalling [W. Zhu (Bytedance)]

TBP?

[JVET-P0588](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8380) AHG17: APS for low latency ALF [V. Seregin, M. Coban, A. K. Ramasubramonian, N. Hu, M. Karczewicz (Qualcomm)]

[JVET-P0610](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8404) AHG8/AHG17: Sub-layer picture rates [M. Sychev (Huawei)]

[JVET-P0108](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7897) AHG17: On parsing dependency between slice data and APS [S. Esenlik, A. M. Kotra, B. Wang, H. Gao, E. Alshina (Huawei)]

[JVET-P0891](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8706) Cross-check of JVET-P0108 (On parsing dependency between slice data and APS) [P. Onno (Canon)]

### HRD (6)

[JVET-P0181](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7970) AHG17: On HRD Information Signalling [S. Deshpande (Sharp)]

[JVET-P0183](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7972) AHG17: On Picture Timing Information Signalling [S. Deshpande (Sharp)]

[JVET-P0189](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7978) AHG8/AHG17: On buffering period, picture timing, and decoding unit information SEI messages [Y.-K. Wang (Futurewei)]

[JVET-P0202](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7991) AHG17: Harmonized HRD parameters signalling for decoding units [V. Drugeon (Panasonic)]

[JVET-P0203](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7992) AHG17: Parsing HRD related SEI messages independently from the SPS [V. Drugeon (Panasonic), K. Sühring (HHI)]

[JVET-P0446](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8235) AHG17: On HRD for VVC: Splicing, Open GOP and DRAP support [Y. Sanchez, R. Skupin, K. Sühring, T. Schierl (HHI)]

### VUI and SEI (6)

[JVET-P0337](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8126) AHG17: On porting SEI messages specified in HEVC and AVC [M. Sean, T. Lu, F. Pu, P. Yin, W. Husak, T. Chen (Dolby)]

[JVET-P0338](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8127) AHG17: Shutter interval information SEI message [M. Sean, T. Lu, F. Pu, P. Yin, W. Husak, T. Chen (Dolby)]

[JVET-P0404](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8193) SEI message for MPEG-I Part 7 metadata [M. M. Hannuksela (Nokia)]

[JVET-P0459](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8248) AHG17: Mergeability identifier for subpictures [R. Skupin, K. Sühring, S. Sanchez, T. Schierl (HHI)]

[JVET-P0462](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8251) AHG6: 360-degree video related SEI messages [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

[JVET-P0597](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8389) AHG6/AHG17: Generalized cubemap projection syntax for 360-degree videos [Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek), J. Boyce, M. Dmitrichenko (Intel)]

## AHG12: high-level parallelism and coded picture regions (46)

### Subpictures (35)

#### General aspects (3)

[JVET-P0693](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8492) AHG12: Summary of HLS proposals on subpictures [M. M. Hannuksela (Nokia)] [late]

Discussed Tuesday 2140 (GJS)

This contribution provides a topic-wise summary of contributions related to:

* General aspects of subpictures
* Subpicture layout and ID signalling
* Subpicture boundary filtering

The purpose of the summary is to help structure and improve efficiency of the discussion of these contributions.

This version of the contribution does not cover contributions related to:

* subpicture-level random access and merging
* subpicture wraparound, padding, and cropping
* subpicture conformance definition and signalling

Discussed general aspects:

1. A subpicture consists of one or more complete rectangular slices within a picture. Subpictures cannot be used with raster-scan-order slices. (several contributions). Confirmed.
2. Tile rows and columns at the picture level apply across the entire picture. (P0245) Confirmed.
3. SPS/PPS parameters must be the same for all the subpictures in a picture. (P0245) Confirmed.
   * Supposedly this means that the same slice\_pic\_parameter\_set\_id value is referenced by all the VCL NAL units of the same picture Confirmed.
4. APS parameters must be the same for all the subpictures in a picture. (P0245). Not confirmed. Limits are established in the text.
5. All of the subpictures in the aggregate picture must use a common DPB with common DPB management (P0245) Confirmed. The DPB operates in units of pictures.
6. Properties shared across each subpicture (P0245):
   1. Same frame rate. Confirmed (i.e., each picture must be complete).
   2. Same reference picture lists. Not confirmed. Each slice has its own RPL, but has the same RPS.
   3. DPB can only be flushed at the same picture. Confirmed. The DPB operates in units of pictures.
   4. Same temporal sublayer. Confirmed (i.e., each picture must be complete and all VCL NAL units of the picture shall have the same TID).
   5. Same reference picture resampling (RPR) scale factor. Proposed to be violated by P0403.
   6. Same collocated reference picture. Confirmed (as a semantic constraint).
   7. Delta-POCs to all reference pictures must be the same. Confirmed. POC operates in units of pictures.
7. Can subpictures, if extractable, have a different random access properties from the whole picture? (P0139) Possibly, but not necessarily affecting the decoding process

Discussed Wednesday 1100 (GJS) & JRO)

***Container structure for signalling subpicture layout***

1. SPS
   * When signalled in the SPS, the signalling cannot use slices, tiles, or bricks for indicating subpicture boundaries
2. PPS
   * When signalled in the PPS, the signalling can use slices, tiles, or bricks for indicating subpicture boundaries
   * Note: There can be semantic constraints to keep the subpicture layout unchanged within a C(L)VS. This is discussed below.

Currently, we have the subpicture layout established at the SPS level. We have no proposals trying to change the subpicture layout within a CLVS.

It was agreed to keep the subpicture signalling in the SPS.

***Subpicture layout signalling in SPS***

1. Using a subpicture grid approach
   * Modifications of the subpicture grid design on VVC Draft 6
     + Indicating the grid in units of 8 luma samples (P0142)
     + Indicating the grid in units of CTBs (P0142, P0377, P0432)
     + replace max\_subpics\_minus1 with max\_subpics\_minus2 (P0129, P0432)
     + single\_subpic\_per\_grid\_flag to avoid signaling grid index for each subpicture when the grid is at the subpicture granularity (P0129)
     + Asserted bug fix: P0464 proposes modifications to the existing semantic derivations of the subpicture height and width dimensions i.e., SubPicHeight and SubPicWidth. In the current working draft (WD 6) of the Versatile Video Coding (VVC), the semantic derivations for SubPicHeight and SubPicWidth result in incorrect values when the subpicture grid index (subpic\_grid\_idx) present in the last row (i.e., subpic\_grid\_idx[row][col]) is different from the grid index present directly above (i.e., subpic\_grid\_idx[row-1][col]) it and alternatively, when the subpicture grid index present in the last column (i.e., subpic\_grid\_idx[row][col]) is different from the subpicture grid index present in front of it (i.e., subpic\_grid\_idx[row][col-1]).
   * Using the grid in units of CTBs with the signalling of the bottom-right delta grid index (P0139, P0143)
   * Having uniform and non-uniform subpicture grid signalling modes (similar to the signalling modes for tiles) (P0471)
2. Using units of CTBs, indicating top-left and bottom-right coordinates (P0171)

Decision: Units of CTBs, using top-left with width (minus1) and height (minus1). The proponent of P0171 agreed to provide text and to help develop software for this.

Constraints:

* + It is required that sub-pictures cannot be overlapped with each other, and all the sub-pictures must cover the whole picture. (P0377). This is already specified, and confirmed not to be changed.
  + Add a requirement of bitstream conformance that the following constraints apply: NumSubPicGridCols and NumSubPicGridRows cannot be concurrently equal to 1 if subpics\_present\_flag is equal to 1. NumSubPics shall be equal to 0 if subpics\_present\_flag is equal to 0. (P0432). This is not relevant to the approach taken.

***Subpicture layout signalling in PPS***

This section of the document is not relevant to the approach taken.

***Constraints on subpicture layout***

This section of the document is not relevant to the approach taken.

***single\_slice\_per\_subpic\_flag***

1. In SPS as an indication only (not affecting decoding) (P0579).
2. A constraint flag general\_constraint\_info( ) of the PTL structure: single\_slice\_subpic\_only\_constraint\_flag (P0579)
3. In PPS, used for inferring the derivation of subpicture\_id when they are not explicitly present (P0579)
4. In PPS, used for skipping subpicture boundary signalling (P0126, P0130) or slice boundary signalling (P0126)

As an initial assessment, it seems sensible to not need to signal slice layout in the PPS if this special case applies. However, other details should be considered for drafting the exact syntax and semantics before making a final conclusion on this. Revisit to finalize.

***Subpicture ID in slice header***

1. Subpicture ID is included in the slice header (P0126, P0431, …)
   * Present, when:
     + subpics\_present\_flag equal to 1 (P0126, P0579, P0609)
     + subpics\_present\_flag equal to 1 and NumSubPics greater than 0 (P0431)
     + rect\_slice\_flag equal to 1 (P0480)
2. subpic ID is proposed in NAL unit header or slice header. First, a flag use\_nuh\_layer\_id\_as\_subpic\_id\_flagis signalled in SPS. When use\_nuh\_layer\_id\_as\_subpic\_id\_flag is equal to 1, subpicID is set equal to nuh\_layer\_id signaled in NAL unit header. When use\_nuh\_layer\_id\_as\_subpic\_id\_flag is equal to 0, subpicID is set equal to subpic\_id, which may be signalled in slice header (P0224)
3. Define a subpicture index for each slice. This could be a fixed length code (FLC) at the top of the slice header for easy bit stream manipulation. (P0242)
   * Details missing from the contribution.

