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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**  15th Meeting: Gothenburg, SE, 3–12 July 2019 | Document: JVET-O\_Notes\_d2 |

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| *Title:* | **Meeting Report of the 15th Meeting of the Joint Video Experts Team (JVET), Gothenburg, SE, 3–12 July 2019** | | |
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| *Purpose:* | Report | | |
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| *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 fifteenth meeting during 3–12 July 2019 at the at the Clarion Post Hotel in Gothenbug, SE. 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 0900 hours on Wednesday 3 July 2019. Meeting sessions were held on all days (including weekend days) until the meeting was closed at approximately XXXX hours on Friday 12 July 2019. Approximately XXX people attended the JVET meeting, and approximately XXX input documents, 11 CE summary reports, and 17 AHG reports were discussed. The meeting took place in a collocated fashion with a meeting of WG11 – 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 11 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-N1001 Versatile Video Coding specification text (Draft 5)
* JVET-N1002 Algorithm description for Versatile Video Coding and Test Model 5 (VTM 5)
* JVET-N1003 Guidelines for VVC reference software development
* JVET-N1005 Methodology and reporting template for coding tool testing
* JVET-N1010 and JVET-N1011, JVET common test conditions and software reference configurations for SDR and, HDR/WCGvideo, respectively
* JVET-N1021 through JVET-N1031, Description of Core Experiments 1 through 11

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, XX Core Experiments (CE) were defined. The next four JVET meetings were planned for 1–9 October 2019 under ITU-T SG16 auspices in Geneva, CH, during 8–17 January 2020 under WG 11 auspices in Brussels, BE, during 15–24 April 2020 under WG 11 auspices in Alpbach, AT, and during 23 June – 01 July 2020 under ITU-T SG16 auspices in Geneva, CH.

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 fifteenth meeting during 3–12 July 2019 at the Clarion Post Hotel in Gothenburg, SE. 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_07_O_Gothenburg/>.

## Primary goals

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 11 Core Experiments (CE), reviewing other technical input on novel aspects of video coding technology, and producing the next versions of draft text and VTM, and plan 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, 25 June 2019. Any documents uploaded after 1159 hours Paris/Geneva time on Wednesday 26 June 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 fourteenth meeting, contributions related to CE proposals 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 19 June were considered “officially late”. After the positive experience, it was agreed to continue having a 2-week deadline for CE proposal documents, including draft text.

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-O0673 were registered after the “officially late” deadline (and therefore were also uploaded late). Likewise, CE proposal documents with registration numbers higher than JVET-O0132 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, many 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-O0XXX (a proposal on …), uploaded 06-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-O0XXX (a document on …), uploaded 06-XX.
* ….

All cross-verification reports at this meeting were registered late and therefore also uploaded late (all with numbers higher than JVET-O0XXX) and therefore are not specifically identified here, in the interest of brevity. 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-O0XXX (withdrawn), JVET-O0XXX (missing by the end of meeting), … .

The following crosschecks had not been uploaded yet by the end of the meeting, but were provided later:

…

“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-O0XXX and … .

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

* JVET-O0XXX (…)
* …

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-N1000, the Versatile Video Coding specification text (Draft 5) JVET-N1001, the Algorithm description for Versatile Video Coding and Test Model 5 (VTM 5) JVET-N1002, the Guidelines for VVC software development JVET-N1003, the Methodology and reporting template for coding tool testing JVET-N1005, the JVET common test conditions and software reference configurations for SDR video JVET-N1010 and for HDR/WCG video JVET-N1011, and the Description of Core Experiments 1 through 11 (JVET-N1021 through JVET-N1031), had been completed and were approved. The software implementation of VTM (versions 5.0 and 5.1) 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

## 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 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 1179.

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.
* **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 set.
* **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.
* **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).
* **GBI**: …
* **GRA**: …
* **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.
* **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
* **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**: …
* **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.
* **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).
* **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.
* **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).
* **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).
* **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.
* **RDOF**: …
* **RDOQ**: Rate-distortion optimized quantization.
* **RDPCM**: …
* **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**: …
* **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 0900 Wednesday 3 July (initially chaired by GJS and later joined by JRO) were as follows.

* The meeting logistics, agenda, working practices, policies, and document allocation were reviewed.
  + The meeting host is the Swedish Institute for Standards
  + Sponsors: Ericsson, SiS, Dolby, Divideon
  + 1030-1130, 1530-1630
  + 1830 Wed Kajskjul 8, Packhusplatsen 11 (14 min by foot)
  + There is a goal of potential CD ballot at this meeting in the ISO/IEC approval process.
  + In addition to problems of late submission of documents, it was remarked that text is missing for a number of documents. 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
* Principles of standards development were discussed.
* Standardization timelines [CD July, DIS October (possibly January), Consent & FDIS July; or CD October, DIS Jan, Consent & FDIS July]

## 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:

* Wed. 3 July, 1st day
  + 0900–1000 JVET opening plenary (chaired by GJS)
  + 1000-1300, 1430-1615 AHG reports (chaired by GJS & JRO)
  + Track A (chaired by GJS)
    - 1645 CE1 CABAC initialization (4+3) (section 5.1)
    - 1800-2000 CE3 intra prediction and mode coding (12+96) (section 5.3)
  + Track B (chaired by JRO)
    - 1700-1930 CE4 inter prediction (8)
    - 5
* Thu. 4 July, 2nd day
  + Track A (GJS)
    - 0900-1030 CE6: Transforms and transform signalling (4) (section 5.6)
    - 1100 CE7: Quantization and coefficient coding (8) (section 5.7)
    - 1430 CE11: Gradual random access (6)
    - 1800 CE11 related – Gradual random access (2) (section 6.11) (Track A)
    - 1900-2230 Quantization parameter signalling (8) (section 6.12) (Track A)
    - HLS BoG in Brevesorterarsalen 3
    - BoG on CE3-related intra prediction and mode coding (96) (section ) [Geert Van der Auwera] Room B2
    - BoG on CE6-related Transforms and transform signalling (50) [X. Zhao] Room?
    - BoG on CE7-related Quantization and coefficient coding (25) (section 6.7) [Heiko Schwarz]
  + Track B (JRO)
    - 0900–XXX CE5 Loop Filters
    - XXX–XXX CE8 Screen Content Coding
    - XXX–XXX CE9 Decoder Motion Vector Derivation
    - XXX–XXX CE10 Neural network caused AI+related
    - Track B BoGs: CE, CE10 – clarify when ready
* Thu. 5 July, 3rd day
  + Track A (GJS)
    - 0900-XXXX Quantization parameter signalling (8) (section 6.12) (Track A)
    - XXXX Entropy coding (6) (section 6.13) (Track A)
    - XXXX Chroma sampling and chroma formats (2) (section 6.14) (Track A)

Brevesorterarsalen 1, 2, 3.

## 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 (17) (section 3) (Plenary)
* Project development (X) (section 4) (Plenary)
  + Text and software development (1)
  + Test conditions (1)
  + Performance assessment (5)
  + Coding studies on specific use cases (0)
  + Test Material (0)
* Core Experiments (xx) (section 5) with subtopics
  + CE1: CABAC initialization (4) (section 5.1) (Track A)
  + CE2: Luma/chroma dependency reduction (5) (section 5.2) (Track B)
  + CE3: Intra prediction and mode coding (12) (section 5.3) (Track A)
  + CE4: Inter prediction (8) (section 5.4) (Track B)
  + CE5: Loop filtering (7) (section 5.5) (Track B)
  + CE6: Transforms and transform signalling (4) (section 5.6) (Track A)
  + CE7: Quantization and coefficient coding (8) (section 5.7) (Track A)
  + CE8: Screen content coding tools (16) (section 5.8) (Track B)
  + CE9: Decoder motion vector derivation (7) (section 5.9) (Track B)
  + CE10: Neural network based loop filtering (2) (section 5.10) (Track B)
  + CE11: Gradual random access (6) (section 5.11) (Track A)
* Non-CE technology proposals (xx) (section 6) with subtopics
  + CE1 related – CABAC initialization (3) (section 6.1) (Track A)
  + CE2 related – Luma/chroma dependency reduction (23) (section 6.2) (Track B)
  + CE3 related – Intra prediction and mode coding (96) (section 6.3) (Track A)
  + CE4 related – Inter prediction (105) (section 6.4) (Track B)
  + CE5 related – Loop filtering (38) (section 6.5) (Track B)
  + CE6 related – Transforms and transform signalling (50) (section 6.6) (Track A)
  + CE7 related – Quantization and coefficient coding (25) (section 6.7) (Track A)
  + CE8 related – Screen content coding tools (46) (section 6.8) (Track B)
  + CE9 related – Decoder motion vector derivation (26) (section 6.9) (Track B)
  + CE10 related – Neural network based loop filtering (2) (section 6.10) (Track B)
  + CE11 related – Gradual random access (2) (section 6.11) (Track A)
  + Quantization parameter signalling (8) (section 6.12) (Track A)
  + Entropy coding (6) (section 6.13) (Track A)
  + Chroma sampling and chroma formats (2) (section 6.14) (Track A)
  + Other coding tools (13) (section 6.15) (Track B)
  + 360 degree video (4) (section 6.16) (Track X)
  + AHG17: General high-level syntax (60) (section 6.17) (Track A)
  + AHG12: High-level parallelism and coded picture regions (41) (section 6.18) (Track A)
  + AHG8: Layered coding and resolution adaptation (24) (section 6.19) (Track A)
* Complexity analysis and reduction (0) (section 7) (Track X)
* Encoder optimization (4) (section 8) (Track B)
* Metrics and evaluation criteria (1) (section 9) (Track B)
* Withdrawn (6) (Track none)
* Joint meetings, plenary discussions, BoG reports, Summary of actions (section 10)
* 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 (313) was generally chaired by GJS, and Track B (338) by JRO.

# AHG reports (17)

These reports were discussed Wednesday 3 July XXXX–XXXX (chaired by GJS and JRO).

[JVET-O0001](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7578) JVET AHG report: Project management (AHG1) [J.-R. Ohm, G. J. Sullivan]

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.

At the 14th meeting of the ITU-T/ISO/IEC Joint Video Experts Team (JVET), an *ad hoc* group on Project Management was established with the following mandates:

* 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.

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

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\_03\_ N\_Geneva/](http://wftp3.itu.int/av-arch/jvet-site/2019_03_%20N_Geneva/)), particularly including the following:

* The meeting report (JVET-N1000) [Posted 2019-07-03]
* Versatile Video Coding (Draft 5) (JVET-N1001) [Posted 2019-04-09, last update 2019-07-02]
* Algorithm description for Versatile Video Coding and Test Model 5 (VTM 5) (JVET-N1002) [Posted 2019-05-21, last update 2019-06-11]
* Guidelines for VVC software development (JVET-N1003) [Posted 2019-03-28]
* Methodology and reporting template for coding tool testing (JVET-N1005) [Posted 2019-04-11]
* JVET common test conditions and software reference configurations for SDR video (JVET-N1010) [Posted 2019-05-08]
* JVET common test conditions and software reference configurations for HDR/WCG video (JVET-N1011) [Posted 2019-04-12]
* Description of CE 1..11 (JVET-N1021..35) [all first posted 2019-03-27, 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-N1023 [last updated 2019-05-30]
    - JVET-N1024 [last updated 2019-06-23]
    - JVET-N1026 [last updated 2019-06-05]
    - JVET-N1027 [last updated 2019-06-12]
    - JVET-L1029 [last updated 2019-06-10]

The seventeen *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 900 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 120 documents were submitted on aspects of high-level syntax, including tile partitioning.

A preliminary basis for the document subject allocation and meeting notes for the 14th meeting had been made publicly available on the ITU-hosted ftp site.

[JVET-O0002](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7600) JVET AHG report: Draft text and test model algorithm description editing (AHG2) [B. Bross, J. Chen, J. Boyce, S. Kim, S. Liu, Y. Ye]

This document reports the work of the JVET ad hoc group on draft text and test model algorithm description editing (AHG2) between the 14th meeting in Geneva, CH, (19–27 March 2019) and the 15th meeting in Gothenburg, SE, (3–12 July 2019).

At the 14th 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 fifth draft of Versatile Video Coding (VVC D5) and the VVC Test Model 5 (VTM5) encoding.

The normative decoding process for Versatile Video Coding is specified in the VVC draft 5 text specification document. The VVC Test Model 5 (VTM 5) Algorithm and Encoder Description document provides an algorithm description as well as an encoder-side description of the VVC Test Model 5, which serves as a tutorial for the algorithm and encoding model implemented in the VTM5.0 software.

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

JVET-N1001 VVC specification (Draft 5)

List of Integrations

Ten versions of JVET-N1001 were published by the Editing AHG between the the 14th meeting in Geneva, CH, (19–27 March 2019) and the 15th meeting in Gothenburg, SE, (3–12 July 2019).

JVET-N1001 has been established based on JVET-M1001 and now contains the following:

* Incorporated JVET-N0067: NAL unit header.
* Incorporated JVET-N0278: Layer concept without inter-layer referencing.
* Incorporated JVET-N0349: Decoding parameter set (DPS).
* Incorporated JVET-N0869: Semantics of DPS ID equal to 0.
* Incorporated JVET-N0805: APS types (with loop).
* Incorporated JVET-N0100: Signalling information about long-term reference picture POC LSB.
* Incorporated JVET-N0100: Conditional signalling of num\_ref\_idx\_active\_overwrite\_flag.
* Incorporated JVET-N0288: Inference rule for num\_bricks\_in\_slice\_minus1.
* Incorporated JVET-N0124: Inference rule for single\_brick\_per\_slice\_flag and signalling the bottom right brick index as a delta from top left brick index.
* Incorporated JVET-N0047: Ref pic list for IDR.
* Incorporated JVET-N0276: 5 new constraint flags.
* Incorporated JVET-N0276: Sub-profile indication.
* Incorporated JVET-N0865: Gradual random access (GRA).
* Incorporated JVET-N0101: CRA decoding process.
* Incorporated JVET-N0070: Ref pic wraparound cleanups.
* Incorporated JVET-N0352: Conformance window.
* Incorporated JVET-N0438: Loop filtering disabling aross virtual boundaries.
* Incorporated JVET-N0498: Uniform tile partitioning.
* Incorporated JVET-N0150: WPP with 1-CTU lag.
* Incorporated JVET-N0120: Editorial improvements to the general decoding process to clarify the difference between a CVS and a bitstream.
* Incorporated JVET-N0857: Tile and brick partitioning.
* Incorporated JVET-N0706: Decoded picture hash SEI message.
* Incorporated JVET-N0494: Dependent RAP indication SEI message.
* Incorporated JVET-N0353: Buffering period & picture timing SEI messages.
* Incorporated JVET-N0867: Temporal scalability HRD parameters.
* Incorporated JVET-N0063: VUI design.
* Incorporated JVET-N0423 & N0350: HRD starting point.
* Incorporated JVET-N0266: Remove 4x4 unipred, and 4x8/8x4 bipred regular inter modes, and remove the use of for shared merge candidates in the regular merge list.
* Incorporated JVET-N0821: 6-tap interpolation filter for affine MC.
* Incorporated JVET-N0068: Restriction of memory bandwidth consumption of affine MC.
* Incorporated JVET-N0481: BCW index inheritance for constructed affine merge candidate.
* Incorporated JVET-N0334: MV clipping for MMVD, DMVR and CPMV of constructed affine merge candidadates.
* Incorporated JVET-N0407: Disable 8x8/4xN CUs for DMVR.
* Incorporated JVET-N0178: Implicitly split BDOF application region along 16x16 boundaries.
* Incorporated JVET-N0146: Disabling BDOF for BCW and WP, and align the condidtion of DMVR and BIO.
* Incorporated JVET-N0444: Condition check of block height is not equal to 4 for BDOF.
* Incorporated JVET-N0325: 8-bit fixed precision for BDOF calculations.
* Incorporated JVET-N0127: MMVD enabling signalling in SPS
* Incorporated JVET-N0332: disable MVD scaling for MMVD for LTRP.
* Incorporated JVET-N0448/JVET-N0380: infer the number of MMVD base merge candidate to 1.
* Incorporated JVET-N0302: CIIP with position-independent weights.
* Incorporated JVET-N0324: Signal a regular merge flag right after the merge flag and skip flag.
* Incorporated JVET-N0851/N0447/N0400/N0500: align triangle merge candidate number and regular merge candidate number.
* Incorporated JVET-N0340: regular merge candidate list is re-used for triangle.
* Incorporated JVET-N0483: disable sub-block transform when triangle mode is used.
* Incorporated JVET-M0335: Round MVs toward zero.
* Incorporated JVET-N0235: Add an SPS-level flag to turn on and off symmetric MVD
* Incorporated JVET-N0213: Remove TMVP from merge and AMVP list for 4x8 and 8x4 CUs
* Incorporated JVET-N0868: Revised spec text for DMVR reconciling with software ticket [#214](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/214)
* Fixed minor bugs and typos reported in [#94](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/94), [#221](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/221), [#227](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/227), [#248](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/248).
* Fixed bug [#232](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/232): Mismatch between specification and software for triangle merge mode weighted prediction.
* Fixed minor bugs and typos reported in [#249](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/249), [#253](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/253), [#256](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/256).
* Fixed bug [#247](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/247): Fix of size constraint for triangle merge mode when MMVD is disabled in SPS (also in VTM).
* Incorporated JVET-M0471/N0473: Deblocking with long tap filters (including ISP and SBT transform boundaries).
* Incorporated JVET-M0908: Deblocking of CIIP boundaries.
* Incorporated JVET-M0277: Apply pcm\_loop\_filter\_disabled\_flag for ALF.
* Incorporated JVET-N0242: Non-linear ALF with clipping.
* Incorporated fixes for JVET-N0278: Layer concept without inter-layer referencing.
* Fixed some bugs related to reference picture list, tiles and bricks (including the bug reported in [#261](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/261)), presence of the VUI syntax in the SPS, CABAC initialization, HRD, semantics of the picture timing SEI message, etc.
* Incorporated JVET-N0415: CTU-adaptive ALF with fixed filter.
* Incorporated JVET-N0180: ALF line buffer reduction.
* Incorporated JVET-N0220: Simplification of LMCS and other fixes.
* Incorporated JVET-N0477: LMCS with no chroma residue scaling in case of CBF=0.
* Incorporated JVET-N0383/N0251: IBC search range constraint.
* Incorporated JVET-N0175/N0251/N0384: IBC search range increase for CTUs less than 128x128.
* Incorporated JVET-N0843: IBC motion vector prediction unification for merge and MVP mode.
* Incorporated JVET-N0317: Put (0,0) vector as default in IBC merge list.
* Incorporated JVET-N0318/N0427: Disable IBC for 128x128 blocks.
* Fixed bug [#262](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/262): Missing text for IBC with shared merge list.
* Incorporated JVET-N0185: Unified MPM list for intra mode coding.
* Incorporated JVET-N0137: Disable 2x2/4x2/2x4 in dual tree only.
* Incorporated JVET-N0308: Restrict the maximum CU size for ISP to be 64x64.
* Incorporated JVET-N0435: Harmonization between WAIP and intra smoothing filters.
* Incorporated JVET-N0271: CCLM derived from four neighbouring samples.
* Fixed bug [#223](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/223): Fixed ISP interpolation filter conditions.
* Fixed bug [#165](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/165): Removed top-left sample availability derivation process in for CCLM.
* Added SPS flag for ISP.
* Added SPS flag for MRL.
* Incorporated JVET-N0217: Matrix-based intra prediction (MIP).
* Fixed bug [#276](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/276): Added regular\_merge\_flag to context derivation table.
* Fixed bug [#277](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/277): Replaced all occurances of slice-level slice\_loop\_filter\_across\_slices\_enabled\_flag with PPS loop\_filter\_across\_slices\_enabled\_flag.
* Incorporated JVET-N0470: Consider SMVD flag for BDOF condition.
* Added SPS flag for MIP.
* Fixed bugs [#279](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/279), [#280](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/280), [#282](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/282), [#283](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/283), [#284](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/284).
* Incorporated JVET-N0054: Joint coding of chrominance residuals.
* Incorporated JVET-N0188: Unified rice parameter derivation for coefficient level coding.
* Incorporated JVET-N0492: Chroma TU CBF dependent luma TU CBF signalling.
* Incorporated JVET-N0103: Determine coefficient group size based on TB size instead of colour component.
* Incorporated JVET-N0600: Context reduction for amvr\_flag syntax.
* Incorporated JVET-N0286: Context reduction for bcw\_idx syntax.
* Incorporated JVET-N0194: Context selection of last x/y syntax based on non-reduced TU size in case of zero-out.
* Incorporated JVET-N0280: Transform skip residual coding.
* Incorporated JVET-N0413: Block-based quantized residual domain DPCM (BDPCM).
* Fixed bug [#292](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/292): Minor transform skip residual coding issues.
* Fixed bug [#270](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/270): (Bug fix) Changed nuh\_layer\_id to nuh\_layer\_id\_plus1.
* Fixed bug [#298](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/298): typo in IBC BV candidate list derivation.
* Fixed bug [#275](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/275): Wrong bdofUtilizationFlag indexing.
* Fixed bug [#274](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/274): Undefined variables sGxGym and sGxGys.
* Fixed bug [#273](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/273): Wrong HMVP table size.
* Fixed bug [#299](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/299): Minor intra prediction issues.
* Fixed bug [#302](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/302): Fix CBF flags syntax and semantics for implicit TU split.
* Fixed bugs [#307](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/307), [#308](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/308), [#316](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/316): Deblocking issues.
* Fixed the bug that DeltaPocMsbCycleLt was used without being defined.
* Incorporated JVET-N0193: Low frequency non-separable transform (LFNST).
* Incorporated JVET-N0105: Remove mode dependency in LFNST ctx derivation.
* Incorporated JVET-N0866: Unification of implicit transform selection for ISP and SBT.
* Incorporated JVET-N0246: Include square root of 2 factor in levelScale values.
* Incorporated JVET-N0671: Support of 4:4:4 and 4:2:2 chroma formats.
* Incorporated JVET-N0225: Separate color plane id.
* Incorporated JVET-N0847: Default and user-defined scaling matrices
* Incorporated DMVR fixes and editorial improvements.
* Fixed bug [#245](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/245): wrong handling of boundary partitioning for a corner case.
* Fixed bug [#341](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/341): coefficients outside the first coefficient group are considered in 8x8 LFNST.

Integration issues to be discussed

The following items have been discussed during integration of the meeting adoptions and need further discussion/clarification:

* **ALF virtual boundaries in combination with slice/brick/tile boundaries**: The ALF virtual boundary was adopted at the last meeting to remove the ALF line buffer, it is located at 4 luma lines above the bottom CTU boundary (except for those CTUs at the last CTU row of a picture). In the current specification text, the ALF virtual boundary is not present for a CTU if its bottom CTU boundary is also a slice/brick/tile boundary (when the loop-filter across those boundaries is disabled) or a 360 video virtual boundary It is asserted that the current text specification defeats the purpose of the ALF virtual boundary adoption and has the following consequences:
* For decoders, not knowing the slice/brick/tile boundaries upfront (i.e. low-delay applications) means that the ALF line buffer needs to be restored. To process the ALF filtering of the bottom lines of the current CTU (e.g. luma lines 5, 6 and 7 above the bottom CTU boundary), the decoders need to know whether the current bottom CTU boundary coincides with other types of boundaries. This information, however, is unknown until the next slice/brick/tile is decoded.
* Even if the slice/brick/tile boundaries are known upfront (e.g. the CABAC decoding is fully decoupled at frame level), the decoders need to run the loop-filters (de-blocking, SAO and ALF) at a speed of 68 lines per 64x64 VDPU all the time (an overprovision of roughly 6%) in order to avoid using the ALF line buffer.
* **Maximum chroma transform size for 4:4:4 and 4:2:2 chroma formats**: the adoption of N0671 brought the 64x64 transform for chroma for 4:4:4 case. However, having 64x64 chroma transform for the 4:2:2 case was not specifically discussed at the JVET-N Geneva meeting and should be clarified.

The current draft incorporates 64x64 scaling matrices for 4:4:4 chroma.

* **Intra reference sample and interpolation filtering for wide angular and integer slope mode** (JVET-N0435): There have been different understandings of what has been adopted with JVET-N0435 where the available draft text is different from the Intra BoG understanding. It can be summarized as follows:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Int-slope modes**  **2, 34, 66** | **Wide-angle modes**  **(int-slope modes)** | **Wide-angle modes**  **(non-int-slope)** |
| **VTM4** | If (w\*h > 32) then (1 2 1) filter;  else no filter | Gauss Interpolation Filter (0 phase) | Gaussian interpolation filter |
| **JVET-N0435** | Idem VTM4 | If (w\*h > 32) then (1 2 1) filter;  else no filter | Idem VTM4 |
| **JVET-N0435**  **(BoG understanding)** | Idem VTM4 | (1 2 1)-filter | Idem VTM4 |

After some discussion, it was decided to integrate the variant provided in JVET-N0435-v3 in specification text and VTM software.

Open specification tickets

At the time of writing this report, the following in the [JVET VVC bug tracking system](https://jvet.hhi.fraunhofer.de/trac/vvc/query?status=accepted&status=assigned&status=new&status=reopened&component=spec&groupdesc=1&group=version&col=id&col=summary&col=status&col=type&col=priority&col=milestone&col=time&col=reporter&report=13&order=priority):

|  |  |
| --- | --- |
| [#225](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/225) | [Alignment between spec and implementation in Affine Merge](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/225) |
| [#271](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/271) | [Motion vector rounding: tiny contradiction between N0335 integration and the meeting decision](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/271) |
| [#290](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/290) | [Mismatch on collocated subblock location in SbTMVP between VTM and spec](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/290) |
| [#306](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/306) | [Redundant clipping in 8.5.5.6](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/306) |
| [#309](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/309) | [APS with same ID referenced from different slices](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/309) |
| [#310](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/310) | [Type of syntax element slice\_num\_alf\_aps\_ids\_luma](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/310) |
| [#315](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/315) | [Inter issues related to global variables](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/315) |
| [#317](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/317) | [Mismatch with vtm on mvp\_l1\_flag parsing](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/317) |
| [#318](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/318) | [Missing initialization of MvdCpL0 array](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/318) |
| [#319](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/319) | [IBC BV range description](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/319) |
| [#321](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/321) | [mvd\_l1\_zero\_flag semantic](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/321) |
| [#322](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/322) | [Parsing condition for ISP split flag](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/322) |
| [#323](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/323) | [Mismatch in Affine MVP candidate list construction between VTM and spec](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/323) |
| [#324](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/324) | [Mismatch in equation 8-784 with SW](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/324) |
| [#325](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/325) | [Redundant syntax parsing related to IBC restriction for 128x128 blocks](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/325) |
| [#331](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/331) | [cu\_cbf is set to 0 when BDPCM is 1](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/331) |
| [#333](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/333) | [Transform / Quantization Bypass Missing](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/333) |
| [#335](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/335) | [Chroma qp offset syntax element missing](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/335) |
| [#336](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/336) | [Explicit RDPCM syntax element missing](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/336) |
| [#340](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/340) | [Bug in the ISP text](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/340) |
| [#344](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/344) | [spatial merge candidate derivation process with wrong prunings](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/344) |
| [#320](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/320) | [Typos](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/320) |

Model 5 (VTM 5) Algorithm and Encoder Description.

Two versions of JVET-N1002 was published by the Editing AHG between the 14th meeting in Geneva, CH, (19–27 March 2019) and the 15th meeting in Gothenburg, SE, (3–12 July 2019).

JVET-N1002 has been established based on JVET-M1002. It provides the algorithm description for majority of coding tools in VVC. In this editing period, the following changes were included:

* Incorporated JVET-N0866: Unification of implicit transform selection
* Incorporated JVET-N0193: LFNST (Low-Frequency Non-Separable Transform)
* Incorporated JVET-N0105: Simplification of LFNST index coding
* Incorporated JVET-N0217: Matrix weighted intra prediction
* Incorporated JVET-N0246: Modified dequantization scaling
* Incorporated JVET-N0847: Support of quantization matrices
* Incorporated JVET-N0188: Unified rice parameter derivation for coefficient level coding
* Incorporated JVET-N0194: Context selection of last non-zero coefficient position in reduced TU
* Incorporated JVET-N0103: Coefficient group size harmonization
* Incorporated JVET-N0185: Unified MPM list for intra mode coding
* Incorporated JVET-N0137: Intra chroma partitioning and prediction restriction
* Incorporated JVET-N0435: Harmonization between WAIP and intra smoothing filters
* Incorporated JVET-N0308: Restriction of the maximum CU size for ISP to 64×64
* Incorporated JVET-N0271: CCLM derived with four neighbouring samples
* Incorporated JVET-N0415: CTU adaptive ALF, and fixed filter set.
* Incorporated JVET-N0242: Non-Linear Adaptive Loop Filtering (NL-ALF)
* Incorporated JVET-N0180: ALF line buffer reduction
* Incorporated JVET-N0473: Deblocking of ISP/SBT TU boundaries
* Incorporated JVET-N0266: Remove 4x4 unipred, and 4x8/8x4 bipred regular inter modes
* Incorporated JVET-N0340: Simplified Merge list construction for TPM
* Incorporated JVET-N0413: quantized residual DPCM
* Incorporated JVET-N0054: joint coding of chroma residuals
* Incorporated JVET-N0251 item 4 on IBC search range.
* Incorporated JVET-M0253 and JVET-N0247 on hash-based motion estimation.
* Incorporated JVET-N0280: residual coding for transform skip mode
* Incorporated JVET-N0325: using 8-bit fixed precision in BDOF
* Incorporated JVET-N0146: disable BDOF if BCW or WP is used
* Incorporated JVET-N0302: CIIP with position-independent weights
* Incorporated JVET-N0483: disallow the combination of sub-block transform with triangle mode
* Incorporated JVET-N0286: simplified BCW index coding
* Incorporated JVET-M0140: Sub-block transform for inter blocks
* Incorporated JVET-N0481: BCW index inheritance for constructed affine merge candidate
* Incorporated JVET-N0407: Disable 8x8/4xN CUs for DMVR
* Incorporated [JVET-N0868](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6623): DMVR reconciling with software ticket #214, 25 points SAD full search
* Incorporated JVET-N0178: Implicitly split BDOF application region along 16x16 boundaries
* Incorporated JVET-N0146: Align DMVR with BDOF on the conditions
* Incorporated JVET-N0447/N0400/N0500/N0851, signalling of triangle merge candidate number
* Incorporated JVET-M0444: Symmetric MVD coding

The AHG recommended to:

* Approve the edited JVET-N1001 and JVET-N1002 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.
* Integrate fixes for open specification tickets in one document and have these fixes confirmed at this meeting.

[JVET-O0003](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=7606) JVET AHG report: Test model software development (AHG3) [F. Bossen, X. Li, A. Norkin, K. Sühring]

This report summarizes the activities of the AhG3 on Test model software development that has taken place between the 14th and 15th 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/>

VTM 4.2 was tagged on Apr. 1, 2019.

Changes related to VTM 4.1 include:

* Removed JVET-Mxxx macros

After one release candidates, VTM 5.0 was tagged on May 7, 2019.

Changes related to VTM 4.2 include:

* JVET-N0477: N0220 LMCS simplifications
* JVET-N0477: LMCS cleanup
* add encoder config constraint for WrapAroundOffset to be a multiple of the minimum CU size
* JVET-N0332: MMVD Fix for LTRPs
* JVET-N0335: MV Rounding Unification
* JVET-N0137: Intra chroma partitioning restriction
* JVET-N0449: Simplification on MMVD distance table
* JVET-N0242: non-linear ALF (clipping)
* JVET-N0483: disable SBT in TPM
* JVET-N0481: BCW index inheritance for constructed affine merge candidate
* JVET-N0334: MV Overflow Prevention
* JVET-N0325: BDOF improvement
* JVET-N0271: simplified CCLM
* JVET-N0178 CE9-2.4 implicit BDOF split
* JVET-N0185: A Unified MPM List for Intra Mode Coding
* JVET-N600: AMVR flag and Triangle flag context reduction
* JVET-N0286: simplified gbi index coding
* JVET-N0188: Unified rice parameter derivation for coefficient level coding
* JVET-N0462: Fix context modeling of inter\_pred\_idc
* JVET-N0329: IBC Search Improvement
* JVET-N0318/N0467: IBC size
* JVET\_N0317\_ADD\_ZERO\_BV
* JVET-N0383/N0251: bug fix for ibc referring to collocated VPDU in left CTU
* JVET-N0175/N0251/N0384: Re-arrange IBC search range for small CTU sizes
* JVET-N0448/N0380: MMVD fix when MaxNumMergeCand is 1
* JVET-N0235: Added smvd flag in SPS
* JVET-N0266: remove 4x4 uni-pred, 4x8/8x4 bi-pred from regular inter modes.
* JVET-N0407: Disable 4xN/8x8 CUs for DMVR.
* JVET-N0235 bugfix
* JVET-N0470, SMVD RefIdxSymLX derivation, aligned software to spec text.
* JVET-N0146/N0162/N0442/N0153/N0262/N0440/N0086: applicable condition of DMVR and BDOF
* JVET-N0843: Block vector prediction simplification
* JVET-N0103: Coefficient group size harmonization
* JVET-N0280: residual coding for transform skip
* Enable repetition of parameter sets in CTC configs
* JVET-N0196: Use six tap filter for affine motion compensation
* JVET-N0671: Support of 4:4:4 and 4:2:2 chroma formats in VVC
* Refactor: align sps\_fpel\_mmvd\_enabled\_flag with spec text
* Added a config file parameter for ISP
* JVET-N0308: Maximum CU Size for ISP
* JVET-N0068: Affine memory bandwidth reduction
* JVET-N0246 method 6: modified quantization scales.
* JVET-N0127 : MMVD enabling flag in SPS
* JVET-N1011: Updated HDR configuration files to match CTC
* Intra-prediction clean-up requested by Ben and discussed at the meeting in Geneva
* JVET-N0213: TMVP removal at specific sizes
* JVET-N0054: Joint chroma residual mode
* JVET-N0168: AMVR cost calculation modification in motion estimation stage
* JVET-N0363: Modified cost criterion for intra encoder mode decision
* JVET-N0492: disallowing hierarchical CBFs signalling
* Adjust IBC local search range according to JVET-N0251 item4.
* JVET-N0324: on Regular Merge Flag
* JVET-N0473, JVET-N0098: Deblocking of ISP/SBT TU boundaries
* JVET-N0435: WAIP Harmonization
* JVET-N0180: line buffer reduction using symmetric padding
* JVET-N0340: regular merge candidate list is re-used for triangle
* JVET-N0866: unified transform derivation for ISP and implicit MTS - refactored
* JVET-N0302: Simplified CIIP
* JVET-N0247: Improvement of Hash Motion Estimation
* JVET-N0413/N0214: RDPCM
* JVET-N0400: Signal max number of triangle merge candidates
* JVET-N0217: matrix-based intra prediction (MIP)
* JVET-N0217: added missing 'isSameCtu' condition
* JVET-N0193: Low Frequency Non-Separable Transform (LFNST)
* JVET-N0105: LFNST context modelling
* JVET-N0415: CTB-based ALF switch
* Retrained CABAC initialization values
* Various bug fixes

VTM 5.1 is expected to be tagged during the 15th JVET meeting. Changes include:

* JVET-N0047: Ref pic list for IDR
* JVET-M0128: Reference picture management for VVC
* JVET-N0278: HLS for immersive media delivery and access requirement
* JVET-N0070: Reference frame wraparound modifications
* JVET-N0805: APS for LMCS (using different APS types)
* JVET-M0853/N0857: Rectangular Slice
* JVET-N0276: add the subprofile syntax
* JVET-N0276: added 5 new adopted constraint flags
* JVET-N0276: Constraint flags
* JVET-N0847: Support scaling matrices
* JVET-N0063: VUI
* JVET-N0150: One CTU delay WPP
* JVET-N0857: slices/tiles/bricks
* JVET-N0741: Enable Rate Control with In-Loop Reshaping
* JVET-N0438: Loop filter disabled across virtual boundaries
* JVET-N0349: decoding parameter set (DPS)
* JVET-N0067: NAL unit header
* Various bug fixes and cleanups

At the beginning of the 15th meeting, some high-level syntax implementations were still pending:

* JVET-N0494 (dependent RAP indication SEI message): SEI decoding code from HEVC seems valid. Encoder code is going to be provided by the October meeting
* JVET-N0353 (buffering period & picture timing SEI messages): In progress; to be submitted soon.
* JVET-N0867 (temporal scalability HRD parameters): depends on JVET-N0353
* JVET-N0100 (signalling information about long-term reference picture POC LSB, Conditional signalling of num\_ref\_idx\_active\_overwrite\_flag): to be commited soon
* JVET-N0288 (inference rule for num\_tiles\_in\_tile\_group\_minus1): to be commited soon
* JVET-N0865 (gradual random access): No software had been provided to support the adopted HLS. (Efforts to get software had started rather late, and some software had been available within CE11 work.)