Decision: When the subpics\_present\_flag is equal to 1 (in which case, raster scan slices are not supported), a subpic ID is sent in the SH, and the slice address is interpreted as an address within the subpicture.

P0224 proposes to have a mode in which the layer ID is instead a subpicture ID. This would have two advantages: 1) saving bits for subpicture ID, 2) exposing the subpicture ID at a more easily accessible location in the NAL unit. A participant commented that it seems undesirable to mix purposes for the layer ID, and that this would only be useful when the number of subpictures is less than 65. No action was taken on that aspect.

***Semantics of slice address (when subpictures are in use)***

1. Slice\_address is defined as the slice index within the subpicture. (P0126, P0609)
2. The slice address is the subPic brick ID (P0480).
   * subPic brick ID is the brick index within the subpicture, where bricks are indexed in their decoding order – to be confirmed with the proponent

Decision: When subpictures are used, the slice address is the slice index within the subpicture.

***Other syntax elements***

1. first\_slice\_in\_sub\_pic\_flag (P0480)

This could be used for detection of subpicture and AU boundaries.

For this aspect see 6.18.5

***Mapping of subpicture IDs to the subpicture layout – may subpicture IDs change within a CVS?***

1. Yes (e.g. P0139)
2. Yes, but it can be signalled if they stay unchanged (P0126)
   * It is indicated with a flag (in PPS) whether the mapping of subpicture IDs to subpicture indices remains unchanged within a CLVS or may change within a CLVS.
3. No (those contributions proposing to signal the mapping in SPS, e.g. P0579, P0609)

Viewport-dependent streaming is a use case where it is suggested for the IDs to be able to change.

Decision:

* flag for presence of the mapping at the PPS level
* flag for presence of the mapping at the SPS level
* the flags cannot both be equal to 1
* if both flags are equal to 0, the IDs are the same as the indexes
* The range of values used for the IDs can be bigger than for the indexes

***Container structure for the mapping of subpicture IDs***

1. A mapping indicated in the picture header NAL unit (P0095)

To be considered with picture header proposals.

1. A mapping of subpicture IDs to subpicture indices is signalled in the PPS

* Loop over the number of subpictures in a picture, each loop entry indicating the subpicture ID (P0126, P0141, P0431, P0579)
* Loop over slices, each loop entry listing the subpicture ID to which the slice belongs (P0144)

Decision: The first approach above is selected (regardless of whether it is as the PPS or SPS level) as a consequence of the conclusion in the previous category.

1. When subpicture IDs do not change in the CVS, a mapping of subpicture IDs to subpicture indices is signalled in the SPS (P0141, P0609)

See above conclusions.

1. A mapping of subpicture IDs to subpicture indices is signalled in the SPS, loop over subpictures, each loop entry indicating the subpicture ID (P0579)

See above conclusions.

***On explicitly signalled slice IDs***

1. The explicitly signalled slice IDs are removed from the PPS and the slice. (P0126, P0609)

This is confirmed as a consequence of the above conclusions.

It was commented that the subpicture concept has been designed to support some particular use cases in which there may be many subpictures in a picture (e.g., 96). The subpicture concept is not adequate without some special slice support (e.g., explicitly signalled slice IDs) if there is a limit on the number of allowed subpictures that is too restrictive.

1. **On flags controlling the behaviour of subpicture boundaries**
2. subpic\_treated\_as\_pic\_flag[ i ] and loop\_filter\_across\_subpic\_enabled\_flag[ i ] moved to PPS (P0126, P0480, …)

Conclusion: Keep these in the SPS level.

1. P0145 and P0246: Disallow loop\_filter\_across\_subpic\_enabled\_flag[ i ] equal to 1 when subpic\_treated\_as\_pic\_flag[ i ] is equal to 1, by either of the following:
   1. Make the presence loop\_filter\_across\_subpic\_enabled\_flag[ i ] conditional on subpic\_treated\_as\_pic\_flag[ i ] equal to 0. When not present, the value of loop\_filter\_across\_subpic\_enabled\_pic\_flag[ i ] is inferred to be equal to 0.

|  |  |
| --- | --- |
| if( !subpic\_treated\_as\_pic\_flag[ i ] ) |  |
| **loop\_filter\_across\_subpic\_enabled\_flag**[ i ] | u(1) |

* 1. Semantic constraint.

Conclusion: Keep these independently switchable, since they affect entirely different parts of the decoding process (and it seems plausible to want to switch them independently).

1. May the value of the flags change within a C(L)VS?
   1. For each subpicture index i, subpic\_treated\_as\_pic\_flag[ i ] and loop\_filter\_across\_subpic\_enabled\_flag[ i ] are required to be unchanged within a CLVS (P0126) / CVS (P0480).
   2. Related to subpicture-based adaptive resolution change: The constraints on having the same subpicture layout and the same values of subpic\_treated\_as\_pic\_flag[ i ] and loop\_filter\_across\_subpic\_enabled\_flag[ i ] throughout a CLVS are not imposed. Instead, when a reference picture is used for prediction, it is required that it has a subpicture with the same ID as the subpicture ID of the current slice.

Conclusion: No, these are in the SPS, so they can't change within the CLVS.

1. **Miscellaneous**
2. max\_subpics\_minus1 is changed to max\_subpics\_minus2 and added in the VPS. Adding num\_subpics\_minus2 in the SPS. (P0140)

Conclusion: No action, since the extraction and merging functionality requires the ability to have subpics\_present\_flag equal to 1 even when max\_subpics\_minus1 is equal to 0.

1. A bug fix (P0579): To change "<=" to "<" in the following.

Conclusion: Actually, this was just a bad variable name, not an error in the loop count. However, this part of the spec is being replaced anyway.

|  |  |
| --- | --- |
| for( i = 0; i <= NumSubPics; i++ ) { |  |
| **subpic\_treated\_as\_pic\_flag**[ i ] | u(1) |
| **loop\_filter\_across\_subpic\_enabled\_flag**[ i ] | u(1) |
| } |  |

[JVET-P0139](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7928) AHG17/AHG12: General questions on subpicture designs for discussion [L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0242](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8031) AHG12/AHG16/AHG17: Subpicture Support [W. Wan, T. Hellman, M. Zhou, B. Heng, P. Chen (Broadcom)]

[JVET-P0245](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8034) AHG12/AHG17: Subpicture Properties [W. Wan, T. Hellman, B. Heng (Broadcom)]

#### Subpicture layout and ID signalling (18)

See 6.19.1.1 for the disposition of topics in this category.

[JVET-P0126](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7915) AHG12: Signalling of subpicture IDs and layout [M. M. Hannuksela (Nokia), Y.-K. Wang, Hendry (Futurewei)]

Some aspects of this are discussed in section 6.19.2.

[JVET-P0129](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7918) AHG12: On subpicture grid syntax [Y. He, A. Hamza (InterDigital)]

[JVET-P0130](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7919) AHG12: On subpicture ID [Y. He, A. Hamza (InterDigital)]

[JVET-P0140](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7929) AHG17/AHG12: Some comments on the VVC text [L. Chen, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

Aspects 1 and 2 of JVET-P0140 belong to this category.

[JVET-P0141](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7930) AHG17/AHG12: On signalling the subpicture IDs [L. Chen, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0142](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7931) AHG17/AHG12: Comments on the subpicture grid in the SPS [L. Chen, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0143](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7932) AHG17/AHG12: On signalling of subpicture structure in the SPS [L. Chen, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0144](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7933) AHG17/AHG12: On associating slices with a subpicture [L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

For a bug fix aspect, see section 6.19.2.

[JVET-P0171](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7960) AHG12: Modification for subpicture [J. Li, K. Abe, V. Drugeon (Panasonic)]

[JVET-P0224](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8013) AHG12: On sub-picture layout and ID [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

[JVET-P0377](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8166) AHG12: Cleanups on syntax design of sub-pictures [K. Zhang, L. Zhang, H. Liu, Z. Deng, J. Xu, N. Zhang (Bytedance)]

[JVET-P0431](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8220) AHG12: On subpicture ID [Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-P0432](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8221) AHG12: On signaling and grid size of subpictures [Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-P0464](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8253) AHG12: Comments on Subpicture Semantic Derivations [S. Paluri, J. Zhao, S. Kim (LGE)]

[JVET-P0471](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8260) AHG12 Explicit Signalling of Uniform and Non-Uniform Subpicture Grid in the SPS [S. Paluri, J. Zhao, S. Kim (LGE)

[JVET-P0480](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8269) AHG17: On simplification of subpicture design [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)] [late]

For the AU boundary detection aspect of this proposal, see section 6.18.5.