CTC Performance

The following table shows **VTM 5.0** performance over **HM 16.20**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra** |  |  |
|  |  |  | **Over HM-16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -26.64% | -39.80% | -37.26% | 2203% | 187% |
| Class A2 | -24.98% | -25.83% | -19.52% | 3501% | 192% |
| Class B | -20.45% | -24.88% | -32.98% | 3670% | 191% |
| Class C | -21.35% | -22.17% | -27.25% | 4915% | 199% |
| Class E | -24.70% | -24.59% | -29.92% | 2795% | 184% |
| **Overall** | -23.14% | -26.88% | -29.67% | 3410% | 191% |
| Class D | -17.46% | -18.93% | -21.66% | 5662% | 190% |
| Class F | -38.15% | -39.65% | -42.08% | 4768% | 186% |
|  |  |  |  |  |  |
|  |  |  | **Random Access** |  |  |
|  |  |  | **Over HM-16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -34.92% | -39.81% | -43.03% | 910% | 185% |
| Class A2 | -39.04% | -37.01% | -30.74% | 991% | 193% |
| Class B | -32.76% | -37.86% | -40.19% | 984% | 178% |
| Class C | -27.86% | -27.10% | -31.11% | 1259% | 192% |
| Class E |  |  |  |  |  |
| **Overall** | -33.14% | -35.21% | -36.45% | 1036% | 186% |
| Class D | -26.07% | -24.83% | -28.17% | 1436% | 192% |
| Class F | -39.81% | -40.67% | -42.91% | 705% | 150% |
|  |  |  |  |  |  |
|  |  |  | **Low Delay B** |  |  |
|  |  |  | **Over HM-16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -25.94% | -21.75% | -23.44% | 817% | 167% |
| Class C | -22.47% | -18.99% | -21.99% | 965% | 165% |
| Class E | -25.58% | -23.94% | -28.23% | 445% | 123% |
| **Overall** | -24.69% | -21.38% | -24.15% | 742% | 154% |
| Class D | -21.22% | -13.76% | -17.49% | 1040% | 170% |
| Class F | -36.30% | -36.19% | -38.05% | 539% | 126% |
|  |  |  |  |  |  |
|  |  |  | **Low Delay P** |  |  |
|  |  |  | **Over HM-16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -30.41% | -24.95% | -26.60% | 766% | 172% |
| Class C | -24.57% | -19.79% | -22.83% | 897% | 170% |
| Class E | -29.16% | -28.61% | -32.22% | 404% | 125% |
| **Overall** | -28.15% | -24.15% | -26.75% | 688% | 158% |
| Class D | -22.98% | -15.00% | -17.53% | 1000% | 170% |
| Class F | -36.11% | -36.22% | -37.88% | 559% | 131% |

The following table shows **VTM 5.0** performance compared to **VTM 4.2**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra** |  |  |
|  |  |  | **Over VTM-4.2** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -3.76% | -1.01% | -0.95% | 165% | 110% |
| Class A2 | -2.56% | -1.33% | 0.80% | 169% | 108% |
| Class B | -1.71% | -0.79% | -3.25% | 163% | 105% |
| Class C | -2.40% | -1.49% | -4.15% | 164% | 105% |
| Class E | -2.53% | -0.90% | -4.02% | 158% | 105% |
| **Overall** | -2.48% | -1.09% | -2.52% | 164% | 106% |
| Class D | -1.49% | -0.89% | -2.57% | 171% | 106% |
| Class F | -7.41% | -5.45% | -7.08% | 153% | 102% |
|  |  |  |  |  |  |
|  |  |  | **Random Access** |  |  |
|  |  |  | **Over VTM-4.2** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -3.26% | -1.41% | -1.53% | 128% | 103% |
| Class A2 | -2.50% | -3.39% | -1.17% | 125% | 112% |
| Class B | -2.14% | -1.58% | -3.57% | 128% | 108% |
| Class C | -1.93% | 0.24% | -3.06% | 135% | 110% |
| Class E |  |  |  |  |  |
| **Overall** | -2.38% | -1.42% | -2.55% | 129% | 108% |
| Class D | -0.93% | 0.20% | -3.04% | 147% | 108% |
| Class F | -6.10% | -4.34% | -6.66% | 144% | 109% |
|  |  |  |  |  |  |
|  |  |  | **Low Delay B** |  |  |
|  |  |  | **Over VTM-4.2** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -1.33% | -3.53% | -6.81% | 110% | 109% |
| Class C | -0.81% | -3.78% | -5.94% | 114% | 107% |
| Class E | -1.49% | -2.58% | -5.37% | 118% | 103% |
| **Overall** | -1.20% | -3.38% | -6.16% | 114% | 107% |
| Class D | 0.46% | -3.08% | -7.76% | 124% | 108% |
| Class F | -5.88% | -5.60% | -7.01% | 129% | 109% |
|  |  |  |  |  |  |
|  |  |  | **Low Delay P** |  |  |
|  |  |  | **Over VTM-4.2** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -1.68% | -3.97% | -7.16% | 116% | 110% |
| Class C | -0.78% | -3.54% | -5.97% | 120% | 106% |
| Class E | -2.29% | -4.67% | -6.24% | 126% | 102% |
| **Overall** | -1.53% | -4.00% | -6.53% | 120% | 107% |
| Class D | 0.36% | -3.08% | -7.28% | 137% | 109% |
| Class F | -6.30% | -6.72% | -8.18% | 139% | 107% |

The following table shows expected **VTM 5.1** performance compared to **VTM 5.0**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra** |  |  |
|  |  |  | **Over VTM-5.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.02% | -0.03% | 0.00% | 102% | 100% |
| Class A2 | 0.01% | 0.00% | 0.01% | 102% | 101% |
| Class B | 0.04% | 0.01% | 0.05% | 102% | 103% |
| Class C | 0.10% | 0.13% | 0.14% | 101% | 103% |
| Class E | 0.12% | 0.15% | 0.07% | 102% | 105% |
| **Overall** | 0.06% | 0.05% | 0.06% | 102% | 102% |
| Class D | 0.33% | 0.33% | 0.26% | 101% | 110% |
| Class F | 0.06% | 0.19% | 0.17% | 103% | 104% |
|  |  |  |  |  |  |
|  |  |  | **Random Access** |  |  |
|  |  |  | **Over VTM-5.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.00% | 0.02% | 0.00% | 102% | 101% |
| Class A2 | 0.05% | 0.19% | 0.00% | 101% | 99% |
| Class B | 0.03% | 0.05% | -0.27% | 102% | 103% |
| Class C | 0.03% | -0.08% | 0.02% | 101% | 106% |
| Class E |  |  |  |  |  |
| **Overall** | 0.03% | 0.04% | -0.09% | 101% | 103% |
| Class D | 0.30% | 0.30% | 0.29% | 101% | 116% |
| Class F | 0.16% | 0.07% | 0.08% | 103% | 107% |
|  |  |  |  |  |  |
|  |  |  | **Low Delay B** |  |  |
|  |  |  | **Over VTM-5.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | TBD | TBD | TBD | TBD | TBD |
| Class C | 0.05% | 0.12% | 0.07% | 102% | 109% |
| Class E | 0.15% | -0.01% | 0.07% | 101% | 107% |
| **Overall** | TBD | TBD | TBD | TBD | TBD |
| Class D | 0.04% | -0.13% | 0.69% | 100% | 116% |
| Class F | -0.04% | -0.16% | -0.62% | 102% | 106% |
|  |  |  |  |  |  |
|  |  |  | **Low Delay P** |  |  |
|  |  |  | **Over VTM-5.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | TBD | TBD | TBD | TBD | TBD |
| Class C | 0.02% | -0.03% | 0.19% | 100% | 107% |
| Class E | 0.19% | 0.17% | 0.39% | 100% | 108% |
| **Overall** | TBD | TBD | TBD | TBD | TBD |
| Class D | 0.07% | 0.62% | -0.25% | 101% | 117% |
| Class F | -0.06% | 0.53% | 0.29% | 103% | 107% |

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

No tests were performed for multi-resolution streaming test conditions with VTM 5.0.

* + After the MTS code was refactored in VTM-4.0, the integration of LFNST re-introduced some of the previously removed code. This was pointed out to the proponents in MR490. Proponents said they would continue to work further on harmonizing the code. No further improvements have been submitted so far. In ticket #287 it was pointed out that setting MTSIntraMaxCand to different values with LFNST enabled is broken. No solution was provided for this problem.
  + After integration of JVET-N0847 (scaling list), several issues were reported in ticket #311, and then two fix merge requests were submitted. There is more than one normative way to fix for one issue. It is suggested to bring proposals for normative fixes unless a fix is straightforward and agreed on the JVET main reflector.
  + The code for JVET-M0128 (reference picture list handling from the previous meeting) was submitted late in the process, while new adoptions already depended on this.
  + A start code emulation was triggered because the second byte of the NAL unit header was allowed to be zero. A straightforward fix (increment nuh\_layer\_id by 1) was discussed and implemented in the draft and software.
  + It was noticed that HRD parameters were missing due to an open discussion point in the BoG notes. The meeting notes indicated that the HRD parameters should be included and that they should be outside of VUI. A straightforward fix (to put them before the VUI) was discussed and implemented in draft and software (JVET-O0153 contains this fix).
  + Uniform tile signalling (JVET-O0153) was not implemented since they introduce a parsing dependency between SPS and PPS. Contributions to the 15th meeting propose ways to fix the problem or to allow parsing dependencies (JVET-O0236, JVET-O0490, JVET-O0113).
  + There was some confusion about the details of the JVET-N0435 adoption, which led to vigorous discussion on gitlab and the main JVET reflector. After further consultation with the JVET chairs, the code provided by the authors of JVET-N0435 was kept, as it was consistent with the draft text provided with JVET-N0435.

Software manual

Very 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 bit-streams/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

[JVET-O0004](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7544) JVET AHG report: Test material and visual assessment (AHG4) [T. Suzuki, M. Wien, V. Baroncini, R. Chernyak, P. Hanhart, A. Norkin, J. Ye]

The test sequences used for the 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).

No test sequence selections for the CTC were changed at the last meeting.

On determining a new structure at test sequence repository, there was not much progress since the last meeting. There was discussion in the last meeting that the current directory structure of test sequence ftp site is not good for the current activities. The ftp directory was created during the preparation of CfE/CfP and the same directory structure is still used. One possibility is to re-design the directory as follows, for example,

* ctc/ : Contains the active test set of the common testing conditions
* ahg/ : Contains subdirectories with sequences under consideration. The subfolder might be structured by meeting period (e.g. named by the doc-number of the corresponding meeting report?)
* ce/ : Contains subdirectories for data exchange for specific CE (already implemented, see ce/JVET-{K,L}1031\_Deblocking
* upload : stays as before

During the Marrakech meeting, there was a comment that all sequences, all classes should be at the same place. But there is still meaningful to separate SDR, HDR, and 360. Further detail should be discussed in the meeting.

In the discussion, it was suggested to not remove the cfe and cfp directories, but to add the additional ones above (even if there might be some duplication of content or use of symbolic links). This approach was agreed.

The following related contribution was noted.

* JVET-O0451 “AHG4: Subjective comparison of VVC and HEVC”, P. Philippe, J. Fournier (Orange), W. Hamidouche (INSA), JY Aubie (b-com)

The AHG recommended to review related contributions and to continue to collect new test sequences available for JVET with licensing statement.

[JVET-O0005](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7546) JVET AHG report: Memory bandwidth consumption of coding tools (AHG5) [R. Hashimoto, T. Ikai, X. Li, D. Luo, H. Yang, M. Zhou]

The document summarizes activities of AHG on memory bandwidth consumption of coding tools between the 14th and the 15th JVET meetings.

There was no related email discussion during this meeting cycle, and no related contributions were noted at this meeting.

A patch on memory bandwidth measurement tools on VTM-5.0 had been provided by the AHG

<https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/230>

There is a discussion about this patch on git system. This identified a bug, and a merge request had been incorporated into the VTM software to fix it.

The AHG recommended to continue investigation of memory bandwidth via AHG13 activities.

[JVET-O0006](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7543) JVET AHG report: 360° video coding tools, software and test conditions (AHG6) [Y. He, K. Choi, J. Boyce, P. Hanhart, J.-L. Lin]

The document summarizes activities on 360-degree video content conversion software development between the 14th (19 – 27 Mar. 2019) and the 15th (3 – 12 July 2019) JVET meetings.

The 360Lib-9.1 software package included the following changes:

* Projection format conversion for hemisphere cubemap and hemisphere equi-angular cubemap (JVET-M0452).
* Added hemisphere cubemap (HCMP) and hemisphere equi-angular cubemap (HEAC) conversion configuration files.

360Lib-9.1 with the support of VTM-5.0 was released on May 14, 2019.

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

<https://jvet.hhi.fraunhofer.de/svn/svn_360Lib/>

The released version of 360Lib-9.1 can be found at:

<https://jvet.hhi.fraunhofer.de/svn/svn_360Lib/tags/360Lib-9.1/>

360Lib-9.1 testing results can be found at:

[ftp.ient.rwth-aachen.de/testresults/360Lib-9.1](ftp://ftp.ient.rwth-aachen.de/testresults/360Lib-9.1)

360Lib bug tracker

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

The first table below is for the projection formats comparison using VTM-5.0 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-5.0.

The second table below is for PERP coding comparison between VTM-5.0 and HM-16.16.

The third table below is to compare VTM-5.0 with PHEC coding and HM-16.16 with CMP coding.

**VTM-5.0 PHEC vs PERP (VTM-5.0 PERP as anchor)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **PHEC over PERP (VTM-5.0)** | | | | | |
|  | **End-to-end WS-PSNR** | | | **End-to-end S-PSNR-NN** | | |
|  | Y | U | V | Y | U | V |
| Class S1 | -11.25% | -9.22% | -9.34% | -11.17% | -9.13% | -9.29% |
| Class S2 | -5.31% | -6.56% | -6.42% | -5.29% | -6.43% | -6.31% |
| **Overall** | -8.87% | -8.15% | -8.17% | -8.82% | -8.05% | -8.09% |

**VTM-5.0 PERP vs HM-16.16 PERP (HM-16.16 PERP as anchor)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **VTM-5.0 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 | -24.37% | -38.11% | -41.60% | -24.36% | -38.12% | -41.54% |
| Class S2 | -33.30% | -34.64% | -37.28% | -33.30% | -34.69% | -37.32% |
| **Overall** | -27.94% | -36.73% | -39.87% | -27.93% | -36.75% | -39.85% |

**VTM-5.0 PHEC vs HM-16.16 CMP (HM-16.16 CMP as anchor)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **VTM-5.0 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 | -28.60% | -39.70% | -42.56% | -28.48% | -39.67% | -42.51% |
| Class S2 | -36.09% | -38.55% | -40.70% | -36.08% | -38.55% | -40.70% |
| **Overall** | -31.60% | -39.24% | -41.81% | -31.52% | -39.22% | -41.79% |

There were 3 input documents related to syntax for signalling of cubeface layouts that were noted.

* JVET-O0487 Geometry padding for cube based 360 degree video using uncoded areas [J. Sauer, M. Bläser (RWTH Aachen University)]
* JVET-O0488 Parameterizable cubemap for 360 degree video coding [J. Sauer, M. Bläser (RWTH Aachen University)]
* JVET-O0891 AHG6/AHG17: Cubemap-based projection syntax for 360-degree videos [Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek)]

The AHG recommended:

* To continue software development of the 360Lib software package.
* To generate CTC VTM anchors according to 360° video CTC, and provide the reporting template for the common test conditions.
* Review input contributions

[JVET-O0007](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7596) JVET AHG report: Coding of HDR/WCG material (AHG7) [A. Segall, E. François, W. Husak, D. Rusanovskyy]

This document summarizes the activity of AHG7: Coding of HDR/WCG material (AHG7) between the 14th meeting in Geneva, CH (19–27 March 2019) and the 15th meeting in Gothenburg, SE (3–12 July 2019).

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 comparing the performance of the VTM for HDR/WCG content.

The AhG performed experiments comparing the performance of VTM 5.0 and VTM 4.0 codecs on HDR content. A summary of the performance is provided below.

VTM 5.0 versus VTM 4.0

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | | | | | |
|  | **Over VTM-4.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | 5.58% | -2.48% | -2.94% | -2.51% | 5.74% | -2.73% | -1.34% | 8.25% | 165% | 109% |
| Class H2 |  |  |  |  |  | -1.31% | -3.96% | -8.62% | 143% | 105% |
| **Overall** | 5.58% | -2.48% | -2.94% | -2.51% | 5.74% | -2.21% | -2.29% | 2.11% | 157% | 108% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access** | | | | | | | | | |
|  | **Over VTM-4.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | 6.47% | -1.44% | -2.15% | -2.02% | 8.75% | -2.04% | -1.65% | 10.99% | 128% | 109% |
| Class H2 |  |  |  |  |  | -2.76% | -3.86% | -9.07% | 112% | 105% |
| **Overall** | 6.47% | -1.44% | -2.15% | -2.02% | 8.75% | -2.30% | -2.46% | 3.70% | 122% | 108% |

VTM 5.0 versus HM 16.18

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | | | | | |
|  | **Over VTM-4.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -40.05% | -24.57% | -24.40% | -53.41% | -56.13% | -22.80% | -49.33% | -48.68% | 2386% | 109% |
| Class H2 |  |  |  |  |  | -20.82% | -38.50% | -40.17% | 2198% | 172% |
| **Overall** | -40.05% | -24.57% | -24.40% | -53.41% | -56.13% | -22.08% | -45.39% | -45.59% | 2316% | 129% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access** | | | | | | | | | |
|  | **Over VTM-4.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -38.75% | -29.15% | -28.91% | -52.95% | -51.45% | -26.84% | -48.47% | -43.51% | 378% | 98% |
| Class H2 |  |  |  |  |  | -26.98% | -44.76% | -48.72% | 563% | 160% |
| **Overall** | -38.75% | -29.15% | -28.91% | -52.95% | -51.45% | -26.89% | -47.12% | -45.41% | 437% | 117% |

There were four contributions related to HDR video coding (and some related cross-checks):

* JVET-O0432 AHG10: LMCS encoder improvement [F. Pu, S. McCarthy, T. Lu, P. Yin, W. Husak, T. Chen (Dolby)]
* JVET-O0661 AHG2/AHG17: Draft text to update BT.2100 references and ICTCP HLG coding equations [S. McCarthy, F. Pu, T. Lu, P. Yin, W. Husak, T. Chen]
* JVET-O0657 AHG7: Tool-on/off experiments for HLG CTC sequences [S. Iwamura, S. Nemoto, A. Ichigaya (NHK)]
* JVET-O0756 HDRTools: VTM software integration [D. Mehlem, A.M. Tourapis, D. Singer]

[Ed. Get sentence about relevant SDR contributions from revised report.]

It was observed that there was a rather large chroma loss between VTM 4.0 and VTM 5.0. This was investigated during the AhG period, and it was identified that the integration of JVET-M0091 resulted in the loss (commit: 65c9bacdf38). It was commented that this relates to QP handling and could be addressed by non-normative approaches.

It was encouraged that QP related adoptions, including those felt to be non-normative, be tested with the HDR CTC.

Computing the metrics for the common test conditions requires the use of the external HDRMetrics package, which in terms requires the management of additional configuration files to control the conversion of decoded YUV sequences to floating point representations in linear light. In one case, a separate configuration file is used for the ShowGirl sequence.

It was noted that JVET-O0756 provides software that incorporates the HDRMetrics packages into the VTM software. This is expected to streamline the calculation of the CTC metrics, and it could have a further benefit of reducing the number of configuration files that need to be managed.

The AHG recommended to review the related input contributions.

[JVET-O0008](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=7610) 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]

AHG08 was established by the 14th meeting (Geneva) to study layered coding and resolution adaptivity. A number of messages were exchanged on the reflector.

There was only limited activity of the AHG between the Marrakech and the Geneva meeting. A total of five emails included the [AHG8] marker.

24 documents related to the subject matter of this ad hoc group were identified. These were listed in the AHG report in the following categories:

* Documents related to reference picture resampling (RPR) (11)
* Scalability (13)

The AHG recommended that those contributions be studied during the meeting.

[JVET-O0009](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7565) JVET AHG report: Neural Networks in Video Coding (AHG9) [S. Liu, K. Kawamura, Y. Li, L. Wang, P. Wu, H. Yang]

This document summarizes the activity of AHG9: Neural network in video coding between the 14th meeting in Geneva, CH (19–27 March 2019) and the 15th Meeting at Gothenburg, SE (3–12 July 2019).

The AHG used the main JVET reflector, [jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de), with [AHG9] in message headers. This AHG worked closely with CE10. Subjects such as software sharing, training data and process, neural network structure and complexity, etc. have been actively discussed among proponents and participants. The following tables summarize the tests for using neural network based filters.

Table 1: CE10 test results with VTM-5.0+ Test Condition 1 (CTC)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **AI Over VTM-5.0** |  |  |  |  | **RA Over VTM-5.0** |  |  |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| In-loop/post filter | CE10-1.2a |  |  |  |  |  | -1.20% | -14.17% | -14.11% | 100% | 117% |
| CE10-1.7a |  |  |  |  |  | -0.80% | -10.56% | -9.93% | 100% | 129% |
| CE10-1.7b |  |  |  |  |  | -0.95% | -10.78% | -10.39% | 100% | 158% |
| CE10-1.11a |  |  |  |  |  | -0.04% | -15.54% | -15.17% | 99% | 190% |
| CE10-1.11b |  |  |  |  |  | 0.25% | -5.04% | -6.01% | 100% | 213% |
| CE10-2.2a | -3.93% | -7.89% | -7.29% | 134% | 74517% | -0.26% | -3.86% | -2.91% | 139% | 132513% |
| CE10-2.2b | -3.05% | -9.02% | -10.47% | 136% | 74083% | -1.89% | -11.91% | -8.90% | 139% | 135869% |
| CE10-2.11a |  |  |  |  |  | -1.10% | -2.94% | -3.35% | 127% | 56667% |
| CE10-2.11b |  |  |  |  |  | -0.32% | -0.66% | -0.81% | 100% | 64536% |

Table 2: CE10 test results with VTM-5.0+ Test Condition 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **RA Over VTM-5.0** |  |  |
|  | **Test#** | **Description** | **Y** | **U** | **V** | **EncT** | **DecT** |
| Para. precision | CE10-1.10a | 6-bit(int) weights | 0.04% | -0.97% | -2.30% | 100% | 127% |
| CE10-1.10b | 14-bit(int) weights | 0.23% | -15.24% | -13.66% | 100% | 190% |
| CE10-2.1a | 32-bit(float) weights | -0.46% | -4.11% | -2.80% | 142% | 134684% |
| CE10-2.1b | 8-bit(int) weights | 0.79% | -5.06% | -4.73% | 192% | 306401% |
| CE10-2.5a | 32-bit(float) weights | -1.01% | -5.01% | -4.24% | 105% | 5652% |
| CE10-2.5b | 8-bit(int) weights | -0.84% | -4.13% | -2.92% | 107% | 5515% |
| CE10-2.8c | 8-bit(int) weights |  |  |  |  |  |
| CE10-2.10a | 8-bit(int) weights | -1.00% | -2.98% | -3.46% | 128% | 57777% |
| CE10-2.10b | 16-bit(int) weights | -1.16% | -3.21% | -3.59% | 129% | 59072% |

Table 3: CE10 test results with VTM-5.0+ Test Condition 3

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **RA Over VTM-5.0** |  |  |
|  | **Test#** | **Description** | **Y** | **U** | **V** | **EncT** | **DecT** |
| QP generation capability | CE10-2.2a | CTC QP for testing | -0.46% | -4.11% | -2.80% | 142% | 134684% |
| CE10-2.3b | CTC QP+5 | -1.52% | -6.15% | -4.31% | 166% | 154379% |
| CE10-2.5a | CTC QP for testing | -1.01% | -5.01% | -4.24% | 105% | 5652% |
| CE10-2.7a | CTC QP-5 | -0.63% | -3.83% | -3.34% | 105% | 5026% |
| CE10-2.7b | CTC QP+5 | -1.15% | -5.01% | -4.47% | 111% | 5525% |

Complexities of above filters are also analyzed. Detailed results and discussions about tool performance and complexity can be found in CE10 report.

AHG9 related input documents for this meeting were listed and summarized in the AHG report (about ten in total).

The AHG recommended to review the related contributions and continue investigating the benefits and complexity of using neural networks in video coding.

[JVET-O0010](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7650) JVET AHG report: Encoding algorithm optimizations (AHG10) [A. Duenas, A.M. Tourapis, C. Helmrich, S. Ikonin, A. Norkin, R. Sjöberg]

The document summarizes the activities of the AHG on Encoding algorithm optimizations between the 14th meeting in Geneva, CH (19-27, March 2019) and the 15th meeting in Gothenburg, SE (3-12, July 2019).

Relevant input contribution documents (5 in total) were listed and summarized in the AHG report.

* JVET-O0256: Non-CE: Fast encoder with adjusted threshold in dependent quantization
* JVET-O0432: AHG10: LMCS encoder improvement
* JVET-O0549: AHG10: Encoder-only GOP-based temporal filter
* JVET-O0635: AHG10 related: Optimized CTU level bit allocation in inter frames
* JVET-O0888: AHG10: Adaptive Coding Sub-set for encoder optimization

It was remarked that there appear to be normative aspects in JVET-O088.

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

[JVET-O0011](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7567) JVET AHG report: Screen Content Coding (AHG11) [S. Liu, J. Boyce, A. Filippov, Y.-C. Sun, J. Xu, M. Zhou]

This document summarizes the activity of AHG11: Screen Content Coding between the 14th meeting in Geneva, CH (19–27 March 2019) and 15th Meeting in Gothenburg, SE (3–12 July 2019).

The AHG used the main JVET reflector, [jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de), with [AHG11] in message headers. There were about a dozen offline emails exchanged with discussions about testing sequences. There were many email exchanges among CE8 participants under [CE8] with tool specific discussions.

In total there were 58 SCC related technical input contributions identified so far, among which 31 were related to IBC, 8 were related to Palette, 3 were related to transform skip, 10 were related to BDPCM, 5 are related to other SCC coding aspects (e.g. some tool on/off switches in SCC scenarios) and 1 related to SCC test materials. They were listed in the AHG report.

It was noted that there were no contributions on in-loop colour transform.

For test sequences and CTC, a contribution was noted:

* JVET-O0483, AHG11: SCC test sequences for VVC standardization and suggestion for class F update, X. Xu, X. Li, S. Liu (Tencent)

The AHG recommended:

* 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-O0012](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7576) 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]

The document summarizes activities of AHG on High-level parallelism and coded picture regions between the 14th and the 15th JVET meetings.

In the JVET email reflector, a kick off message was sent. There was no other discussion on the email reflector regarding AHG12.

A total of 35 input contributions related to AHG12 were listed in the report, categorized as:

* Slice, tile, brick information signalling (13)
* Sub-pictures / independent coded regions (12)
* Non-CE5 / picture boundaries (6)
* WPP (3)

A summarization of the proposals had been submitted in JVET-O0800

The AHG recommended to review all related contributions and continue to study VVC high-level parallelism and coded picture regions aspects.

[JVET-O0013](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7609) JVET AHG report: Tool reporting procedure (AHG13) [W.-J. Chien, J. Boyce, Y.-W. Chen, R. Chernyak, K. Choi, R. Hashimoto, Y.-W. Huang, H. Jang, R.-L. Liao, S. Liu, D. Luo]

This document summarizes the activity of AHG13: “Tool reporting procedure” between the 14th Meeting in Geneva, CH (19–27 March 2019) and the 15th meeting in Gothenburg, SE (3–12 July 2019). Tool on/off experimental results vs. VTM anchors are provided for the tools specified in JVET-N1005.

The initial version of JVET-N1005 “Methodology and reporting template for tool testing” was provided on April 11th. The document contained a reporting template.

All tests described in JVET-N1005 were conducted. VTM tool tests were conducted on VTM-5.0 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.

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.

Full experimental results and configuration files can be found at the link below:

https://hevc.hhi.fraunhofer.de/svn/svn\_VVCTestConfig/branches/VTM-5.0/

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.

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 | 0.41% | 12.73% | 13.50% | 170% | 103% | 172% | 103% |
| DQ | 1.90% | -0.94% | -0.95% | 96% | 108% | 91% | 105% |
| CCLM | 1.85% | 17.20% | 17.54% | 99% | 100% | 98% | 98% |
| MTS | 0.84% | 0.37% | 0.42% | 87% | 99% | 87% | 98% |
| ALF | 2.42% | 2.73% | 3.06% | 98% | 87% | 97% | 87% |
| MRLP | 0.36% | 0.16% | 0.18% | 96% | 99% | 95% | 99% |
| IBC | 0.63% | 0.63% | 0.66% | 68% | 100% | 69% | 97% |
| LMCS | 0.81% | -1.20% | -0.98% | 100% | 99% | 99% | 99% |
| RDPCM on | -0.05% | -0.05% | -0.06% | 104% | 100% | 106% | 100% |
| MIP | 0.36% | 0.10% | 0.14% | 87% | 100% | 86% | 97% |
| LFNST | 1.26% | 0.39% | 0.55% | 77% | 99% | 77% | 100% |
| JCCR | 0.29% | 0.58% | 1.40% | 95% | 100% | 98% | 102% |

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 | 0.14% | 6.05% | 7.57% | 105% | 98% | 101% | 97% |
| DQ | 1.71% | -0.51% | -0.72% | 101% | 104% | 97% | 101% |
| CCLM | 0.90% | 15.85% | 16.95% | 99% | 100% | 98% | 99% |
| MTS | 0.33% | 0.51% | 0.42% | 91% | 100% | 92% | 101% |
| ALF | 4.91% | 4.56% | 4.07% | 97% | 79% | 97% | 83% |
| AFF | 2.53% | 1.83% | 1.75% | 90% | 99% | 89% | 98% |
| SbTMVP | 0.43% | 0.29% | 0.31% | 100% | 100% | 100% | 98% |
| AMVR | 1.05% | 1.51% | 1.48% | 89% | 101% | 89% | 99% |
| TPM | 0.35% | 0.63% | 0.67% | 92% | 100% | 92% | 99% |
| BDOF | 0.78% | 0.24% | 0.15% | 96% | 93% | 99% | 92% |
| CIIP | 0.38% | 0.08% | 0.02% | 96% | 99% | 99% | 99% |
| MMVD | 0.58% | 0.64% | 0.64% | 91% | 100% | 92% | 101% |
| BCW | 0.43% | 0.53% | 0.58% | 96% | 101% | 98% | 102% |
| MRLP | 0.20% | 0.03% | -0.02% | 99% | 100% | 99% | 100% |
| IBC | -0.01% | 0.33% | 0.25% | 94% | 100% | 95% | 102% |
| ISP | 0.13% | 0.04% | 0.08% | 98% | 100% | 98% | 100% |
| DMVR | 0.82% | 1.05% | 1.07% | 101% | 96% | 100% | 96% |
| SBT | 0.41% | -0.02% | 0.07% | 95% | 100% | 96% | 100% |
| LMCS | 1.39% | -2.83% | -2.55% | 94% | 99% | 94% | 99% |
| SMVD | 0.25% | 0.25% | 0.23% | 96% | 101% | 97% | 101% |
| RDPCM on | -0.01% | -0.07% | -0.05% | 100% | 100% | 101% | 101% |
| MIP | 0.27% | 0.26% | 0.32% | 94% | 100% | 93% | 97% |
| LFNST | 0.79% | 0.39% | 0.81% | 85% | 100% | 86% | 100% |
| JCCR | 0.25% | 0.65% | 0.72% | 97% | 99% | 99% | 102% |
| TMVP | 1.19% | 0.93% | 1.03% | 100% | 97% |  |  |

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 | 0.08% | 2.44% | 3.56% | 100% | 99% | 99% | 99% |
| DQ | 1.37% | 1.78% | 1.42% | 99% | 102% | 97% | 102% |
| CCLM | 0.12% | 4.53% | 5.62% | 100% | 100% | 100% | 103% |
| MTS | 0.23% | 0.49% | 0.62% | 97% | 99% | 98% | 99% |
| ALF | 4.16% | 4.74% | 3.85% | 95% | 81% | 94% | 83% |
| AFF | 2.18% | 1.54% | 1.73% | 83% | 97% | 83% | 95% |
| SbTMVP | 0.60% | 0.62% | 0.36% | 101% | 98% | 100% | 97% |
| AMVR | 0.39% | 0.82% | 0.73% | 91% | 97% | 91% | 97% |
| TPM | 0.88% | 1.34% | 1.02% | 87% | 101% | 88% | 103% |
| CIIP | 0.46% | 0.93% | 0.81% | 96% | 98% | 96% | 99% |
| MMVD | 0.57% | 0.39% | 0.18% | 94% | 102% | 94% | 104% |
| BCW | 0.31% | 0.32% | 0.25% | 97% | 99% | 98% | 100% |
| MRLP | 0.12% | 0.06% | 0.11% | 100% | 103% | 100% | 102% |
| IBC | -0.03% | 0.04% | 0.35% | 84% | 100% | 86% | 103% |
| ISP | 0.06% | 0.19% | 0.44% | 99% | 100% | 100% | 102% |
| SBT | 0.69% | 0.48% | -0.08% | 92% | 99% | 93% | 98% |
| LMCS | 0.68% | -2.23% | -2.21% | 94% | 99% | 93% | 100% |
| RDPCM on | -0.02% | 0.16% | 0.10% | 100% | 99% | 102% | 101% |
| MIP | 0.07% | 0.20% | 0.06% | 97% | 100% | 96% | 101% |
| LFNST | 0.34% | -2.30% | -2.60% | 86% | 102% | 85% | 98% |
| JCCR | 0.12% | 3.39% | 5.19% | 99% | 99% | 101% | 101% |
| TMVP | 2.16% | 1.85% | 1.82% | 101% | 97% |  |  |