[JVET-P0579](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8370) AHG12: On Subpicture Information Signalling [S. Deshpande, J. Samuelsson (Sharp)]

[JVET-P0609](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8402) AHG12: On slice address signalling [R. Sjöberg, M. Damghanian, M. Pettersson (Ericsson)] [late]

#### Subpicture-level random access and merging (6)

[JVET-P0095](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7884) AHG12/AHG17: On signalling of picture-specific syntax elements in access unit delimiter [M. M. Hannuksela (Nokia)]

One aspect of JVET-P0095 belongs to here.

[JVET-P0124](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7913) AHG17: On mixed NAL unit types within a picture [Y.-K. Wang, Hendry (Futurewei)]

[JVET-P0146](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7935) AHG17/AHG12: On AUD as a picture header [L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-P0458](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8247) AHG17: NAL unit type mapping [R. Skupin, K. Sühring, Y. Sanchez, T. Schierl (HHI)]

[JVET-P0351](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8140) [AHG12] On Subpictures merging [N. Ouedraogo, F. Denoual, F. Mazé (Canon)]

[JVET-P0378](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8167) AHG12: Removal of dependency between sub-pictures [K. Zhang, L. Zhang, H. Liu, Z. Deng, J. Xu, Y. Wang (Bytedance)]

#### Subpicture wraparound, padding, and cropping (4)

[JVET-P0127](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7916) AHG12: On subpicture wraparound motion compensation signalling [Y. He, Y. He, A. Hamza (InterDigital)]

[JVET-P0220](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8009) AHG12: On padding processing with sub-pictures [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

[JVET-P0494](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8283) AHG12: Sub-picture signaling [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

[JVET-P0581](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8372) AHG12: On Subpicture Cropping [S. Deshpande, J. Samuelsson, A. Segall (Sharp)]

#### Subpicture conformance definition and signalling (2)

[JVET-P0131](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7920) AHG12: On output sub\_picture sets [Y. He, A. Hamza (InterDigital)]

[JVET-P0448](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8237) AHG17: Sub-picture level info for extraction and merging [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

#### Subpicture boundary filtering (2)

[JVET-P0145](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7934) AHG17/AHG12: On the flags for processing with subpictures [L. Chen, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

See 6.19.1.1 for the disposition of this contribution.

[JVET-P0246](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8035) AHG17/Non-CE5: on loop filter processing for subpicture treated as a picture

See 6.19.1.1 for the disposition of the HLS aspects of this contribution.

The low-level signal processing aspect of this contribution, see section 6.5.

### Slices, tiles, and bricks (12)

[JVET-P0144](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7933) AHG17/AHG12: On associating slices with a subpicture [L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

For other aspects of this contribution, see section 6.19.1.1.

A bug fix: When single\_tile\_in\_pic\_flag is equal to 1, the value of num\_slices\_in\_pic\_minus1 is inferred to be equal to 0. (P0144). Decision: Adopt this aspect if still relevant and necessary after consideration of JVET-P0240.

[JVET-P0686](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8485) AHG12: A summary of HLS proposals on slices, tiles, and bricks [Y.-K. Wang (Futurewei)] [late]

Discussed Wednesday 1720 (GJS & JRO).

This contribution provides a summary of high-level syntax proposals submitted to this JVET meeting related to slices, tiles, and bricks. A list of design questions is provided to help structure the review of the proposals.

1. Have a single signalling mode instead of separate uniform and explicit tile/brick spacing modes (JVET-P0096)? Note that this proposal overlaps with a lot of aspects listed below. See notes below for JVET-P0096.
2. Change brick signalling as in JVET-P0233? Not relevant after other actions.
3. Remove brick signalling and signal rectanglar slices directly based on tiles? (JVET-P0240). See notes for that contribution.
4. Remove num\_tiles\_in\_pic\_minus1 from the brick syntax? (JVET-P0096, JVET-P0140, JVET-P0308, JVET-P0357, JVET-P0433) Not relevant after other actions.
5. Change " i <= num\_tiles\_in\_pic\_minus1 + 1" to "i < NumTilesInPic" in the loop for brick signalling? (JVET-P0096, JVET-P0140, JVET-P0186, JVET-P0308, JVET-P0357, JVET-P0433)? Resolved by action taken on JVET-P0096.
6. Add CTU size in PPS? (JVET-P0308, JVET-P0357, JVET-P0433) Resolved by action taken on JVET-P0096.
7. Add "i > 0" to the syntax condition for brick\_idx\_delta\_sign\_flag[ i ]? (JVET-P0126, JVET-P0140, JVET-P0232) Not relevant if action taken on JVET-P0240.
8. Add "isLastTileColumn[ BottomRightBrickIdx[ i − 1 ] ] = = 0" to the syntax condition for brick\_idx\_delta\_sign\_flag[ i ]? (JVET-P0232)? Not relevant if action taken on JVET-P0240.
9. Add the missing value range of brick\_row\_height\_minus1[ i ][ j ] to be 0..RowHeight[ i ] − 2? (JVET-P0186) Not relevant if action taken on JVET-P0240.
10. Allow a picture that contains only a single tile to be split into bricks/slices? (JVET-P0186) Editorial action item: Change the name of the flag and clarify the semantics to indicate that the flag disallows any partitioning of the picture into tiles/slices/brick/subpictures. Decision: Also allow there to be only one tile in the picture when the flag is 0 (which may or may not contain multiple slices).
11. Change/fix the equation for deriving slices based on bricks? (JVET-P0126, JVET-P0186) Not relevant if action taken on JVET-P0240.
12. Change the inferred value of brick\_height\_minus1[ i ] from RowHeight[ i ] − 1 to RowHeight[ i ] − 2? (JVET-P0231) Not relevant if action taken on JVET-P0240.
13. Add a constraint to explicitly express the requirement that when single\_tile\_in\_pic\_flag is equal to 1 there shall be no brick splitting? (JVET-P0231) See item 11 above.
14. Add loop\_filter\_across\_tiles\_enabled\_flag? (JVET-P0252) Decision: Adopt.
15. Split uniform\_tile\_spacing\_flag into uniform\_tile\_row\_spacing\_flag and uniform\_tile\_col\_spacing\_flag? (JVET-P0308) Resolved by action taken on JVET-P0096.
16. Replace tile\_row\_height\_minus1[ i ] and tile\_column\_width\_minus1[ i ] with tile\_row\_height\_delta[ i ] plus a sign flag and tile\_column\_width\_delta[ i ] plus a sign flag? (JVET-P0308) Resolved by action taken on JVET-P0096.
17. Allow signalling of multiple alternative tile configurations in the PPS and referring to one in the slice header? (JVET-P0364) It was commented that this may be related to how we support GDR. Revisit after offline study and considering GDR/CE2 contributions.
18. Replace "if( RowHeight[ i ] > 1 )" and "if( RowHeight[ i ] > 2 )" in brick syntax with "if( TileHeight[ i ] > 1 )" and "if( TileHeight[ i ] > 2 )", respectively, and add that TileHeight[ i ] is derived to be equal to RowHeight[ i % ( num\_tile\_columns\_minus1 + 1 ) ]? (JVET-P0433) Not relevant if action taken on JVET-P0240.

[JVET-P0096](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7885) AHG12: On signalling of tile and brick partitioning [M. M. Hannuksela (Nokia)]

Discussed Wednesday 1820 (GJS & JRO).

This contribution proposes having a single signalling mode instead of separate uniform and explicit tile/brick spacing modes. The contribution is asserted to reduce:

* the number of syntax elements from 13 to 8,
* the number of syntax table rows from 28 to 17,
* the length of the semantics, and
* the length of the scanning process in clause 6.5.1.

The contribution is asserted to require a similar amount or fewer bits compared to VVC Draft 6 depending on the partitioning scheme.

Decision (Cleanup/simplification): Adopt.

[JVET-P0126](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7915) AHG12: Signalling of subpicture IDs and layout [M. M. Hannuksela (Nokia), Y.-K. Wang, Hendry (Futurewei)]

Some aspects in section 6.19.1.2.

Two aspects of JVET-P0126 (adding "i > 0" to the syntax condition for brick\_idx\_delta\_sign\_flag[ i ], and changing/fixing the equation for deriving slices based on bricks) belong to this category.

[JVET-P0140](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7929) AHG17/AHG12: Some comments on the VVC text [L. Chen, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

Aspects 3 and 4 of JVET-P0140 belong to this category.

[JVET-P0186](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7975) AHG12: On Tiles, Bricks, Slices [S. Deshpande (Sharp)]

[JVET-P0231](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8020) AHG12: On brick information signalling [B.-K. Lee (XRis), D. Jun (Kyungnam University)]

[JVET-P0232](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8021) AHG12: On rectangular slice addressing information [B.-K. Lee (XRis), D. Jun (Kyungnam University)]

[JVET-P0233](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8022) AHG12: Signaling of tile and brick information [B.-K. Lee (XRis), D. Jun (Kyungnam University)]

[JVET-P0240](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8029) AHG17: Slices [T. Hellman, W. Wan, M. Zhou, B. Heng, P. Chen (Broadcom)]

Discussed Wednesday 1740 (GJS & JRO).