Pixel usage and memory bandwidth results of VTM tool “off” test. (VTM anchor)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | AI |  | RA |  |  | LDB |  |
| Acronym | Pixel usage | Pixel usage | Ave mem BW | Max mem BW | Pixel usage | Ave mem BW | Max mem BW |
| CCLM | 48.03% | 3.54% |  |  | 0.92% |  |  |
| ALF | 99.00% | 65.38% |  |  | 60.05% |  |  |
| AFF |  | 13.41% |  |  | 19.38% |  |  |
| SBTMC |  | 6.13% |  |  | 7.64% |  |  |
| AMVR |  | 4.79% |  |  | 2.02% |  |  |
| TAP |  | 2.38% |  |  | 5.62% |  |  |
| BDOF |  | 50.03% |  |  |  |  |  |
| CIIP |  | 1.09% |  |  | 1.57% |  |  |
| MMVD |  | 7.67% |  |  | 9.34% |  |  |
| BPWA |  | 9.66% |  |  | 8.37% |  |  |
| MRLP | 6.99% | 0.80% |  |  | 0.27% |  |  |
| DMVR |  | 42.79% |  |  |  |  |  |
| SBT |  | 2.50% |  |  | 4.06% |  |  |
| SMVD |  | 2.68% |  |  |  |  |  |
| MIP | 13.03% | 3.75% |  |  | 2.10% |  |  |
| LFNST | 10.05% | 2.70% |  |  |  |  |  |
| JCCR | 4.38% | 0.22% |  |  | 0.08% |  |  |

Table 7 test results of VTM tool “off” test on various VTM versions

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **VTM RA** |  |
| **Abbreviation** | **VTM3** | **VTM4** | **VTM5** |
| CST | 0.74% | 1.25% | 1.47% |
| DQ | 1.39% | 1.36% | 1.24% |
| CCLM | 4.09% | 4.20% | 4.00% |
| MTS | 1.25% | 0.80% | 0.36% |
| ALF | 3.61% | 3.73% | 4.79% |
| AFF | 2.42% | 2.46% | 2.38% |
| SbTMVP | 0.52% | 0.43% | 0.40% |
| AMVR | 0.98% | 1.13% | 1.14% |
| TPM | 0.43% | 0.43% | 0.41% |
| BDOF | 1.02% | 0.63% | 0.66% |
| CIIP | 0.43% | 0.51% | 0.31% |
| MMVD | 0.81% | 0.52% | 0.59% |
| BiCW | 0.48% | 0.45% | 0.45% |
| MRLP | 0.24% | 0.18% | 0.16% |
| IBC | 0.07% | 0.00% | 0.05% |
| ISP |  | 0.24% | 0.12% |
| DMVR |  | 0.80% | 0.87% |
| SBT |  | 0.33% | 0.33% |
| LMCS |  | 0.62% | 0.57% |
| SMVD |  | 0.26% | 0.24% |
| RDPCM on |  |  | -0.02% |
| MIP |  |  | 0.27% |
| LFNST |  |  | 0.75% |
| JCCR |  |  | 0.34% |
| TMVP |  |  | 1.15% |

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)

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

It was suggested that some things that were not tested should be considered, including SAO and PDPC.

It was suggested to take a hard look at things that add complexity and provide less than 0.3% coding efficiency benefit and that RA is higher priority than AI.

It was commented that the test did not include testing of:

* Inter MTS (which reportedly provides about 0.3% gain for 10% runtime increase and is disabled in the CTC)
* SAO

Some things to consider focusing on were:

* ISP (intra subblock partitioning)
* MIP (matrix-based intra prediction)
* MRLP (multi-reference-line prediction)
* SMVD (symmetric motion vector difference)
* JCCR (joint coding of chroma residuals, although it has higher gain in chroma)
* Triangle prediction (which has a similar tradeoff except in low-delay B and is enabled in the CTC; it provides more gain for low-delay B)

Related contributions were noted to include the following:

* JVET-O0461 AHG13: On chroma tool evaluation in dual tree [T. Poirier, F. Le Léannec, F. Galpin, E. Francois (InterDigital)]
* JVET-O0551 AHG13: Tool-off tests on OpenImage database images [J. Ström, D. Saffar, P. Wennersten, R. Sjöberg]

[JVET-O0014](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7581) JVET AHG report: Operation modes for low latency support (AHG14) [J.-M. Thiesse, S. Deshpande, A. Duenas, Hendry, K. Kazui, R. Sjöberg, A. Tourapis]

The document summarizes activities of the AHG on operation modes for low latency support between the 14th and the 15th JVET meetings.

Eleven related contributions were identified in the report:

* Contributions on CE11 (8)
* High-level syntax (3)

The AHG recommends to review all related contributions.

[JVET-O0015](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7500) JVET AHG report: Quantization control (AHG15) [R. Chernyak, E. François, C. Helmrich, S. McCarthy, A. Segall]

This document summarizes the activity of AHG15: Quantization control between the 14th meeting in Geneva, CH (19–27 Mar. 2019) and the 15th meeting in Gothenburg, SE (3–12 Jul. 2019).

There were about a dozen emails exchanged with discussions related to the AHG.

Discussed topics included:

* VTM QP control techniques
  + Legacy adaptive QP (QP adaptation based on a psycho-visual model
  + Chroma QP adjustment (ported from HEVC, not adopted to VVC yet
  + Perceptual QP adaptation (perceptQPA) – perceptually motivated adaptive QP method
  + QP-RDO – slice and QG level QP adaptation
  + Luma-based QP – used in HDR CTCs – mostly compatible with all the rest
  + Rate control
* Chroma mapping table flexibility, with the following considerations:
  + Coding method: discrete representation or piece-wise linear representation (differences between two neighboring points in the table or pivot points are signalled).
  + Ability to choose one table from a set of predefined tables.
  + Restrictions on the resulting mapping table.
  + Ability to send shared CbCr table or separate Cb and Cr tables.
  + Signalling cost (how much bits are used by each syntax variant for custom QPc signalling).

Relevant contributions were identified in the following areas:

* Chroma mapping table related (5)
* Quantization matrices related (3)
* Delta QP related (3)
* Minimum Allowed QP for Transform Skip Mode (1)
* Derivation of QP predictors for DUAL\_TREE\_CHROMA in deblocking (1)

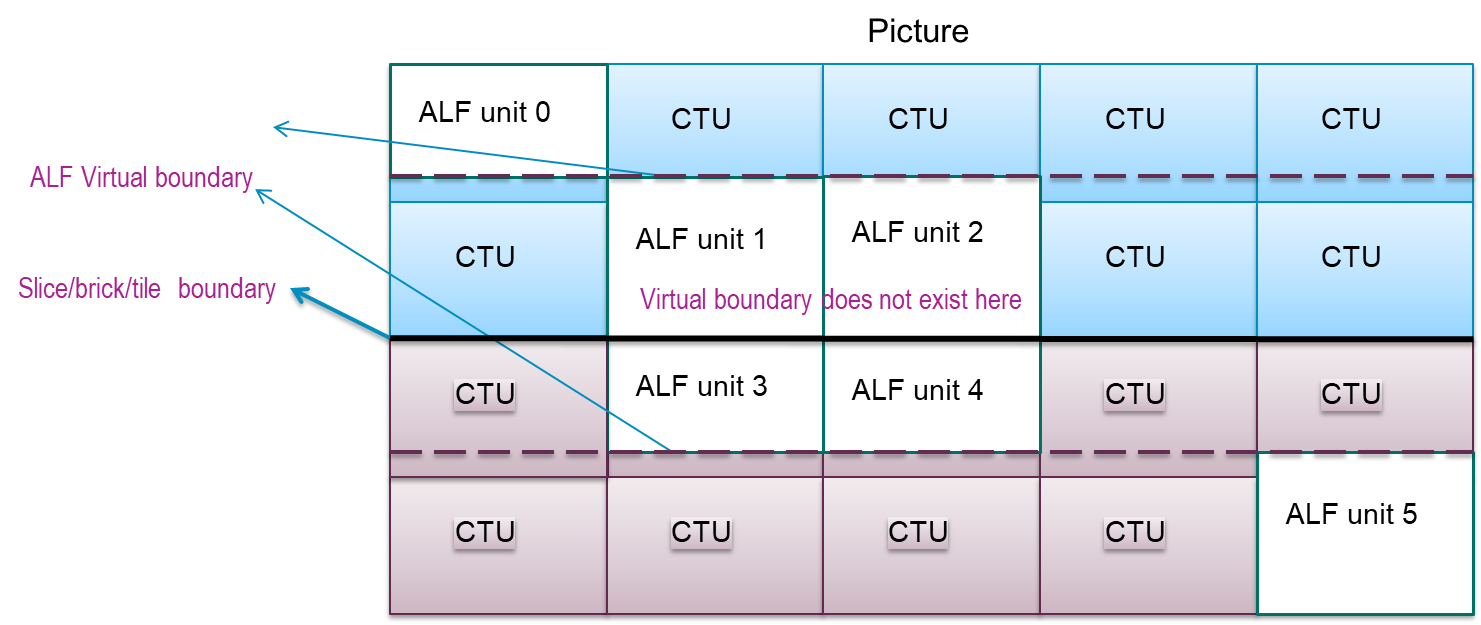
The AHG recommended to:

* Review all related contributions;
* Establish BOG on Chroma mapping table related contributions;
* Continue investigating VTM QP control techniques;
* Encourage people to test VTM QP control techniques more extensively;
* Encourage people to perform refactoring of VTM QP control techniques.

[JVET-O0016](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7349) JVET AHG report: Implementation studies (AHG16) [M. Zhou, J. An, E. Chai, K. Choi, S. Sethuraman, T. Hsieh, X. Xiu]

This document summarizes the activity of AHG16: implementation studies, between the 14th JVET meeting in Geneva, CH (19–27 March 2019) and the 15th JVET meeting in Gothenburg, SE (3-12 July 2019). Comments made on the email reflector are included below.

* Comments on the current VTM5.0 design and some of tools being tested
  + It is strongly recommended to simply remove the 1xN/2xN sub-partitions from the intra sub-partition prediction (ISP) to alleviate implementation difficulties in both the intra prediction and transform parts of the design. It is not desirable to make the design even more complicated by introducing more small size sub-partitions.
  + The CE2 tests aiming for the reduction of the chroma reconstruction latency (caused by the combination of separate tree and CCLM) may not serve the purpose, as the derivation of the cclmEnabled flag is a complex process and the CABAC parsing depends on it. It is hence recommended to seek simplifications outside the CE.
  + There are CE tests going on to move the validity check of luma/chroma IBC vectors to the decoder side. While those methods may make decoder designs safer, it should be investigated whether there are enough cycles on the decoder side to do the check, as the operation is down to 4x4 for luma and 2x2 for chroma in the worst case.
  + The newly adopted residual coding for transform skip is significantly different from the existing residual coding method, requiring yet another building block. It codes the coefficients in reverse order, requires three additional loops through all the coefficients for gt3/gt4/gt5 coding, and does not benefit coding of camera captured content. It is desirable to align it with the existing residual coding in terms of coefficient coding order and to reduce the number of coefficient coding passes/loops for CABAC throughput improvement and cost reduction.
  + For the baseline VVC design, it is generally not recommended to introduce more context coded bins and specific processing logic for minor gain in SCC without benefiting coding of camera captured content, because doing so not only decreases the CABAC throughput but also adds cost. It might be more appropriate to study those for more complex profiles.
  + The maximum number of distinct APSs that a picture can use for the ALF and LMCS should be properly defined, in order to constrain the memory footprint required for storing ALF/LMCS parameters and computational complexity needed for LMCS table derivation (which has divisions in it). For example, the current design allows up to 32 APSs signaled. It would require roughly 13 Kbytes on-chip memory to buffer those APSs if all of them are used for the ALF of a picture (not counting fixed filters that need roughly 1 Kbytes additional memory). Each ALF parameter set has about 410 bytes.
  + The MV context storage of triangle merge mode (in which the triangle MVs are populated to create 4x4 block vectors that are stored as TMVPs and used as spatial MV neighbors of merge/AMVP modes) seems to be unnecessarily complicated, it should be simplified.
  + Removal of small block size (e.g. 2x2) chroma intra-prediction for the shared tree case is essential for high performance decoder implementations (being studied in CE3). The issue was already resolved for the separate (dual) tree case at the last meeting.
  + As the project is approaching the CD stage, more attention should be paid to non-CTC and corner cases, and developing solutions to fix the broken parts of design (if any). For example, in the current VTM5.0 design the merge mode is broken, because the decoder behavior is undefined when all the merge flags are set to zero.
  + In the current design, the LFNST flag is derived at the end of the CU (need to check total number of coefficients inside and outside the LFNST corner regions). For a 128x128 CU, the first PB could not be processed without waiting for the LFNST index that comes after the last PB. Although this does not necessarily break the overall 64x64 based decoder pipeline (if the CABAC could be decoupled), it increases the data buffering by 4x for a certain number of decoder pipeline stages. It is costly. It is desirable to disable the LFNST flag derivation across the 64x64 VDPU boundaries. Potential simplifications could include e.g. moving it to a per TU index rather than a per-CU index, or disabling it for CU size 128x128.
* Implementation issues identified
  + In the newly adopted RDPCM, the residual coefficients could potentially grow significantly larger than the standard 16-bit coefficient range (-32767, 32767) for 10-bit video coding if allowed to grow unbounded across all the columns (or rows). It is desirable to constraint the residual coefficients in 16-bit range. This was fixed by adding a clamping after each step of residual coefficient reconstruction to both the reference software and text.
  + ALF line buffer issue along slice/brick/tile boundary and 360 video virtual boundary

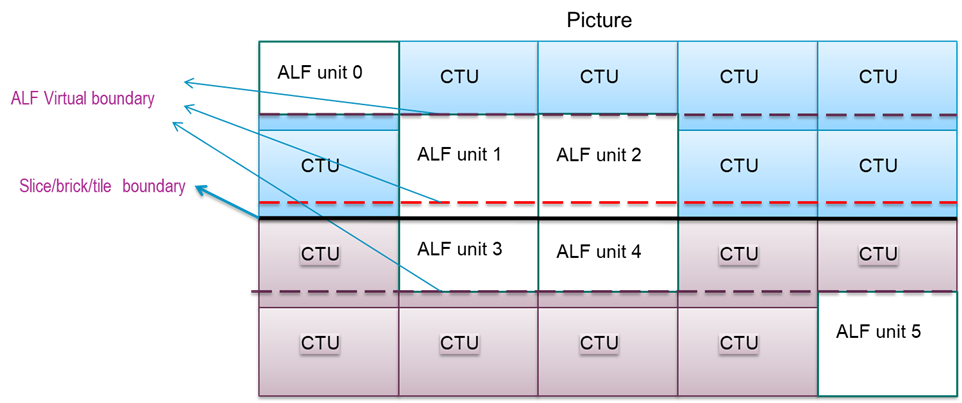


The ALF virtual boundary was adopted at the last meeting to remove the ALF line buffer, it is located at 4 luma lines above the bottom CTU boundary (except for those CTUs at the last CTU row of a picture). In the current specification text, the ALF virtual boundary is not present for a CTU if its bottom CTU boundary is also a slice/brick/tile boundary (when the loop-filter across those boundaries is disabled) or a 360 video virtual boundary (see Fig. 1 for example).

It is asserted that the current text specification defeats the purpose of the ALF virtual boundary adoption and has the following consequences:

* + - For decoders, not knowing the slice/brick/tile boundaries upfront (i.e. low-delay applications) means that the ALF line buffer needs to be restored. To process the ALF filtering of the bottom lines of the current CTU (e.g. luma lines 5, 6 and 7 above the bottom CTU boundary), the decoders need to know whether the current bottom CTU boundary coincides with other types of boundaries. This information, however, is unknown until the next slice/brick/tile is decoded.
    - Even if the slice/brick/tile boundaries are known upfront (e.g. the CABAC decoding is fully decoupled at frame level), the decoders need to run the loop-filters (de-blocking, SAO and ALF) at a speed of 68 lines per 64x64 VDPU all the time (an overprovision of roughly 6%) in order to avoid using the ALF line buffer.

It is therefore recommended to specify the ALF virtual boundary at the fixed location of 4 lines above the bottom CTU boundary, regardless of whether the bottom CTU boundary coincides with a slice/brick/tile boundary or a 360 video virtual boundary (see Figure 2 for example). It is also desirable to unify the padding methods along an ALF virtual boundary, a 360 video virtual boundary and a slice/brick/tile boundary.



Memory bandwidth study for VTM5.0

Broadcom conducted a memory bandwidth study by running both the VTM5.0 and VTM4.0 for CTC with a commercial motion compensation cache model integrated. The summary results of the random access configuration are provided in the the table below (for informational purposes).

The changes which may cause the difference in memory bandwidth consumption between the VTM5.0 and VTM4.0 include: removing the 4x4 uni-pred and 8x4/4x8 bi-pred PUs, using the 6-tap filters for affine MC and restricting the sub-block motion vector spread of the affine mode. Both the average (see ABW\_diff column) and the peak memory bandwidth consumption (see MBW\_diff column) are slightly decreased.

Memory bandwidth comparison (VTM5.0 vs.VTM4.0, RA)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access** | | | | | | | |
|  | **Over VTM-4.0** | | | | | | | |
|  | Y | U | V | TCM\_diff | ABW\_diff | MBW\_diff | EncT | DecT |
| Class A1 | -3.29% | -1.44% | -1.58% | -2.10% | -2.21% | -1.28% | 118% | 108% |
| Class A2 | -2.56% | -3.40% | -1.19% | -0.92% | -0.99% | -0.95% | 123% | 117% |
| Class B | -2.09% | -1.63% | -3.70% | -0.56% | -0.50% | -4.10% | 124% | 112% |
| Class C | -1.82% | 0.26% | -3.17% | -0.14% | -0.34% | -2.32% | 135% | 112% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -2.35% | -1.44% | -2.63% | -0.93% | -1.01% | -2.16% | 125% | 112% |
| Class D | -0.52% | 0.42% | -2.76% | 0.28% | 0.15% | -3.30% | 148% | 107% |
| Class F (optional) | -6.09% | -4.39% | -6.63% | 1.53% | 1.81% | 1.24% | 141% | 111% |

Where

* TCM\_diff : Total cache misses (over all the frames coded), percentage difference relative to VTM4.0.
* 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 VTM4.0.