This contribution proposes that the dimensions and locations of rectangular slices be signalled directly by using tile information rather than bricks. The proposal removes the need to predefine and store brick information at the PPS level in an effort to reduce the computation and storage required to determine rectangular slice dimensions and locations. It is asserted that there is no change to the slice and brick partitioning options available to the encoder, as the proposed changes only affect the signalling while keeping the underlying partitioning concepts intact.

The proposal was missing signalling for the number of entry points.

Brick boundaries would be established by a stop bit after each CTU row.

The proponent indicated that if the encoder does not want to use bricks, this could be indicated, e.g. at the picture or sequence level and the stop bit would not need to be sent.

It was noted that if the height is checked, the stop bit would not be needed after the last CTU row of the tile, which seems to be a sensible optimization.

The proponent indicated that the problem with the current syntax is that it requires storing information at the PPS level and using indirection to use this information which is needed only for determining brick sizes, whereas this could be signalled in the "old-fashioned" way of using a stop bit within the slice data.

It was commented that there is a bug in this approach, in that the entry points are useless because the vertical starting position of the brick would be unknown without parsing the slice data of the previous brick.

It was suggested that an alternative signalling that would achieve the same goal would be to signal in the slice header the number of bricks and the brick heights; this approach would preserve the usefulness of entry points and the ability to have multi-brick slices and would eliminate the need for the stop bits and might be more bit efficient.

It was questioned whether we really need multi-brick slices within tiles.

Revisit after studying:

* Do we need multi-brick slices within tiles?
* Text for the approach with brick heights in header.
* Text for the approach without multi-brick slices within tiles.

[JVET-P0252](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8041) AHG12: Loop filter control flag for tile boundary [K. Abe, T. Toma, V. Drugeon (Panasonic)]

[JVET-P0308](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8097) AHG12: On signalling of tile partitioning [J. Do, D. Park, Y.-U. Yoon, J.-G. Kim (KAU)]

[JVET-P0357](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8146) AHG12: Signal the CTU size in both SPS and PPS [R. Sjöberg, M. Pettersson, M. Damghanian (Ericsson)]

[JVET-P0364](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8153) AHG12: Multiple tile partitions in PPS [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

[JVET-P0433](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8222) AHG12: On brick signalling [Y.-J. Chang, M. Coban, M. Karczewicz (Qualcomm)]

## AHG8: layered coding and resolution adaptivity (36)

### Scalability (27)

#### Output layer sets (3)

See also P0226 (open).

[JVET-P0115](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=7904) AHG8: Scalability - general and operation points [Y.-K. Wang (Futurewei)]

Discussed 1630 Tuesday (GJS).

It is asserted that the scalability design in VVC version 1 should be as simple as possible as long as main scalability use cases are addressed, while those fancy features that are not necessary for main scalability use cases, whenever they complicates the design and the specification, should not be included in VVC version 1.

This contribution proposes signalling of output layer sets.

It was asked whether we should define OLSs with inter-layer referencing. The current draft supports only identification of one operating point.

It was commented that this may partly be a matter of whether we consider the perspective of the server, which may have a more complete data set than what is served to a decoder. It was commented that conformance of an entire server-side bitstream may not need to be specified, versus only specifying what is sent to a decoder (which uses one operating point) and how to extract that.

At least as a starting point, the following was agreed:

A bitstream fed to a decoder would have only one specified conforming decoded output.

Metadata may be present in a bitstream to indicate how to convert the bitstream to a different bitstream with a different conforming decoded output.

There may be a larger set of data stored on a server for which there is no conformance point specified as the decoded output, without first applying a conversion/extraction/rewriting process to that set of data.

This is different from the current spec in regard to temporal sublayering , as the current draft has a concept of an indication to a decoder of the highest sublayer to decode. Similarly, the current spec has a concept of a decoder receiving an indication of a layer to decode within a bitstream that contains more than one layer (for independent simulcast layers). Decision: Agreed. This affects only subclause 8.1.1 of the draft text.

The extraction process is not conceptually part of the decoding process; it is something that happens before the creation of a bitstream to be consumed by a decoder. It becomes part of the specification of the semantics of the syntax used for the extraction.

It was noted that the current text does not even have level specifications yet (or even profile text).

[JVET-P0204](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7993) AHG8: Clarifications on output layers mode [V. Drugeon (Panasonic)]

[JVET-P0225](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8014) AHG8: On output layer set and PTL signalling [B. Choi, S. Wenger, S. Liu (Tencent)]

#### Random access and POC (3)

Discussed Tuesday 1750 (GJS).

Both proposals suggest to allow IRAP and non-IRAP pictures in the same AU (not new; also supported in SHVC and SVC). For example, this would allow spatial scalability with more frequent IRAPs in the base layer than in the enhancement layer. Viewport-dependent ROI enhancement is another example, where there could be more frequent IRAPs in the enhancement layer than in the base layer.

Delay and coding efficiency were mentioned as issues involved in this. There was some questioning of whether this functionality is really needed.

It was mentioned that the point cloud coding activity in MPEG is using different IRAP periods in different layers. Another participant said that if the layers are independent, a system could use multiple bitstreams.

It was suggested that this functionality should not be difficult to support – mostly a matter of POC bookkeeping.

This is left open for revisit.

[JVET-P0100](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7889) AHG8: Unaligned IRAP pictures across layers and layer-wise start-up [M. M. Hannuksela (Nokia)]

[JVET-P0101](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7890) AHG8: POC derivation for a multi-layer bitstream [M. M. Hannuksela (Nokia)]

JVET-P0116 AHG8: Scalability - random access [Y.-K. Wang (Futurewei)]

#### PTL, bitstream extraction, and conformance (6)

Discussed Tuesday 1830 (GJS).

SHVC supports PTL indication per layer in the context of each OLS.

It was discussed whether level should indicate the incremental resource needed to decode an individual layer or the total resource needed to decode an entire OLS. In SVC the latter approach was taken and in SHVC the former approach was taken. It was commented that the desire here is to use the same resource pool for scalable decoding as for single-layer decoding (e.g., with RPR being the same resource as spatial scalability upsampling and with a single DPB serving as a multilayer DPB), which would suggest the OLS approach. In SHVC the concept was more like using multiple single-layer decoders to implement a scalable decoder. Decision in principle: Level indicates total resource for an operating point (incl. CPB and DPB).

[An operation point is a temporal subset of an OLS.]

[JVET-P0117](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7906) AHG8: Scalability - PTL and decoder capability [Y.-K. Wang (Futurewei)]

[JVET-P0098](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7887) AHG8/AHG17: Handling of VPS and EOB NAL units in the sub-bitstream extraction process [M. M. Hannuksela (Nokia)]

[JVET-P0380](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8169) AHG8/AHG17: On the role of nuh\_layer\_id in the layer design [E. Thomas (TNO), M. Hannuksela (Nokia), L. Chen (MediaTek), Yong.He@InterDigital.com, S. Wenger, B. Choi (Tencent)]

[JVET-P0118](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7907) AHG8: Scalability - HRD [Y.-K. Wang (Futurewei)]

[JVET-P0125](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7914) AHG17: Miscellaneous HLS topics [Y.-K. Wang (Futurewei)]

[JVET-P0190](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7979) AHG8/AHG17: Scalable nesting SEI message [Y.-K. Wang (Futurewei)]

#### Region-wise scalability (1)

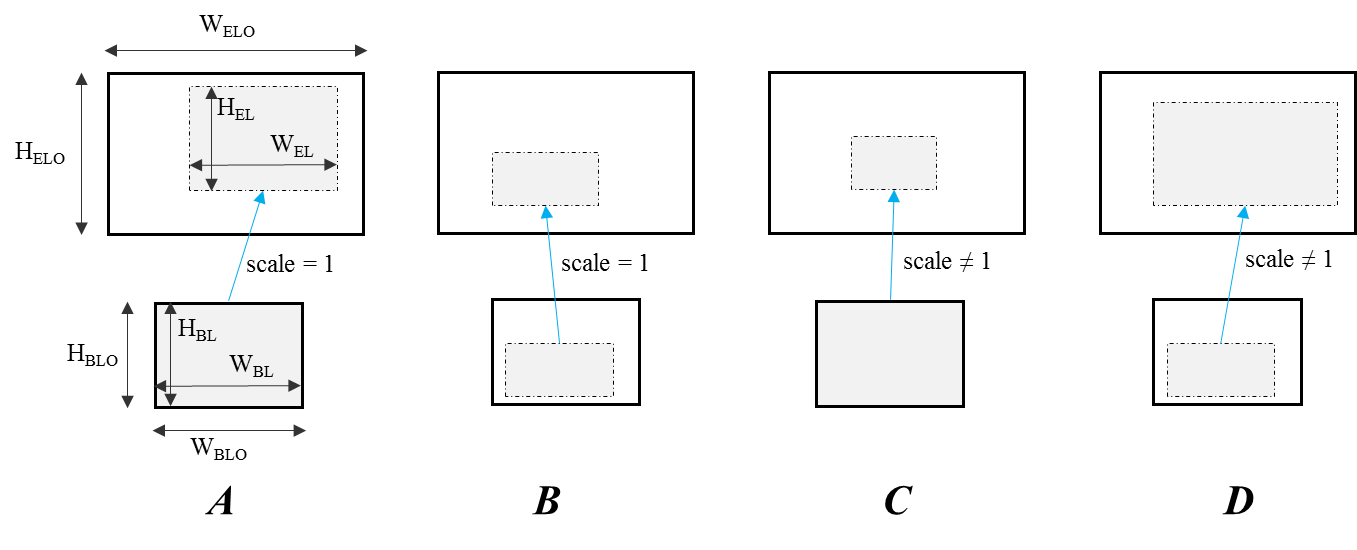
[JVET-P0336](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8125) AHG8: Support of ROI (Region-Of-Interest) scalability [T. Lu, F. Pu, P. Yin, M. Sean, W. Husak, T. Chen (Dolby)]

In SHVC we have the proposed functionality, illustrated below. A basic functionality is to have controllable spatial offsets and scaling between the reference layer and the enhancement layer. The proposal might also involve having some different treatment based on location within enhancement layer. It might also involve changing the bounding box of picture extrapolation for motion compensation.

It was commented that P0219 and P0482 for RPR are related.

Further clarity on the details of what is proposed and consideration of such details is needed.

Revisit.



#### VPS and single-layer bitstreams/decoders (2)

Discussed Tuesday 1950 (GJS).

At the previous meeting, we had agreed in principle for VPS syntax to not be required to be present in a single-layer bitstream (and we actually had an ability to not have the VPS present, but did not properly specify what happened in that case).

[JVET-P0097](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7886) AHG8/AHG17: Removing dependencies on VPS from the decoding process of a non-scalable bitstream [M. M. Hannuksela (Nokia)]

This was said to be a bug fix for places in the spec text that are not aligned with the above-described decision.

[JVET-P0205](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7994) AHG17: Presence of Video Parameter Set in bitstreams [V. Drugeon (Panasonic)]

This was said to be a bug fix for places in the spec text that are not aligned with the above-described decision.

[JVET-P0185](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7974) AHG8/AHG17: On Video Parameter Set and Highest Temporal Sub-layer [S. Deshpande (Sharp)]

This has a bug fix for the above-described issue and has some additional aspects.

#### External independent layers (1)

Discussed Tuesday 2005 (GJS).

The basic question is whether to support external independent layers as was done in SHVC. This could be something for further study as an extension project, but does not seem like a priority to consider for v1.

[JVET-P0213](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8002) AHG8: External independent layers [M. M. Hannuksela (Nokia)]

#### Multi-layer based single-layer decoding and subpicture support (3)

[JVET-P0212](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8001) AHG8/AHG12: Decoding multiple independent layers with single-layer decoding process [M. M. Hannuksela (Nokia), S. Wenger, B. Choi (Tencent), E. Thomas (TNO), V. Seregin, M. Coban (Qualcomm), Y. He (InterDigital), L. Chen (MediaTek)]

Discussed Tuesday 2015 (GJS).

This proposes a method of using a single decoder instance and the single-layer VVC decoding process for decoding multiple independent layers. The decoding is performed as if all NAL units resided in a single layer only.

It is reported that the proposal can be used with any types of independent layers, such as "independent coded region" layers, and texture or depth layers, e.g. for 3DoF+. The type of a layer has no normative impact in the decoding process.

One use of this is to enable subpictures by decoding the rectangles separately and using a post-decoding compositor to assemble a combined picture. It was commented that this can enable non-CTU-aligned subpicture sizes. However, it was commented that the compositing step would be an additional processing compositing stage that would be needed and may or may not be outside the scope of the specified conforming decoding process.

In the contribution, the layout of the subpictures is signalled in an SEI message.

This was assuming aspects such as PTL per layer that are different from the design philosophy agreed to earlier in the meeting.

No action was taken on this.

[JVET-P0226](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8015) AHG8/AHG12: On output layer set with sub-pictures [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

Discussed Tuesday 2035 (GJS).

Part of this relates to multi-layer-based subpicture support as with P0212; see notes for that contribution.

Another part proposes signalling of OLSs and should be considered with contributions in 6.20.1.1.

[JVET-P0481](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8270) AHG17: On output layers and output layer sets [Y. Sanchez, R. Skupin, K. Sühring, T. Schierl (HHI)] [late]

Discussed Tuesday 2050 (GJS).

Part of this relates to multi-layer-based subpicture support as with P0212 and P0226; see notes for that contribution.

In this proposal, the subpictures would be CTU aligned.

This aspect can provide a way to indicate conformance of a set of subpictures, since the subset an OLS. However, a participant commented that the same thing can be done for the illustrated use case using subpictures without using layers.

That subpicture aspect is only one functionality of the proposed approach.

Another is layer switching where the decoder is instructed to treat different layer IDs as the same for adaptive stream switching. However, it was commented that the server could use just one layer ID for both tracks and keep track for itself of which track to put into the bitstream that is given to the decoder and when to switch between the tracks; this sort of thing is sometimes done today (and DASH has some track switching metadata support).

There was no clear need for action on this, although it can be kept in mind if some further study indicates a way this can support necessary functionality that is not otherwise provided.

#### Miscellaneous scalability HLS topics (7)

[JVET-P0128](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7917) AHG8: Scalability - GDR [Y. He, A. Hamza (InterDigital)]

[JVET-P0132](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7921) AHG8: On inter-layer motion vector prediction [Y. He, Y. He, A. Hamza (InterDigital)]

[JVET-P0187](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7976) AHG8/AHG17: Comments on HLS of VVC [S. Deshpande (Sharp)]

[JVET-P0223](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8012) AHG8: Signalling representation format [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

[JVET-P0228](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8017) AHG17: General comments on HLS of VVC [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-P0453](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8242) AHG8: On diagonal referencing for layered VVC [Y. Sanchez, R. Skupin, K. Sühring, T. Schierl (HHI)]

Discussed Tuesday 2120 (GJS).

This contribution proposes to add support of diagonal referencing for layered VVC bitstream, i.e., inter-layer dependency for picture of different access units.

It was reported that SVC had a "medium granularity scalability" referencing of higher reference layers, but otherwise we have not supported diagonal referencing in prior scalability designs.

The proposal allows diagonal references to lower layers.

This would seem not especially difficult to support. However, no strong argument for supporting it was provided. Further study was encouraged to determine whether there is any significant advantage (e.g., in coding efficiency) for supporting this.

### Reference picture resampling (RPR) (6)

[JVET-P0206](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7995) AHG17: Clean-up on disabling temporal motion vector prediction in case of reference picture resampling [T. Nishi, V. Drugeon (Panasonic)]

[JVET-P0219](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8008) AHG8/AHG17: On signalling reference picture resampling [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-P0403](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8192) AHG8/AHG12: Subpicture-specific reference picture resampling [M. M. Hannuksela, A. Aminlou, K. Kammachi-Sreedhar (Nokia)]

[JVET-P0450](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8239) AHG17: On Sample Aspect Ratio for RPR [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

[JVET-P0482](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8271) AHG8: On reference picture resampling [Y. Sanchez, R. Skupin, K. Sühring, T. Schierl (HHI)] [late]

[JVET-P0591](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8383) AHG8: Resampled output picture [V. Seregin, A. K. Ramasubramonian, M. Coban, M. Karczewicz (Qualcomm)]

# Complexity analysis and reduction (2)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0084](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7873) Decoding Energy Assessment of VTM-6.0 [M. Kränzler, C. Herglotz, A. Kaup]

[JVET-P0085](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7874) Bit Stream Analyzer for Coding Tool Statistics [C. Herglotz, M. Kränzler, A. Kaup]

# Encoder optimization (1)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0092](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7881) AHG13: Encoder speed up for SMVD [H. Chen, H. Yang (Huawei)]

[JVET-P0903](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8718) Crosscheck of JVET-P0092 on encoder speed-up for SMVD [X. Xiu (Kwai Inc.)]

# Metrics and evaluation criteria (1)

Contributions in this category were discussed XXday X Oct. XXXX–XXXX in Track X (chaired by XXX).

[JVET-P0393](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8182) On BD rate computation for tools affecting quantization [S. Keating, K. Sharman, A. Browne (Sony)]

# Withdrawn (15)

JVET-P0048 Withdrawn

JVET-P0102 Withdrawn

JVET-P0103 Withdrawn

JVET-P0104 Withdrawn

JVET-P0138 Withdrawn

JVET-P0227 Withdrawn

JVET-P0229 Withdrawn

JVET-P0268 Withdrawn

JVET-P0296 Withdrawn

JVET-P0323 Withdrawn

JVET-P0564 Withdrawn

JVET-P0618 Withdrawn

JVET-P0627 Withdrawn

JVET-P0765 Withdrawn

JVET-P0794 Withdrawn

JVET-P0920 Withdrawn

# Plenary meetings, joint meetings, BoG reports, and summary of actions taken

## High-level syntax / systems relation meeting Saturday 5 Oct. 0900-XXXX

This session, held on XXXX at XXXX, was co-chaired by GJS and Youngkown Lim.