MBW\_diff is suggested to be the most important measure, which shows the worst case memory bandwidth consumption difference of VTM5.0 relative to VTM4.0.

Bin to bit ratio study for VTM5.0

It has been reported that the bin to bit ratio continues to increase from VTM4.0 to VTM5.0. The summary results are provided in the table below for informational purposes (data from JVET-O0068).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Bin2bit ratio (peak, weighted)** | | | | | | | | **Bin2bit ratio (peak, unweighted)** | | | | | |
|  | HM16.19 | VTM4.0 | | VTM5.0 | diff (%, VMT4.0 vs. HM16.19) | diff (%, VMT5.0 vs. HM16.19) | diff\* (%, VMT5.0 vs. VTM4.0) | | HM16.19 | VTM4.0 | VTM5.0 | diff (%, VMT4.0 vs. HM16.19) | diff (%, VMT5.0 vs. HM16.19) | diff\* (%, VMT5.0 vs. VTM4.0) |
|  | **QP = (22, 27, 32, 37), CTC** | | | | | | | | | | | | | |
| **AI** | 0.95 | 1.10 | | 1.13 | 15.72% | 19.71% | **3.99%** | | 1.23 | 1.38 | 1.40 | 12.38% | 14.21% | **1.82%** |
| **RA** | 0.93 | 1.09 | | 1.12 | 17.39% | 20.88% | **3.49%** | | 1.21 | 1.38 | 1.40 | 13.75% | 15.25% | **1.50%** |
| **LB** | 0.96 | 1.09 | | 1.13 | 13.34% | 16.99% | **3.64%** | | 1.24 | 1.37 | 1.39 | 11.25% | 12.88% | **1.63%** |
| **LP** | 0.96 | 1.09 | | 1.13 | 13.24% | 17.30% | **4.06%** | | 1.23 | 1.37 | 1.39 | 11.08% | 13.02% | **1.94%** |
|  | **QP = (2, 7, 12, 17), 100 frames** | | | | | | | | | | | | | |
| **AI** | 0.79 | | 0.94 | 0.95 | 18.11% | 20.24% | | **2.12%** | 1.19 | 1.31 | 1.33 | 10.45% | 11.40% | **0.95%** |
| **RA** | 0.74 | | 0.87 | 0.88 | 17.17% | 19.00% | | **1.83%** | 1.18 | 1.28 | 1.28 | 7.63% | 8.39% | **0.76%** |
| **LB** | 0.78 | | 0.92 | 0.93 | 17.67% | 19.67% | | **2.00%** | 1.18 | 1.30 | 1.31 | 9.54% | 10.28% | **0.74%** |
| **LP** | 0.78 | | 0.92 | 0.93 | 17.46% | 19.46% | | **2.00%** | 1.18 | 1.30 | 1.31 | 9.50% | 10.24% | **0.74%** |
| Note\*: Percentage difference between VTM5.0 and VTM4.0 is measured against HM16.19 | | | | | | | | | | | | | | |

It was also reported that the weighted bin to bit ratio in class F sequences is already higher than the average numbers presented in Table 2.

In the table above, 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.

The following contributions are identified for the AHG

* Contributions related to the luma-chroma latency reduction for the combination of CCLM and dual-tree (5)
* Contributions for simplification of IBC vector validity check (4)
* Contributions related to the residual coding of transform skip mode (4)
* Contributions related to the MV context storage of triangle merge mode (11)
* Contributions for the LFNST latency reduction (6)
* Contributions for ALF padding unification and line buffer reduction (1)
* Other AHG16-related contributions (5)

[JVET-O0017](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7615) JVET AHG report: High-level syntax (AHG17) [R. Sjöberg, J. Boyce, S. Deshpande, M. M. Hannuksela, R. Skupin, A. Tourapis, Y.-K. Wang, W. Wan, S. Wenger]

This AHG report summarizes the activities of the AHG on High-level syntax (HLS) between the 14th JVET meeting in Geneva, CH (19–27 Mar. 2019) and the 15th JVET meeting in Gothenburg, SE (3–12 July 2019).

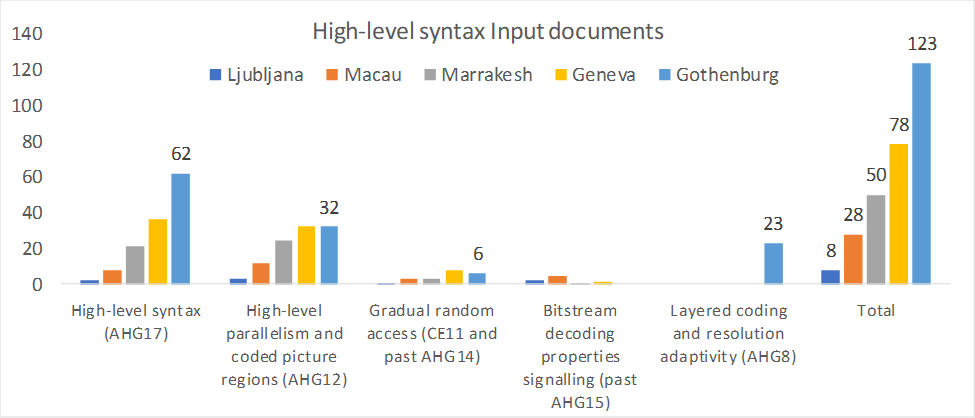
It is reported that the estimated number of input contributions related to high-level syntax has increased from 78 at the 14th JVET meeting to 123 at this 15th meeting.

It is also reported that the highest number of high-level syntax contributions for version 1 of HEVC was recorded at the 11th JCT-VC meeting in Stockholm 2012 with an estimated 96 contribution, excluding 36 documents on profile, level and constraint definitions. The AHG report notes that an additional high-level syntax AHG meeting was held the day before that 11th JCT-VC meeting.

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

As a rough indication, inputs to the meeting were summarized and illustrated as shown below.

|  |  |
| --- | --- |
| **Category** | **HLS inputs (AHG estimation)** |
| Layered coding and resolution adaptivity (AHG8) | 23 |
| High-level parallelism and coded picture regions (AHG12) | 32 |
| General high-level syntax (AHG17) | 62 |
| Gradual random access (CE11) | 6 |
| Total | 123 |



The AHG report included a comparative discussion of HLS activity in the JCT-VC development of HEVC and discussion of how such work was handled at that time.

The AHG recommended that this JVET meeting is planned such that there is enough time allocated to review high-level syntax related contributions. A BoG was thus established to start work right away from the first day of the meeting.

# Project development (X)

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

## Text and software development (1)

[JVET-O0756](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7377) HDRTools: VTM software integration [D. Mehlem, A.M. Tourapis, D. Singer (Apple)] [late]

## Test conditions (1)

[JVET-O0483](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7090) AHG11: SCC test sequences for VVC standardization and suggestion for class F update [X. Xu, X. Li, S. Liu (Tencent)]

## Performance assessment (5)

[JVET-O0451](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7057) AHG4: Subjective comparison of VVC and HEVC [P. Philippe, J. Fournier (Orange), W. Hamidouche (INSA), J. Y. Aubie (b-com)]

[JVET-O0551](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7164) AHG13: Tool-off tests on Open Images dataset [J. Ström, D. Saffar, P. Wennersten, R. Sjöberg]

[JVET-O0967](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7598) Crosscheck of JVET-O0551 (AHG13: Tool-off tests on OpenImage database images) [P. Cowan, A. Segall (Sharp Labs)]

[JVET-O0641](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7257) AHG 8: JVET Common test conditions for adaptive resolution change (ARC) [M. G. Sarwer, R.-L. Liao, J. Chen, J. Luo, Y. Ye (Alibaba)]

[JVET-O0657](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7274) AHG7: Tool-on/off experiments for HLG CTC sequences [S. Iwamura, S. Nemoto, A. Ichigaya (NHK)]

[JVET-O0966](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7597) Crosscheck of JVET-O0657 (AHG7: Tool-on/off experiments for HLG CTC sequences) [P. Cowan, A. Segall (Sharp Labs)]

[JVET-O0898](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7520) Extra results to JVET-N0605 “Comparative study of video coding solutions VVC, AV1 and EVC versus HEVC” [E. François (InterDigital)] [late] [miss]

## Coding studies on specific use cases (X)

[JVET-O1061](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7698) Modifications to support the lossless coding [T.-C. Ma, Y.-W. Chen, X. Xiu, X. Wang (Kwai Inc.), T. Poirier, F. Le Léannec, F. Galpin (InterDigital), H. Jang, J. Nam, N. Park, J. Choi, S. Kim, J. Lim (LGE)] [late] [miss]

## Test material (X)

# Core Experiments

## CE1: CABAC initialization (4)

[JVET-O0021](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7180) CE1: Summary report on CABAC initialization [F. Bossen, J. Dong, H. Kirchhoffer]

This contribution was discussed in Track A Wednesday 3 July 1645 (chaired by GJS).

Core experiment 1 on CABAC initialization was conducted between the 14th and 15th JVET meeting. Results are reported for five experiments, all aimed at simplifying the CABAC initialization process.

Detailed reports are provided in the following input contributions, which were provided in a timely manner:

* JVET-O0065: CE1-1.2 and CE1-2.1: Simplification of CABAC initialization process
* JVET-O0085: CE1-1.1: Simplification of the initialization process for context variables
* JVET-O0112: CE1: CABAC Initialization, all experiments

Detailed descriptions of experiments are provided in the CE description document JVET-N1021. At a high-level, experiments can be distinguished between:

* Methods that use a 6-bit initValue (CE1-1.1, CE1-1.2, CE1-3.1.b) and methods that use an 8-bit initValue (CE1-2.1, CE1-3.1.a)
* Methods that use a linear space (CE1-1.1, CE1-1.2, CE1-2.1) and methods that use a logarithmic space (CE1-3.1.a, CE1-3.1.b)

In addition to regular CTC conditions, the “random access” configuration was also tested at very low (2-17) and very high (42-57) QP values. The table below captures BD rate difference averages for the luma component.

The table below captures BD rate difference averages for the luma component.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Experiment | AI | RA | LB | LP | RA (low) | RA (high) |
| 6-bit | Linear Space | CE1-1.1 | -0.02% | 0.01% | 0.04% | 0.00% | -0.01% | 0.66% |
| CE1-1.2 | -0.02% | -0.01% | 0.03% | -0.09% | -0.01% | 0.22% |
| 8-bit | CE1-2.1 | -0.02% | -0.02% | -0.01% | -0.07% | -0.02% | 0.74% |
| Logarithmic Space | CE1-3.1.a | -0.01% | -0.02% | -0.01% | -0.02% | 0.00% | 0.33% |
| 6-bit | CE1-3.1.b | 0.00% | 0.00% | 0.00% | -0.04% | 0.01% | 0.65% |

Coding efficiency differences are minor except for the very high QP values case. In general, no significant differences in coding efficiency are observed between:

* Methods that use a 6-bit initValue (CE1-1.1, CE1-1.2, CE1-3.1.b) and methods that use an 8-bit initValue (CE1-2.1, CE1-3.1.a)
* Methods that use a linear space (CE1-1.1, CE1-1.2, CE1-2.1) and methods that use a logarithmic space (CE1-3.1.a, CE1-3.1.b)

No complexity analysis metric was defined in the CE description. Nevertheless, at a high level, the following can be said about the methods studied in this CE:

* all methods are less complex than the method in the current VVC draft because they avoid a large lookup table
* methods that use a logarithmic space (CE1-3.1.x) are a bit more complex because a log-to-linear conversion needs to be done
* methods that use a 6-bit initValue (CE1-1.1, CE1-1.2, CE1-3.1.b) do not require more operations than those that use an 8-bit initValue (CE1-2.1, CE1-3.1.a)

An analysis of operation counts for each method is provided below, based on the implementations provided in the CE software repository. Note that multiplications by a constant are counted as combinations of shift and add operations. Also note that the bit width of each operation is not considered here. It was remarked that there was not full agreement on the reported necessary operation counts (esp. for CE1-1.1).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Shift  (<<, >>) | Multiplication (×) | Addition (+/-) | AND  (&) | XOR  (^) | Compare (if, Clip3) |
| CE1-1.1 | 7 or 5 | 1 | 5 | 1 | 0 | 4 |
| CE1-1.2 | 5 | 1 | 5 | 1 | 0 | 2 |
| CE1-2.1 | 4 | 1 | 4 | 1 | 0 | 2 |
| CE1-3.1.a | 8 | 1 | 8 | 2 | 1 | 2 |
| CE1-3.1.b | 10 | 1 | 8 | 2 | 1 | 2 |

Additionally, cycle counts based on optimized software implementations are reported in JVET-O0191.

Tools for training were kindly provided by Fraunhofer HHI. It was remarked that training effects could be having some effect on the results.

The following non-CE contributions related to CE1 have been registered:

* JVET-O0191: CE1-related: Simplified CABAC initialization method

It was commented that this is just for the initial state, and in the way it was tested, the initial state value does not matter so much for low QPs.

The current draft has a mapping from log domain to linear domain that serves no function and can be eliminated (apparently without a penalty) by adopting one of the proposed linear domain approaches.

The main motivation here is a cleanup simplification. The mapping is not a rational part of the design; it resulted from a prior design change.

Testing with more frequent probability resets was suggested, to increase the effect of the initialization on the test results. One suggestion was to initialize CABAC for every CTU.

Decision: Adopt CE1-1.2, pending consideration of non-CE contributions or additional test results.

[JVET-O0065](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6669) CE1-1.2 and CE1-2.1: Simplification of CABAC initialization process [J. Dong, A. Said, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0085](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6689) CE1-1.1: Simplification of the initialization process for context variables [H. Kirchhoffer, D. Marpe, H. Schwarz, T. Wiegand (HHI)]

[JVET-O0112](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6716) CE1: CABAC Initialization, all experiments [F. Bossen (Sharp)]

## CE2: Luma/chroma dependency reduction (5)

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

[JVET-O0022](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7272) CE2: Summary report on luma-chroma dependency reduction [J. Chen, E. François, P. Yin]

This document provides a summary report of Core Experiment 2 (CE2) on luma-chroma dependency reduction. This CE comprises 3 categories, as follows:

* CE2-1: Chroma residual scaling luma-chroma dependency reduction – Single-tree case (8 tests)
* CE2-2: Chroma residual scaling luma-chroma dependency reduction – Dual-tree case (7 tests)
* CE2-3: CCLM luma-chroma dependency reduction in Dual-tree case (2 tests)

All the techniques are implemented on top of VTM5.0 and tested against VTM5.0. The simulation results and crosscheck reports are summarized in this contribution.

|  |  |  |  |
| --- | --- | --- | --- |
| **CE2-1 – Chroma residual scaling luma-chroma dependency reduction – Single-tree case** | | | |
| **Test #** | **Description** | **Source** | **Cross-checker** |
| CE2-1.1 | Derive the scaling factor from the **average value of the top-left 16×16 luma prediction samples** | JVET-O0049 (MediaTek) | J. Chen (alibaba) |
| CE2-1.2 | Derivation of the scaling factor from the **first (upper-left) sample value of the corresponding luma prediction** | JVET-O0098 (Dolby) | C. Chevance (Interdigital) |
| CE2-1.3.a | For intra coded blocks, derivation of the scaling factor from one of the **top-left, top or left neighboring reconstructed luma samples**, based on their availability | JVET-O0087 (Interdigital) | T. Lu (Dolby) |
| ~~CE2-1.3.b~~  (withdrawn) | ~~For intra coded blocks, derivation of the scaling factor from the~~ **~~average value of 2 available neighboring reconstructed luma samples~~** | ~~JVET-O0087 (Interdigital)~~ | ~~J. Chen (Alibaba)~~ |
| CE2-1.3.c | For intra coded blocks, derivation of the scaling factor from the **average value of 4 available neighboring reconstructed luma samples** | JVET-O0087 (Interdigital) | J. Chen (Alibaba) |
| CE2-1.3.d | For intra coded blocks, derivation of the scaling factor from the **average value of 8 available neighboring reconstructed luma samples** | JVET-O0087 (Interdigital) | J. Chen (Alibaba) |
| CE2-1.3.e | For intra coded blocks, derivation of the scaling factor from the **average value of all available neighboring reconstructed luma samples** | JVET-O0087 (Interdigital) | J. Chen (Alibaba) |
| CE2-1.4.a | For intra coded blocks, derivation of the scaling factor from the **top-left reference luma sample** used for intra prediction | JVET-O0102  (Alibaba) | T. Lu (Dolby) |
| CE2-1.4.b | For intra coded blocks, derivation of the scaling factor from the **averaged value of 2 reference luma samples** | JVET-O0102 (Alibaba) | Z.-Y. Lin (MediaTek) |
| CE2-1.4.c | For intra coded blocks, derivation of the scaling factor from the **averaged value of 4 reference luma samples** | JVET-O0102 (Alibaba) | E. Francois (Technicolor) |
| CE2-1.4.d | For intra coded blocks, derivation of the scaling factor from the **averaged value of 8 reference luma samples** | JVET-O0102 (Alibaba) | Z.-Y. Lin (MediaTek) |
| CE2-1.4.e | For intra coded blocks, derivation of the scaling factor from the **averaged value of reference luma samples** used for intra prediction | JVET-O0102 (Alibaba) | E. Francois (Technicolor) |

The major benefit is that it is no longer necessary to wait for prediction of co-located luma samples, but use neighbor blocks, which is beneficial for the processing pipeline.

Most simple solutions are 2-1.3a and 2-1.4a which just use one sample.

It is asked if by reducing the prediction to only 1 sample the chroma scaling could become entirely wrong at certain loactions (e.g. high local contrast). It is reported that it was not possible to identify artifacts. Furthermore, an encoder would would likely not use that mode if the prediction was wrong.

Performance-wise, all solutions are very similar:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access** | | | | | **Low delay B** | | | | |
| **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 2-1.1 | 0.00% | -0.04% | -0.04% | 100% | 99% | 0.00% | 0.04% | -0.06% | 100% | 100% |
| 2-1.2 | 0.00% | -0.09% | -0.10% | 99% | 99% | 0.02% | 0.05% | -0.03% | 100% | 98% |
| 2-1.3.a | 0.01% | -0.09% | -0.03% | 101% | 100% | *0.02%* | *0.05%* | *-0.07%* | *100%* | *100%* |
| 2-1.3.c | 0.00% | 0.00% | -0.07% | 99% | 101% | *0.00%* | *0.19%* | *-0.05%* | *100%* | *99%* |
| 2-1.3.d | 0.00% | -0.01% | -0.02% | 100% | 99% | *0.00%* | *0.04%* | *-0.07%* | *99%* | *98%* |
| 2-1.3.e | -0.01% | -0.02% | -0.06% | 99% | 101% | 0.00% | 0.11% | -0.13% | 101% | 102% |
| 2-1.4.a | -0.01% | -0.08% | -0.01% | 100% | 100% | -0.01% | 0.28% | -0.22% | 100% | 99% |
| 2-1.4.b | 0.00% | -0.04% | -0.07% | 100% | 100% | -0.01% | 0.04% | -0.06% | 100% | 99% |
| 2-1.4.c | 0.00% | -0.02% | -0.03% | 100% | 100% | -0.01% | 0.14% | 0.03% | 100% | 99% |
| 2-1.4.d | 0.00% | -0.03% | -0.02% | 100% | 100% | -0.01% | 0.10% | -0.10% | 100% | 99% |
| 2-1.4.e | 0.01% | -0.08% | -0.06% | 100% | 100% | 0.02% | 0.23% | 0.06% | 100% | 99% |

It is concluded from the results of the CE that the luma-chroma dependency in CS can be largely reduced without affecting the performance of LMCS. It is however mentioned that CE-related contributions potentially even further reduce the dependency, or give better performance. Further action to be decided after reviewing the CE2 related documents.

|  |  |  |  |
| --- | --- | --- | --- |
| **CE2-2 – Chroma residual scaling luma-chroma dependency reduction – Dual-tree case** | | | |
| **Test #** | **Description** | **Tester** | **Cross-checker** |
| CE2-2.1.a | CRS on in dual-tree For all intra coded blocks, scaling factor derived from one of the **top-left, top or left reconstructed luma samples** neighboring the collocated luma block, based on their availability | JVET-O0087 (Interdigital) | T. Lu (Dolby) |
| CE2-2.1.b | CRS on in dual-tree For all intra coded blocks, scaling factor derived from the **average of 2 available reconstructed luma samples** neighboring the collocated luma block | JVET-O0087 (Interdigital) | T. Lu (Dolby) |
| CE2-2.1.c | CRS on in dual-tree For all intra coded blocks, scaling factor derived from the **average of 4 available reconstructed luma samples** neighboring the collocated luma block | JVET-O0087 (Interdigital) | T. Lu (Dolby) |
| CE2-2.1.d | CRS on in dual-tree For all intra coded blocks, scaling factor derived from the **average of 8 available reconstructed luma samples** neighboring the collocated luma block | JVET-O0087 (Interdigital) | J. Chen (Alibaba) |
| CE2-2.1.e | CRS on in dual-tree For all intra coded blocks, scaling factor derived from the **average of all available reconstructed luma samples** neighboring the collocated luma block | JVET-O0087 (Interdigital) | J. Chen (Alibaba) |
| CE2-2.2.a | CRS on in dual-tree For all intra coded blocks, scaling factor derived from the **top-left reference luma sample** neighboring the collocated luma block | JVET-O0087 (Interdigital) | J. Chen (Alibaba) |
| CE2-2.2.b | CRS on in dual-tree For all intra coded blocks, scaling factor derived from the **average of 2 reference luma samples** neighboring the collocated luma block | JVET-O0087 (Interdigital) | J. Chen (Alibaba) |
| CE2-2.2.c | CRS on in dual-tree For all intra coded blocks, scaling factor derived from the **average of 4 reference luma samples** neighboring the collocated luma block | JVET-O0087 (Interdigital) | J. Chen (Alibaba) |
| CE2-2.2.d | CRS on in dual-tree For all intra coded blocks, scaling factor derived from the **average of 8 reference luma samples** neighboring the collocated luma block | JVET-O0087 (Interdigital) | J. Chen (Alibaba) |
| CE2-2.2.e | CRS on in dual-tree For all intra coded blocks, scaling factor derived from the **average of all reference luma samples** neighboring the collocated luma block | JVET-O0087 (Interdigital) | J. Chen (Alibaba) |
| CE2-2.3 | CRS on in dual-tree  For intra coded blocks in **dual-tree**, scaling factor derived from the **average of available reconstructed luma samples** neighboring the collocated luma block  For intra coded blocks in **single-tree**, scaling factor derived from the **average of reference luma samples** neighboring the collocated luma block | JVET-O0087 (Interdigital) | J. Chen (Alibaba) |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | **Random Access** | | | | | **Low delay B** | | | | |
| **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 2-2.1.a | 0.03% | -0.46% | -0.62% | 102.00% | 101.00% | 0.03% | -0.71% | -0.59% | 101% | 100% | 0.00% | -0.60% | -0.19% | 99% | 100% |
| 2-2.1.b | 0.03% | -0.36% | -0.52% | 101.00% | 101.00% | 0.02% | -0.60% | -0.61% | 100% | 102% |  |  |  |  |  |
| 2-2.1.c | 0.02% | -0.37% | -0.51% | 101.00% | 102.00% | 0.03% | -0.65% | -0.66% | 100% | 102% |  |  |  |  |  |
| 2-2.1.d | 0.02% | -0.37% | -0.53% | 101.00% | 100.00% | 0.02% | -0.64% | -0.59% | 101% | 100% |  |  |  |  |  |
| 2-2.1.e | 0.03% | -0.37% | -0.52% | 100.00% | 101.00% | 0.01% | -0.64% | -0.66% | 101% | 101% | -0.01% | -0.39% | -0.50% | 101% | 99% |
| 2-2.2.a | 0.04% | -0.44% | -0.60% | 102.00% | 99.00% | 0.02% | -0.66% | -0.61% | 101% | 101% | *0.01%* | *-0.50%* | *-0.29%* | *99%* | *97%* |
| 2-2.2.b | 0.03% | -0.36% | -0.52% | 101.00% | 101.00% | 0.02% | -0.60% | -0.61% | 100% | 102% | *0.00%* | *-0.68%* | *-0.50%* | *99%* | *98%* |
| 2-2.2.c | 0.02% | -0.37% | -0.51% | 101.00% | 102.00% | 0.03% | -0.65% | -0.66% | 100% | 102% | *0.00%* | *-0.57%* | *-0.49%* | *99%* | *98%* |
| 2-2.2.d | 0.03% | -0.36% | -0.51% | 101.00% | 101.00% | 0.02% | -0.67% | -0.67% | 101% | 101% | *0.01%* | *-0.47%* | *-0.44%* | *99%* | *97%* |
| 2-2.2.e | 0.03% | -0.34% | -0.52% | 102.00% | 101.00% | 0.03% | -0.58% | -0.65% | 101% | 100% | 0.00% | -0.48% | -0.50% | 99% | 100% |
| 2-2.3 | 0.03% | -0.37% | -0.52% | 102.00% | 101.00% | 0.03% | -0.61% | -0.68% | 103% | 101% | 0.02% | -0.45% | -0.41% | 101% | 98% |

For the dual-tree case, the chroma gain is relatively low (at most 0.4%-0.6%), which might not justify to introduce additional dependency from luma to chroma here. Such a step should only be made if really necessary. Currently, the CS part of LMCS is disabled for dual tree it is reported verbally that the benefit of enabling CS in case of single tree is much larger (about 4% for RA). This is however only compared against a configuration that uses LM, which by itself affects the chroma quality, where the CS recovers it partially (see e.g. the results of AHG 13 which indicate that the chroma has some gain while the luma has significant loss when disabling LMCS). As an interpretation, LM performs kind of adaptive quantization on luma, which in case of single tree is inherited by chroma, and CS compensates for that.

It is mentioned that the effect would be larger for HDR-PQ, as per non-CE contributions. For SDR under CTC, the results of the CE do not necessarily indicate the need for action of enabling CS for the dual-tree case. Further action to be decided after reviewing the CE2 related documents.

|  |  |  |  |
| --- | --- | --- | --- |
| **CE2-3 - CCLM luma-chroma dependency reduction in Dual-tree case** | | | |
| **Test #** | **Description** | **Tester** | **Cross-checker** |
| CE2-3.1 | CCLM enabled if chroma block and its collocated luma blocks are inside the same 16x16/32x32 non-overlapping area | E. François (Technicolor) | A. Segall (Sharp) |
| CE2-3.2 | CCLM parameters derived from reconstructed luma/chroma samples neighboring the luma block collocated with the chroma block top-left sample | E. Francois (Technicolor) | A. Segall (Sharp) |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | **Random Access** | | | | | **Low delay B** | | | | |
| **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 2-3.1 | 0.28% | 2.37% | 2.53% |  |  | 0.07% | 1.08% | 0.96% |  |  | *0.00%* | *0.31%* | *0.24%* | *100%* | *99%* |
| 2-3.2 | 0.33% | 2.17% | 2.28% |  |  | 0.10% | 1.16% | 0.98% |  |  | *-0.01%* | *0.15%* | *-0.48%* | *101%* | *99%* |

*Note: tests 2-3.1 and 2-3.2, LDB configuration, have not been produced by the proponent. Reported results come from the cross-checker.*

None of the solutions fully resolves the latency problem, because the tree structure is different and therefore in worst case it would still be necessary to wait for reconstruction of a 64x64 luma block (even if it is not colocated but a neighbor) before the chroma can be predicted from luma. It is further mentined that better solutions might be available from CE related proposals. Further action to be decided after reviewing the CE2 related documents.

BoG (J. Chen, E. François) to perform a review of CE2 related documents, summarize and suggest actions.

[JVET-O0049](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6653) CE2-1.1: Simplified LMCS [Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0087](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6691) CE2: report of CE2 experiments from InterDigital [E. François, T. Poirier (InterDigital)]

[JVET-O0098](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6702) CE2.1.2: luma-chroma dependency reduction for LMCS [T. Lu, F. Pu, P. Yin, S. McCarthy, W. Husak, T. Chen (Dolby)]

[JVET-O0102](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6706) CE2-1.4: luma-chroma dependency reduction for chroma scaling [J. Chen, R.-L. Liao, Y. Ye (Alibaba)]

## CE3: Intra prediction and mode coding (12)

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

[JVET-O0023](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7250) CE3: Summary Report on Intra Prediction and Mode Coding [G. Van der Auwera, L. Li, A. Filippov]

This contribution was discussed in Track A Wednesday 3 July 1800 (chaired by GJS).

The goal of CE3 is to study intra prediction tools, including mode coding, for potential inclusion into the VVC standard.

The following is the list of defined sub-tests in CE3:

* CE3-1: ISP (9 tests)
* CE3-2: Small chroma block size restrictions for shared tree (3 tests)
* CE3-3: CCLM model improvements (6 tests)

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

Defined tests

|  |  |  |
| --- | --- | --- |
| **Test #** | **Short description** | **Doc. #** |
| 3-1.1.1 | CU-based prediction is applied for CUs whose sub-partition size is 1xN or 2xN. | JVET-O0080 (KDDI) |
| 3-1.1.2 | CU-based prediction is applied for CUs whose sub-partition size is 1xN. |
| 3-1.2.1 | Disable partitions in ISP that can result into either 1xN or 2xN sub-blocks. An 8xN block can be split into 2 4xN blocks | JVET-O0048 (Huawei) |
| 3-1.2.2 | Disable partitions in ISP that can result into 1xN sub-blocks |
| 3-1.3 | Apply CU-based low latency ISP to 4×8, 8×4 CUs, and the sub-partition with 1xN or 2xN partition size is disabled. | JVET-O0099 (InterDigital) |
| 3-1.4.1 | Remove ISP CU if it causes 1xN sub-partition | JVET-O0109 (Kwai) |
| 3-1.4.2 | Remove ISP CU if it causes 1xN or 2xN sub-partition |
| 3-1.6 | 4xN prediction regions for 4xN and 8xN (N > 4) ISP-coded blocks with vertical subpartitions | JVET-O0106 (Qualcomm, HHI) |
| 3-1.7 | Test 3-1.6 with additional restriction of only allowing vertical prediction mode for 4xN ISP-coded blocks with vertical subpartitions | JVET-O0107 (HHI) |

The following tables provide an overview of the aspects of each test. The data is provided for luma CBs that can potentially be split into narrow 1xN and 2xN vertical sub-partitions (if a 4-way ISP split would be performed), i.e., luma CBs with width equal to 4 and 8. The first table specifies the sizes of dependent sub-partitions that require reconstruction of the neighbouring sub-partition to the left for prediction of the current sub-partition. The second table specifies the transform block sizes that are applied to the dependent sub-partitions. The VTM anchor data is provided for reference. Yellow highlights indicate tested changes with respect to the VTM anchor.

Sub-partition sizes with prediction dependency (V: vertical splitting; H: horizontal splitting)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Test# vs. CB size** | **4x4** | **4x8** | **4xN (N>=16)** | **8x4** | **8xN (N>=8)** |
| VTM | No ISP | V: 2x8  H: 4x4 | V: 1xN  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 2xN  H: 8x(N/4) |
| 3-1.1.1 | No ISP | V: 4x8  H: 4x4 | V: 4xN  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 8xN  H: 8x(N/4) |
| 3-1.1.2 | No ISP | V: 2x8  H: 4x4 | V: 4xN  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 2xN  H: 8x(N/4) |
| 3-1.2.1 | No ISP | V: No ISP  H: 4x4 | V: No ISP  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 4xN  H: 8x(N/4) |
| 3-1.2.2 | No ISP | V: 2x8  H: 4x4 | V: No ISP  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 2xN  H: 8x(N/4) |
| 3-1.3 | No ISP | V: No ISP  H: 4x8 | V: No ISP  H: 4x(N/4) | V: 8x4  H: 8x4 | V: 4xN  H: 8x(N/4) |
| 3-1.4.1 | No ISP | V: 2x8  H: 4x4 | V: No ISP  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 2xN  H: 8x(N/4) |
| 3-1.4.2 | No ISP | V: No ISP  H: 4x4 | V: No ISP  H: 4x(N/4) | V: 4x4  H: 8x2 | V: No ISP  H: 8x(N/4) |
| 3-1.6 | No ISP | V: 4x8  H: 4x4 | V: 4xN  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 4xN  H: 8x(N/4) |
| 3-1.7 | No ISP | V: 4x8 (\*)  H: 4x4 | V: 4xN (\*)  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 4xN  H: 8x(N/4) |

(\*) VER pred mode only

Transform block sizes:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Test# vs. CB size** | **4x4** | **4x8** | **4xN (N>=16)** | **8x4** | **8xN (N>=8)** |
| VTM | No ISP | V: 2x8  H: 4x4 | V: 1xN  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 2xN  H: 8x(N/4) |
| 3-1.1.1 | No ISP | V: 2x8  H: 4x4 | V: 1xN  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 2xN  H: 8x(N/4) |
| 3-1.1.2 | No ISP | V: 2x8  H: 4x4 | V: 1xN  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 2xN  H: 8x(N/4) |
| 3-1.2.1 | No ISP | V: No ISP  H: 4x4 | V: No ISP  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 4xN  H: 8x(N/4) |
| 3-1.2.2 | No ISP | V: 2x8  H: 4x4 | V: No ISP  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 2xN  H: 8x(N/4) |
| 3-1.3 | No ISP | V: No ISP  H: 4x4 | V: No ISP  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 4xN  H: 8x(N/4) |
| 3-1.4.1 | No ISP | V: 2x8  H: 4x4 | V: No ISP  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 2xN  H: 8x(N/4) |
| 3-1.4.2 | No ISP | V: No ISP  H: 4x4 | V: No ISP  H: 4x(N/4) | V: 4x4  H: 8x2 | V: No ISP  H: 8x(N/4) |
| 3-1.6 | No ISP | V: 2x8  H: 4x4 | V: 1xN  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 2xN  H: 8x(N/4) |
| 3-1.7 | No ISP | V: 2x8  H: 4x4 | V: 1xN  H: 4x(N/4) | V: 4x4  H: 8x2 | V: 2xN  H: 8x(N/4) |

Test results

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra - Over VTM-5.0** | | | | | **Random Access - Over VTM-5.0** | | | | |
| **Test #** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 3-1.1.1 | 0.03% | 0.02% | 0.02% | 99% | 100% | 0.01% | -0.07% | -0.03% | 100% | 100% |
| 3-1.1.2 | 0.01% | -0.01% | 0.02% | 99% | 100% | 0.02% | 0.01% | -0.10% | 100% | 100% |
| 3-1.2.1 | 0.07% | 0.02% | 0.07% | 98% | 99% | 0.03% | -0.13% | -0.09% | 99% | 98% |
| 3-1.2.2 | 0.01% | -0.02% | 0.03% | 99% | 99% | 0.01% | -0.07% | -0.04% | 99% | 98% |
| 3-1.3 | 0.08% | 0.03% | 0.07% | 100% | 99% | 0.04% | 0.00% | -0.04% | 101% | 100% |
| 3-1.4.1 | 0.01% | -0.02% | 0.03% | 97% | 99% | 0.01% | -0.07% | -0.04% | 99% | 100% |
| 3-1.4.2 | 0.08% | 0.00% | 0.04% | 98% | 101% | 0.02% | -0.10% | -0.05% | 100% | 100% |
| 3-1.6 | 0.03% | -0.01% | 0.01% | 100% | 98% | 0.03% | -0.06% | -0.11% | 99% | 99% |
| 3-1.7 | 0.01% | -0.01% | 0.03% | 99% | 97% | 0.02% | -0.02% | -0.04% | 99% | 100% |

Generally, these are tested simplifications. It was remarked that 3-1.4.2, which removes ISP CU if it causes 1xN or 2xN sub-partition, is clearly a substantial simplification. It was commented that if the main motivation is to remove the 1xN and 2xN prediction dependencies, ways to do that with less penalty are available as 3-1.1.1 or 3-1.6 (which both have narrow transforms over wider predictions – the same transforms as currently). 3-1.1.1 is similar to 3-1.6 in spirit, while disallowing a vertical split of 8xN coding blocks (a very small difference between these two).