## Plenary meeting XXday X Oct. XXXX-XXXX

Reports of the tracks were presented as follows:

The general status of track A was presented and discussed, which particularly included the following aspects (not every small decision is noted):

…

The general status of track B was then presented and discussed, which particularly included the following aspects. Decisions recommended from track B were agreed and approved, unless otherwise noted:

…

Need more consideration of potential removal of low-coding-gain stuff.

## Closing Plenary meeting Friday 11 Oct.

… .

## Joint meeting XXday XX March XXXX-

JVET with … .

## BoGs (X)

[JVET-P0968](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8783) Report of BoG on high-level syntax [Y.-K. Wang]

## List of actions taken affecting the draft text of VVC, the VTM, and 360Lib

The following is a summary, in the form of a brief list, of the actions taken at the meeting that affect the text of the VVC draft text, VTM or 360Lib description. Both technical and editorial issues are included. This list is provided only as a summary – details of specific actions are noted elsewhere in this report and the list provided here may not be complete and correct. The listing of a document number only indicates that the document is related, not that it was adopted in whole or in part. The description given in the “Tool” column is a best effort for the sake of understanding but may not precisely reflect the functionality of the tool. It is also noted that in cases where several contributions proposed the same method, usually only one of the is listed as adoption below; refer to the meeting notes about the adoption to see which other contributions are related.

…

# Project planning

## Core experiment planning

…

## Drafting of specification text, encoder algorithm descriptions, and software

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.

## 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 EEs).

Suggestions for future meetings included the following generally-supported principles:

* No review of normative contributions without draft specification text
* VTM algorithm description 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

The document upload deadline for the next meeting was planned to be XXday XX Jan 2020.

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.

## General issues for experiments

It was emphasized during the opening plenary on January 9 that those rules which had been set up or refined during the 12th meeting should be observed. In particular, for some CEs, results were available late, and some changes in the experimental setup (particularly in CE4) were not discussed on the JVET reflector.

Group coordinated experiments have been planned as follows:

* “Core experiments” (CEs) are the coordinated experiments on coding tools which are deemed to be interesting but require more investigation and could potentially become part of the draft standard by the next meeting.
* A CE is a test of a specific fully described technology in a specific agreed way. It is not a forum for thinking of new ideas (like an AHG). The CE coordinators are responsible for making sure tha the CE description is complete and correct and has adequate detail. Reflector discussions about CE description clarity and other aspects of CE plans are encouraged.
* A description of each experiment is to be approved at the meeting at which the experiment plan is established. This should include the issues that were raised by other experts when the tool was presented, e.g., interference with other tools, contribution of different elements that are part of a package, etc. The experiment description document should provide the names of individual people, not just company names.
* Software for tools investigated in a CE will be provided in one or more separate branches of the software repository. Each CE will have a “fork” of the software, and within the CE there may be multiple branches established by the CE coordinator. The software coordinator will help coordinate the creation of these forks and branches and their naming. All JVET members will have read access to the CE software branches (using shared read-only credentials; the method for members to obtain the credentials is TBA on the reflector).
* During the experiment, revisions of the experiment plans can be made, but not substantial changes to the proposed technology.
* The CE description must match the CE testing that is done. The CE description needs to be revised if there has been some change of plans.
* The CE summary report must describe any changes that were made in the process of finalizing the CE.
* By the next meeting it is expected that at least one independent cross-checker will report a detailed analysis of each proposed feature that has been tested and confirm that the implementation is correct. Commentary on the potential benefits and disadvantages of the proposed technology in cross-checking reports is highly encouraged. Having multiple cross-checking reports is also highly encouraged (especially if the cross-checking involves more than confirmation of correct test results). The reports of cross-checking activities may (and generally should) be integrated into the CE report rather than submitted as separate documents.

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

As a general rule, it was agreed that each CE should be run under the same testing conditions using one software codebase, which should be based on the group test model 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.

The general agreed common conditions for single-layer coding efficiency experiments are described in the output document JVET-N1010.

Experiment descriptions should be written in a way such that it is understood as a JVET output document (written from an objective “third party perspective”, not a proponent perspective – e.g. not 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 contain a basic description of the technology under test, but 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 documents that are referenced in the CE description that are also available in the JVET document archive.

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

[Add info on software access.]

Some agreements relating to CE activities were established as follows:

* Only qualified JVET members can participate in a CE.
* Participation in a CE is possible without a commitment of submitting an input document to the next meeting. Participation is requested by contacting the CE coordinator.
* All software, results, and documents produced in the CE should be announced and made available to JVET in a timely manner.
* A JVET CE reflector will be established and announced on the main JVET reflector. Discussion of logistics arrangements, exchange of data, minor refinement of the test plans, and preparation of documents shall be conducted on the JVET CE reflector, with subject lines prefixed by “[CEx: ]”, where “x” is the number of the CE. All substantial communications about a CE other than such details shall take place on main JVET reflector. In the case that large amounts of data are to be distributed, it is recommended to send a link to the data rather than the data itself, or upload the data as an input contribution to the next meeting.

General timeline for CEs

Reviewed Thursday 11 July 2019 1900 (Y. Ye).

T1= 3 weeks after the JVET meeting: To revise the CE description and refine questions to be answered. Questions should be discussed and agreed on JVET reflector. Any changes of planned tests after this time need to be announced and discussed on the JVET reflector. Initially assigned description numbers shall not be changed later. If a test is skipped, it is to marked as “withdrawn”.

T2 = Test model software release + 2 weeks or X XX, whichever is earlier: Integration of all tools into a separate CE branch of the VTM is completed and announced to JVET reflector.

* Initial study by cross-checkers can begin.
* Proponents may continue to modify the software in this branch until T3
* 3rd parties are encouraged to study and make contributions to the next meeting with proposed changes

T3: 3 weeks before the next JVET meeting or T2 + 1 week, whichever is later: Any changes to the CE test branches of the software must be frozen, so the cross-checkers can know exactly what they are cross-checking. A software version tag should be created at this time. The name of the cross-checkers and list of specific tests for each tool under study in the CE plan description shall be documented in an updated CE description by this time.

T4: Regular document deadline – 1 week: CE contribution documents including specification text and complete test results shall be uploaded to the JVET document repository (particularly for proposals targeting to be promoted to the draft standard at the next meeting).

The CE summary reports shall be available by the regular deadline. This shall include documentation about crosscheck of software, matching of CE description and confirmation of the appropriateness of the text change, as well as sufficient crosscheck results to create evidence about correctness (crosscheckers must send this information to the CE coordinator at least 3 days ahead of the document deadline). Furthermore, any deviations from the timelines above shall be documented. The numbers used in the summary report shall not be changed relative to the description document.

CE reports may contain additional information about tests of straightforwared combinations of the identified technologies. Such supplemental testing needs to be clearly identified in the report if it was not part of the CE plan.

New branches may be created which combine two or more tools included in the CE document or the VTM (as applicable).

It is not necessary to formally name cross-checkers in the initial version of the CE description document. To adopt a proposed feature at the next meeting, we would like see comprehensive cross-checking done, with analysis that the description matches the software, and recommendation of value of the tool given tradeoffs.

The establishment of a CE does not indicate that a proposed technology is mature for adoption or that the testing conducted in the CE is fully adequate for assessing the merits of the technology, and a favourable outcome of CE does not indicate a need for adoption of the technology.

Availability of spec text is important to have a detailed understanding of the technology and also to judge what its impact on the complexity of the spec will be. There must also be sufficient time to study it in detail. CE contributions without sufficiently mature draft spec text in the CE input document should not be considered for adoption.

Plans for the CEs to be conducted were established Thursday 11 July (Y. Ye); CE plan documents were reviewed Thursday 11 July (Y. Ye).

Lists of participants in CE documents should be pruned to include only the active participants. Read access to software will be available to all members.

## Software development and anchor generation

The planned timeline for software releases was established as follows:

* VTM6.0 will be released by 2019-08-12 including all adoptions necessary for CTC and CE basis references. VTM6.1 with non-CTC adoptions will be released later. Further versions of VTM may be released for additional bug fixing, as appropriate.
* Preparation of the VTM software will include immediate removal of macros that were added in the previous meeting cycle. The software coordinator has the discretion to retain some such macros.
* No change of of 360lib or HDRTools was noted in response to meeting.

# 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 JVET reflector ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de)).

|  |  |  |
| --- | --- | --- |
| **Title and Email Reflector** | **Chairs** | **Mtg** |
| **Project Management (AHG1)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Coordinate overall JVET interim efforts. * Supervise CE and AHG studies. * Report on project status to JVET reflector. * Provide a report to next meeting on project coordination status. | J.-R. Ohm, G. J. Sullivan (co-chairs) | N |
| **Draft text and test model algorithm description editing (AHG2)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Produce and finalize JVET-O2001 VVC text specification draft 6. * Produce and finalize JVET-O2002 VVC Test Model 6 (VTM 6) Algorithm and Encoder Description. * Gather and address comments for refinement of these documents. * Coordinate with test model software development AhG to address issues relating to mismatches between software and text. | B. Bross, J. Chen (co-chairs), J. Boyce, S. Kim, S. Liu, Y.-K. Wang, Y. Ye (vice-chairs) | N |
| **Test model software development (AHG3)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Coordinate development of test model (VTM) software and associated configuration files. * Produce documentation of software usage for distribution with the software. * Discuss and make recommendations on the software development process. * Propose improvements to the guideline document for developments of the test model software. * Perform tests of VTM 6 behaviour relative to HEVC and VTM 5 using the VTM common test conditions. * Coordinate with AHG on Draft text and test model algorithm description editing (AHG2) to identify any mismatches between software and text, and make further updates and cleanups to the software as appropriate. * Coordinate with AHG6 for integration with 360lib software. | F. Bossen, X. Li, K. Sühring (co-chairs) | N |
| **Test material and visual assessment (AHG4)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Maintain the video sequence test material database for development of the VVC standard. * Identify and recommend appropriate test materials for use in the development of the VVC standard. * Identify missing types of video material, solicit contributions, collect, and make available a variety of video sequence test material. * Evaluate new test sequences, particularly including the material recently submitted by the Blender Foundation / Blender Animation Studio and Twitch. * Propose a new structure for the test sequence repository. * Prepare availability of viewing equipment and facilities arrangements for the next meeting, and prepare testing upon consultation with CE coordinators. * Coordinate with AHG11 on test material for screen content coding | T. Suzuki, M. Wien (co-chairs), V. Baroncini, R. Chernyak, A. Norkin, J. Ye (vice-chairs) | N |
| **Memory bandwidth consumption of coding tools (AHG5)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Develop improved software tools for measuring both average and worst case of memory bandwidth, and provide information for usage of these tools. * Study cache configurations for measuring decoder memory bandwidth consumption. * Identify coding tools in CEs and VTM with significant memory bandwidth impact. * Study the impact of memory bandwidth on specific application cases. | R. Hashimoto (chair), T. Ikai, X. Li, D. Luo, H. Yang, M. Zhou (vice-chairs) | N |
| **360° video coding tools, software and test conditions (AHG6)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study the effect on compression and subjective quality of different projections formats, resolutions, and packing layouts. * Discuss refinements of common test conditions, test sequences, and evaluation criteria. * Solicit additional test sequences, and evaluate suitability of test sequences on head-mounted displays and normal 2D displays. * Study coding tools dedicated to 360° video, their impact on compression, and implications to the core codec design. * Study the effect of viewport resolution, field of view, and viewport speed/direction on visual comfort. * Study complexity of GPU rendering of projection formats * Study syntax for signalling of projection formats, cubeface layouts, spherical rotations * Prepare and deliver the 360Lib-9.1 software version and common test condition configuration files according to JVET-M1012. * Generate CTC (PHEC) anchors and PERP results for VTM according to JVET-M1012, and finalize the reporting template for the common test conditions. * Produce documentation of software usage for distribution with the software. | J. Boyce and Y. He (co-chairs), K. Choi, J.-L. Lin, Y. Ye (vice-chairs) | N |
| **Coding of HDR/WCG material (AHG7)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study and evaluate available HDR/WCG test content. * Study objective metrics for quality assessment of HDR/WCG material, including investigation of the correlation between subjective and objective results. * Compare the performance of the VTM and HM for HDR/WCG content. * Prepare for expert viewing of HDR content at the next JVET meeting if feasible. * Investigate the implications of chroma sampling location. * Coordinate implementation of HDR anchor aspects in the test model software with AHG3. * Study additional aspects of coding HDR/WCG content. | A. Segall (chair), E. François, W. Husak, S. Iwamura, D. Rusanovskyy (vice-chairs) | N |
| **Layered coding and resolution adaptivity (AHG8)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study adaptive-resolution coding approaches for real-time communication, adaptive streaming, and 360-degree viewport-dependent streaming, including reference picture management and related scope and signalling * Study approaches for temporal scalability to avoid temporal judder when temporal scalability sub-bitstream extraction is used for achieving lower frame rate, and consider whether this should have a normative impact. * Develop a software framework which allows testing various layered coding and resolution adaptivity modalities in the context of the VTM software * Study approaches for support of layered coding scalability including spatial, temporal, quality, and view scalability; and analyse their coding efficiency and complexity characteristics * Coordinate with CEx on resampling filters | S. Wenger and A. Segall (co-chairs), M. M. Hannuksela, Hendry, S. McCarthy, Y.-C. Sun, P. Topiwala, M. Zhou (vice-chairs) | N |
| **Neural networks in video coding (AHG9)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Investigate the benefit of using neural networks in video compression such as CNN loop filter, intra prediction, resampling in adaptive resolution coding, and encoder-side partition mode decisions. * Investigate the complexity impact of using neural networks in video compression. * Investigate the complexity measurement of neural network coding tools. * Investigate benefit of universal versus selectable networks, both in terms of compression benefit and complexity. * Investigate how CNN parameters can be established for operation of the decoding process. * Investigate the impact of training materials on the performance of neural network coding tools. * Investigate the impact of the training process on performance and complexity. | S. Liu and Y. M. Li (co-chairs), B. Choi, K. Kawamura, Y. Li, L. Wang, P. Wu, H. Yang (vice-chairs) | N |
| **Encoding algorithm optimization (AHG10)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study the impact of using techniques such as GOP structures and perceptually optimized adaptive quantization for encoder optimization. * Study the impact of adaptive quantization on individual tools in the test model. * Study the quantization adaptation tool in the test model. * Investigate the feasibility of adding a CTC test category in which adaptive quantization is turned on. * Study quality metrics for measuring subjective quality using e.g. the CfP response MOS scores. * Investigate other methods of improving objective and/or subjective quality, including adaptive coding structures, adaptive quantization without signalling, and multi-pass encoding. * Study methods of rate control and their impact on performance, subjective and objective quality. | A. Duenas, A. Tourapis (co-chairs), S. Ikonin, A. Norkin, R. Sjöberg, J. Le Tanou, J.-M. Thiesse (vice-chairs) | N |
| **Screen content coding (AHG11)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Investigate coding tools targeted at screen content in terms of compression benefit and implementation complexity. * Identify test materials, discuss testing conditions for screen content coding, and propose associated updated common test conditions. * Study the impact of loop filters on screen content coding. | S. Liu (chair), J. Boyce, A. Filippov, Y.-C. Sun, J. Xu, H. Yang (vice-chairs) | N |
| **High-level parallelism and coded picture regions (AHG12)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study wavefront processing including the relationship with tiles and low delay characteristics. * Study flexible loop filter control and tile size restriction, including identifying implications on coding tools and implementation. * Study flexible tile partitioning (e.g. more flexible than HEVC and tile boundaries not spanning a full picture). * Study support of independently coded picture regions, including easy rewriting of such regions into a conforming sub-bitstream. * Prepare software and configurations for the test model to facilitate parallel processing tests. * Study the coding efficiency impact of parallel processing and coded picture regions. | S. Deshpande (chair), M. M. Hannuksela, R. Sjöberg, R. Skupin, W. Wan, Y.-K. Wang S. Wenger (vice-chairs) | N |
| **Tool reporting procedure (AHG13)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Prepare output document JVET-O2005, which describes the methodology of tool-off testing and a list of tools to be tested by identified testers. * Provide configurations files, bitstreams, and results of tool-on/tool-off testing. * Use the tool usage counts and memory bandwidth usage to study the decoder complexity of features in on/off testing. * Prepare a report with results of the tests. | W.-J. Chien, J. Boyce (co-chairs), W. Chen, Y.-W. Chen, R. Chernyak, K. Choi, R. Hashimoto, Y.**-**W. Huang, H. Jang, R.-L. Liao, S. Liu (vice-chairs) | N |
| **Operation modes for low latency support (AHG14)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Define relevant test conditions for the study of low latency modes * Study and propose low-latency performance assessment criteria/metrics * Update the implementation in the VTM model for supporting GRA. * Study a parallel framework for GRA assessment | J.-M. Thiesse (chair), S. Deshpande, A. Duenas, Hendry, K. Kazui, R. Sjöberg, A. Tourapis (vice-chairs) | N |
| **Quantization control (AHG15)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Identify methods for quantization step size control for luma and chroma, including spatially and frequency-adaptive approaches * Develop methods for evaluating quantization step size control operation * Study the association between transforms and quantization matrices * Develop testing conditions for evaluating QP signalling improvements including rate control and perceptual optimization strategies as appropriate * Evaluate the performance of the current VVC QP design using the adaptive quantization control techniques currently available in the VTM | R. Chernyak (chair), E. François, C. Helmrich, S. McCarthy, A. Segall (vice-chairs) | N |
| **Implementation studies (AHG16)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study draft and proposed coding tools to identify implementation issues relating to decoder pipelines, decoder throughput, and other aspects of implementation difficulty. * Solicit hardware analysis of complex tools. * Provide feedback on potential solutions to address identified issues. | M. Zhou (chair), J. An, E. Chai, K. Choi, S. Sethuraman, T. Hsieh, X. Xiu (vice-chairs) | N |
| **High-level syntax (AHG17)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study NAL unit header, sequence parameter set, picture parameter set, adaptation parameter set, and tile group header syntax designs * Study reference picture buffering and list construction * Study random access signalling and random access approaches, including approaches with reference pictures provided by external means * Assist in software development and text drafting for the high-level syntax in the VVC design. * Study syntax approaches for interoperability point signalling * Study selection of constraint flags to be included in the VTM and their impact on syntax, semantics, and decoding process | R. Sjöberg, J. Boyce (co-chairs), S. Deshpande, M. M. Hannuksela, R. Skupin, A. Tourapis, Y.-K. Wang, W. Wan, S. Wenger (vice-chairs) | N |
| **Lossless and near-lossless coding tools (AHG18)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study coding tools for lossless and near-lossless coding, including transform skip, BDPCM, and other potential technologies * Consider the interaction between coding tools and other processing such as loop filtering and LMCS for lossless and near-lossless coding * Develop proposals for lossless and near-lossless coding for chroma and non-YCbCr colour space content * Consider throughput bottlenecks for lossless and near-lossless coding at high resolutions and frame rates | T. Nguyen and T.-C. Ma (co-chairs), M. Ikeda, S. Iwamura, H. Jang, X. Zhao (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. Where applicable, dates of planned finalization and corresponding parent-body document numbers are also noted.