Considering that the gain of ISP appears to be quite small currently (~0.13% in RA), it was commented that we should try hard to lose as little of that gain as possible. It was suggested that 3-1.6 is the minimal action necessary to address the identified problem. Decision (complexity): Adopt JVET-O0106 for 3-1.6 (pending non-CE contribution review).

One participant commented that there would be a throughput benefit from 3-1.3. However, others commented that the worst case is for 4x4 blocks, which is not affected by 3-1.3.

CE3-2 on small chroma block size restrictions for shared tree

Defined tests

|  |  |  |
| --- | --- | --- |
| **Test #** | **Short description** | **Doc. #** |
| 3-2.1.1 | Do not split chroma blocks of smallest chroma intra prediction units (SCIPU)  - SCIPU determined from the coding mode of the first CU inside SCIPU | JVET-O0050 (MediaTek, Huawei) |
| 3-2.1.2 | Do not split chroma blocks of smallest chroma intra prediction units (SCIPU)  - SCIPU determined from a flag in coding\_tree() |
| 3-2.2 | All coded blocks within a parallel-processable region (PPR) of size larger than or equal to 16 chroma samples to be reconstructed in parallel in the single-tree case by removing the dependency between blocks within the PPR. | JVET-O0118 (Qualcomm, MediaTek) |

The following table provides summary of each test:

|  |  |  |
| --- | --- | --- |
| **Test** | **Separate trees** | **Shared trees** |
| 3-2.1.1 | Not changed | Smallest chroma intra CB size is 16 chroma samples. SCIPU(\*) mode (inter or non-inter) is derived from prediction mode of the first luma CB in the SCIPU (without explicit signalling) |
| 3-2.1.2 | Not changed | Smallest chroma intra CB size is 16 chroma samples. SCIPU mode (inter or non-inter) is explicitly signalled on CU level in P,B slice |
| 3-2.2 | Not changed | Parallel-processable region (PPR) of size 16 or 32 chroma samples, where reference samples within PPR are marked as unavailable. VVC reference sample substitution process is used to construct reference sample array for intra prediction. In case of IBC block, the block vector of luma component that leads to an overlap between the reference block of the chroma and its PPR area is restricted. |

(\*) SCIPU: A coding tree node whose chroma block size is larger than or equal to 16 chroma samples (32 or 16 samples) and has at least one child luma block smaller than 64 luma samples. Coding blocks within one SCIPU should be all inter-coded or all non-inter (intra or IBC) coded. Chroma components cannot be further split if the SCIPU is intra/IBC predicted.

CE3-2: Test results

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access - Over VTM-5.0** | | | | | **Low Delay B - Over VTM-5.0** | | | | |
| **Test #** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 3-2.1.1 | 0.07% | -0.08% | -0.11% | 100% | 100% | 0.14% | 0.16% | 0.07% | 100% | 100% |
| 3-2.1.2 | 0.09% | -0.01% | -0.02% | 99% | 101% | 0.19% | 0.19% | 0.10% | 101% | 103% |
| 3-2.2 | 0.07% | 0.02% | 0.09% | 100% | 100% | 0.05% | 0.13% | -0.16% | 100% | 100% |

It was agreed that these proposals address a problem that requires some action.

Conceptually, the first two method create a separate tree at the CU level (with 3-2.1.1 and 3-2.1.2 having different methods of signalling), while the third method keeps the smallest PUs but makes it possible to process them in parallel. It was commented that the approach of the first two is cheaper to support in hardware and these are more like what we have done in the past). The differences in decoding runtime were agreed to be basically noise here. The potential benefits of the third approach are the LB coding efficiency, and minimal spec changes.

There is a potential problem with the first two approaches in the bottom right corner if the picture size is an odd multiple of 4. Such picture sizes are not supported in HEVC, and another contribution has suggested not to support such picture sizes in VVC.

It was commented that if a single tree is used in an intra slice, the first two approaches have a (small) gain and an encoder runtime reduction (as tested).

Between 3-2.1.1 and 3-2.1.2 proposals, the 3-2.1.1 proposal avoids some signalling redundancy by using somewhat more checking of conditions. It thus has a little better coding efficiency. The spec is simpler and more straightforward for 3-2.1.2. Decision: Adopt 3-2.1.2 with spec text in JVET-O0050.

CE3-3 on CCLM model improvements

Defined tests

|  |  |  |
| --- | --- | --- |
| **Test #** | **Short description** | **Doc. #** |
| 3-3.1 | Modified beta parameter derivation in context of the CCLM simplification (JVET-N0271). Luma and chroma averaged values are used to derive the CCLM parameter. | JVET-O0088 (Sony) |
| 3-3.2.1 | Filtering is applied to both luma and chroma templates to remove outliers (VTM5 filters luma samples only) | JVET-O0095 (Huawei, HHI) |
| 3-3.2.2 | Test CE3-3.2.1 with calculating mean values for more robust parameter deriving |
| 3-3.2.3 | Test CE3-3.2.2 without template filtering |
| 3-3.2.4 | Test CE3-3.2.1 with calculating mean values for more robustly deriving both parameters and |
| 3-3.2.5 | Test CE3-3.2.4 without template filtering |

The following table provides an overview for assessing the computational complexity of each test. The changes caused by subtests CE3-3 relate to preparing input data for min / max method, namely: template filtering and mean value calculations for CCLM parameter derivation. In particular, for VTM-5.0, the number of fetched samples equals 28 (4 luma samples after down-sampling x 6 luma samples as input values for 6-tap filter + 4 chroma samples = 24 + 4 =28) and the quantity of add operations is equal to 32 (4 luma samples after down-sampling x 6 add ops per each filtering operation + 2 add ops to calculate min for luma + 2 add ops to calculate min for chroma + 2 add ops to calculate max for luma + 2 add ops to calculate max for chroma = 24 + 8 = 32 add operations).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test # | Chroma 4x4 blocks  (dual-tree type) | | Chroma 4x8 blocks  (dual-tree type) | | Chroma 8x4 blocks  (dual-tree type) | | Other chroma blocks  (any tree type) | |
| Samples fetched | Add ops | Samples fetched | Add ops | Samples fetched | Add ops | Samples fetched | Add ops |
| VTM-5.0 | 28 | 32 | 28 | 32 | 28 | 32 | 28 | 32 |
| Test 3-3.1 | 28 | 34 | 28 | 34 | 28 | 34 | 28 | 34 |
| Test 3-3.2.1 | 34 | 44 | 35 | 44 | 35 | 44 | 36 | 44 |
| Test 3-3.2.2 | 28 | 46 | 28 | 46 | 28 | 46 | 36 | 46 |
| Test 3-3.2.3 | 8 | 10 | 8 | 10 | 8 | 10 | 28 | 34 |
| Test 3-3.2.4 | 35 | 44 | 35 | 44 | 35 | 44 | 36 | 44 |
| Test 3-3.2.5 | 8 | 8 | 8 | 8 | 8 | 8 | 28 | 32 |

CE3-3: Test results

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test #** | **All Intra - Over VTM-5.0** | | | | | **Random Access - Over VTM-5.0** | | | | |
| **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 3-3.1 | -0.01% | -0.11% | -0.07% | 100% | 100% | 0.00% | -0.18% | -0.19% | 99% | 100% |
| 3-3.2.1 | 0.03% | 0.32% | 0.39% | 99% | 99% | 0.02% | 0.44% | 0.48% | 98% | 99% |
| 3-3.2.2 | 0.02% | 0.24% | 0.32% | 99% | 99% | 0.00% | 0.30% | 0.35% | 98% | 99% |
| 3-3.2.3 | 0.00% | 0.04% | 0.08% | 99% | 99% | 0.00% | -0.12% | -0.09% | 98% | 99% |
| 3-3.2.4 | 0.01% | 0.27% | 0.32% | 99% | 99% | 0.01% | 0.31% | 0.39% | 98% | 99% |
| 3-3.2.5 | 0.00% | 0.07% | 0.10% | 99% | 99% | 0.00% | -0.02% | -0.11% | 98% | 99% |

The proposals have a mixture of changes motivated by either coding efficiency or complexity reduction benefits. The test results basically do not show coding efficiency benefit.

It was agreed to focus on 3-3.2.5 as having the most complexity reduction benefit. This proposal introduces a different type of operation for small blocks.

It was noted that CCLM operation depends on a chroma location flag, and only one value of that flag is used in the CTC. The other value of the flag (indicating collocated chroma rather than vertically interstitial chroma) was not considered in this test.

It was commented that CCLM operation for small blocks is not really a problem that requires action.

Revisit after offline study.

[JVET-O0048](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6652) CE3: Simplification on Intra sub-partition coding mode (tests 3-1.2.1 and 3-1.2.2) [B. Wang, A. M. Kotra, S. Esenlik, H. Gao, E. Alshina (Huawei)]

[JVET-O0050](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6654) CE3-2.1.1 and CE3-2.1.2: Removing 2x2, 2x4, and 4x2 chroma CBs [Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek), Y. Zhao, H. Yang (Huawei)]

[JVET-O0080](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6684) CE3-1.1: CU-based prediction for 1xN and 2xN sub-partitions [K. Unno, K. Kawamura, S. Naito (KDDI)]

[JVET-O0088](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6692) CE3-3.1: Modified beta derivation for CCLM [M. Ikeda, T. Suzuki (Sony)]

[JVET-O0095](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6699) CE3-3.2: Simplified and robust CCLM parameter derivation [A. Filippov, V. Rufitskiy, E. Alshina (Huawei), C. Helmrich, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

[JVET-O0099](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6703) CE3-1.3: CU-level low latency intra sub-partitions for 4x8 and 8x4 CUs [H. Yang, Y. He, R. Vanam (InterDigital)]

[JVET-O0106](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6710) CE3-1.6: On 1xN and 2xN subblocks of ISP [A. K. Ramasubramonian, G. Van der Auwera, T. Hsieh, V. Seregin, L. Pham Van, M. Karczewicz (Qualcomm), S. De-Luxan Hernandez, B. Bross, T. Nguyen, V. George, B. Stabernack, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

[JVET-O0174](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6778) Crosscheck of JVET-O0106 (CE3-1.6: On 1xN and 2xN subblocks of ISP) [H. Yang (InterDigital)]

[JVET-O0107](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6711) CE3-1.7: On 1xN and 2xN subblocks of ISP with vertical intra mode restriction for 4xN vertically split ISP-coded blocks [A. K. Ramasubramonian, G. Van der Auwera, T. Hsieh, V. Seregin, L. Pham Van, M. Karczewicz (Qualcomm)]

[JVET-O0109](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6713) CE3-1.4: Intra Sub-Partitions Coding without Thin Partitions [T.-C. Ma, X. Xiu, Y.-W. Chen, X. Wang, H.-J. Jhu (Kwai Inc.)]

[JVET-O0118](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6722) CE3-2.2: Enabling parallel reconstruction of small intra-coded chroma blocks [L. Pham Van, G. Van der Auwera, A. K. Ramasubramonian, V. Seregin, H. Huang, T. Hsieh, M. Karczewicz (Qualcomm), Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

## CE4: Inter prediction (8)

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

[JVET-O0024](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7289) CE4: Summary report on inter prediction [H. Yang, C.-C. Chen]

This contribution provides a summary report of Core Experiment 4 on inter prediction. This CE comprises 3 categories, as follows:

1. Switchable interpolation filter,
2. Affine motion compensation,
3. Combination of LIC and affine MC.

All techniques as planned in the context of CE4 are implemented on top of and tested against VTM-5.0. Simulation results and crosschecking reports of each test specified in this document are provided.

CE4-1: Switchable interpolation filter

Test specification

|  |  |  |
| --- | --- | --- |
| **Test #** | **Description** | **Source** |
| 4-1.1 | Additional half-pel AMVR mode only (for comparison purposes) | JVET-O0057 (HHI) |
| 4-1.2 | Test 1.1 + one alternative switchable luma half-pel interpolation filter, selected half-pel filter is propagated as part of the spatial merging candidate | JVET-O0057 (HHI) |
| 4-1.3 | Test 1.1 + two alternative switchable luma half-pel interpolation filters, selected half-pel filter is propagated as part of the spatial merging candidate | JVET-O0057 (HHI) |
| 4-1.4 | Test 1.2 without propagation of selected half-pel filter in merge mode | JVET-O0057 (HHI) |
| 4-1.5 | Test 1.3 without propagation of selected half-pel filter in merge mode | JVET-O0057 (HHI) |
| 4-1.6 | Test 1.2 with DMVR disabled for CUs using an alternative half-pel interpolation filter | JVET-O0057 (HHI) |
| 4-1.7 | Test 1.3 with DMVR disabled for CUs using an alternative half-pel interpolation filter | JVET-O0057 (HHI) |

Simulation results

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access** | | | | | **Low delay B** | | | | |
| **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 4-1.1 | -0.05% | -0.12% | -0.16% | 103% | 100% | 0.01% | 0.04% | -0.26% | 103% | 100% |
| 4-1.2 | -0.26% | -0.81% | -0.84% | 101% | 99% | -0.10% | -0.02% | -0.27% | 103% | 100% |
| 4-1.3 | -0.34% | -0.98% | -0.93% | 104% | 99% | -0.12% | -0.03% | -0.05% | 106% | 99% |
| 4-1.4 | -0.12% | -0.63% | -0.53% | 102% | 99% | -0.06% | -0.04% | -0.09% | 103% | 99% |
| 4-1.5 | -0.18% | -0.70% | -0.69% | 105% | 100% | -0.04% | -0.12% | -0.23% | 108% | 101% |
| 4-1.6 | -0.26% | -0.85% | -0.85% | 102% | 99% | -0.10% | -0.02% | -0.27% | 103% | 100% |
| 4-1.7 | -0.33% | -0.94% | -0.90% | 105% | 99% | -0.12% | -0.03% | -0.05% | 106% | 99% |

Test 4/5 are same as 2/3, but no inheritance of filter in merge mode (i.e. no alternative filter is used in merge mode). Test 6/7 are same as 2/3, but DMVR is disabled. The results show that DMVR is not useful when the alternative filters are used. This test was requested in the last meeting. This however does not help the worst case complexity. Furthermore, it would require additional check beyond the value of the vector to be checked in DMVR.

The tool introduces an additional building block, the interpretation of MV is an extension of AMVR, and need to switch yet another interpolation filter (which has more smooth characteristics than the current half-pel filter). The best tradeoff is the solution with one filter, which can be interpreted as a straightforward extension of AMVR, wheras the choice of the second filter would need additional logic which is not there in the current decoder design, and it also increases the encoder search without giving much additional gain. From here, the solution 4-1.2 would be the best choice.

Decision: Adopt JVET-O0057 version 4-1.2 (revisit: pending on confirmation of full results after a last-minute software change which was suggested by the cross-checker to match the software with the text; the current partial results indicate that there is no change in performance).

CE4-2: Affine motion compensationspecification

|  |  |  |
| --- | --- | --- |
| **Test #** | **Description** | **Source** |
| 4-2.1a | Prediction refinement with optical flow. The subblock size for affine motion compensation is 4x4 for both uni- and bi-prediction. | JVET-O0070 (InterDigital) |
| 4-2.1b\* | Prediction refinement with optical flow. The subblock size for affine motion compensation is 4x4 for uni-prediction and 8x8 for bi-prediction. | JVET-O0070 (InterDigital) |
| 4-2.1c\* | Prediction refinement with optical flow. The subblock size for affine motion compensation is 4x4 for uni-prediction with and 8x8 for bi-prediction. 8-tap interpolation filter is used for 8x8 subblocks. | JVET-O0070 (InterDigital) |
| 4-2.2a | Withdrawn |  |
| 4-2.2b | Withdrawn |  |
| 4-2.3a | Interweaved prediction for luma component. | JVET-O0069 (Bytedance) |
| 4-2.3b | Interweaved prediction for luma component with equal weighting values | JVET-O0069 (Bytedance) |
| 4-2.3c | Test 4-2.3a + 4-2.1a  PROF is applied on the two auxiliary prediction individually. | JVET-O0069 (Bytedance) |
| 4-2.3d | Test 4-2.3b + 4-2.1a  PROF is applied on the two auxiliary prediction individually. | JVET-O0069 (Bytedance) |
| 4-2.4a | Simplifications of interweaved affine motion compensation in test 4-2.3a, reusing bi-prediction processes. | JVET-O0082 (Tencent) |
| 4-2.4b | Simplifications of interweaved affine motion compensation in test 4-2.3b, reusing bi-prediction processes. | JVET-O0082 (Tencent) |
| 4-2.5a | Phase-variant affine MC. Up to 9 rows and 4 columns of MVx/MVy are derived. | JVET-O0051 (MediaTek) |
| 4-2.5c | Phase-variant affine MC. Test 4-2.5a with fallback mode disabled. | JVET-O0051 (MediaTek) |
| 4-2.5d\*\* | Phase-variant affine MC. The input reference samples of a 4x4 block is limited to be 9x9 square block. | JVET-O0051 (MediaTek) |
| 4-2.5e | Test 4-2.5a + 4-2.1a | JVET-O0051 (MediaTek) |
| \* The software of Test 4-2.1b/c was re-tagged after T3 to fix 2 bugs to make the software align itself with the planned CE descriptions of CE4-2.1b/c.  \*\* The software of Test 4-2.5d was re-tagged after T3 to remove one line of code that triggers compilation error due to an unused variable. | | |

Simulation results

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access** | | | | | **Low delay B** | | | | |
| **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 4-2.1a | -0.48% | -0.09% | -0.07% | 