It was reminded that in cases where the JVET document is also made available as MPEG output document, a separate version under the MPEG document header should be generated. This version should be sent to GJS and JRO for upload.

JVET-O2000 Meeting Report of the 15th JVET Meeting [G. J. Sullivan, J.-R. Ohm] (2019-xx-xx, near next meeting)

Initial versions of the meeting notes (d0 … d9) were made available on a daily basis during the meeting.

JVET-O2001 Versatile Video Coding (Draft 6) [B. Bross, J. Chen, S. Liu] [WG 11 CD 23090-3, N18692] (2019-07-31)

(Initial version planned to be made available by 2019-07-18.)

See the list of elements under section 11.7, as agreed by the Fri. 12 July plenary.

JVET-O2002 Algorithm description for Versatile Video Coding and Test Model 6 (VTM 6) [J. Chen, Y. Ye, S. Kim] [WG 11 N 18693] (2019-09-09)

(Initial version planned to be made available by 2019-08-15.)

See the list of elements under section 0, as agreed by the Wed. 27 March plenary.

Remains valid – not updated: [JVET-N1003](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6638) Guidelines for VVC reference software development [K. Sühring] (2019-04-01)

Remains valid – not updated: [JVET-M1004](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=5757) Algorithm descriptions of projection format conversion and video quality metrics in 360Lib (Version 9) [Y. Ye, J. Boyce] (2019-02-15)

JVET-O2005 Methodology and reporting template for coding tool testing [W.-J. Chien and J. Boyce] (2019-07-31)

Remains valid – not updated: [JVET-M1006](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=5758) Methodology and reporting template for neural network coding tool testing [Y. Li, S. Liu, K. Kawamura] (2019-02-01)

This output was produced to capture aspects specific to enable study of neural network techniques.

JVET-O2007 Supplemental enhancement information messages for coded video bitstreams [J. Boyce, G. J. Sullivan, Y.-K. Wang] [WG 11 CD 23002-7, N18699] (2019-07-31)

(.)

See the list of elements under section 11.8, as agreed by the Wed. 27 March plenary.

Remains valid – not updated: JVET-N1010 JVET common test conditions and software reference configurations for SDR video [F. Bossen, J. Boyce, X. Li, V. Seregin, K. Sühring] (2019-04-12)

(Old document revised for editorial refinement of headings.)

JVET-O2011 JVET common test conditions and evaluation procedures for HDR/WCG video [A. Segall, E. François, W. Husak, S. Iwamura, D. Rusanovskyy] (2019-07-31)

Remains valid – not updated: [JVET-L1012](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=4840) JVET common test conditions and evaluation procedures for 360° video [P. Hanhart, J. Boyce, K. Choi, J.-L. Lin] (2018-10-26)

[JVET-O2021](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7821) Description of Core Experiment 1 (CE 1): Reference picture resampling filters [D. Luo, V. Seregin, W. Wan]

Regarding 0.5 second switching point, it was agreed to round down the switching point frame number to be a multiple of 4 to align with the GOP structure in LDB. In terms of the number of pictures tested, it will be set equal to 5-second-worth of test material without rounding.

Because the dimensions of coded pictures (full-resolution and downsampled) must be multiple of 8, it was agreed that the CE coordinators and participants will fill out the detailed plan for what lower resolution to code for each of the different source resolutions and different resampling ratios in the CE description document.

For PSNR1 caluclation, averaging PSNR values of different picture sizes may not be desirable. One way to address this is to accumulate the MSEs of all pictures and only convert to PSNR at the end of coding. It was agreed that the CE coordinators and participants will fill out the detailed plan for PSNR1 caluclation in the CE description document.

[JVET-O2022](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7823) Description of Core Experiment 2 (CE2): Gradual decoding refresh [K. Kazui, J.-M. Thiesse, Hendry, K. Kawamura]

Reviewed in closing plenary 1245.

Will test normative change of intra boundary, normative change of MC boundary extrapolation, and wavefront GDR.

[JVET-O2023](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7816) Description of Core Experiment 3 (CE3): Intra prediction and mode coding [G. Van der Auwera, L. Li, A. Filippov]

[JVET-O2024](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7820) Description of Core Experiment 4 (CE4): Inter prediction [C.-C. Chen, H. Yang, X. Xiu]

[JVET-O2025](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7822) Description of Core Experiment 5 (CE5): Loop filtering [C.-Y. Chen, A. Norkin]

Includes ALF, SAO, bilateral, HDTF, and deblocking.

Includes considering removal of SAO (or merging filters).

CE5-1.3 will include testing the proposed methods with DMVR off.

CE5-3.3 will include testing removal of SAO.

[JVET-O2026](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7817) Description of Core Experiment 6 (CE6): Transforms and transform signalling [H. E. Egilmez, M. Salehifar, X. Zhao]

CE tests that retrain the basis functions will provide the training software, training data, and version information of the VTM software used to conduct the training.

The CE test condition will include some non-CTC sequences.

[JVET-O2027](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7818) Description of Core Experiment 7 (CE7): Quantization and coefficient coding [H. Schwarz, M. Coban, C. Auyeung]

Bug fix to ensure that bin-to-bit ratio is accurate will be included in VTM6.0.

[JVET-O2028](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7819) Description of Core Experiment 8 (CE8): 4:4:4 Screen Content Coding Tools [X. Xu, Y.-H. Chao, Y.-C. Sun, J. Xu]

It was noted that CTC for 4:4:4 content has not been decided yet.

In the context of CE8, it was agreed that palette mode should be turned on in the anchors.

# 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 (ordinarily starting meetings on the Tuesday of the first week and closing it on the Wednesday of the second week of the SG 16 meeting – a total of 9 meeting days), and
* Otherwise meeting under ISO/IEC JTC 1/SC 29/WG 11 auspices when it meets (ordinarily starting meetings on the Wednesday prior to such meetings and closing it at lunchtime on the last day of the WG 11 meeting – a total of 9.5 meeting days).

In cases where an exceptionally high workload is expected for a meeting, an earlier starting date may be defined. For the upcoming meeting in October 2019, the SG16 parent-level meeting dates had been shifted after the JVET and MPEG meeting plans were established, which has caused an additional adjustment in the JVET dates.

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

* Wed. 8 – Fri. 17 January 2020, 17th meeting under WG 11 auspices in Brussels, BE.
* Wed. 15 – Fri. 24 April 2020, 18th meeting under WG 11 auspices in Alpbach, AT.
* Tue. 23 June – Wed. 1 July 2020, 19th meeting under ITU-T auspices in Geneva, CH.
* Wed. 7 – Fri. 16 October 2020, 20th meeting under WG 11 auspices in Rennes, FR.

The agreed document deadline for the 16th JVET meeting was planned to be XXday XX January 2020. CE proposal documents are due one week ahead of that date. Plans for scheduling of agenda items within that meeting remained TBA.

ITU was thanked for the excellent hosting of the 14th meeting of the JVET.

EBU, HHI, ITU-T and Sharp Labs of America were thanked for providing equipment used for subjective viewing during the 14th JVET meeting. Philippe Hanhart, Andrew Segall and Mathias Wien were thanked for preparing and conducting the subjective test efforts related to CE1, CE5 and CE11, and Vittorio Baroncini was thanked for his advice. Roger Miles was thanked for support in providing the displays from EBU; Kenneth Andersson, Johannes Sauer and Vadim Seregin were thanked for carefully transporting these. The experts who participated in the role as test subjects were also thanked.

The 16th JVET meeting was closed at approximately XXXX hours on Friday 11 Oct. 2019.

# Annex A to JVET report: List of documents

# Annex B to JVET report: List of meeting participants

The participants of the sixteenth meeting of the JVET, according to an attendance sheet circulated during the meeting sessions (approximately XXX people in total), were as follows: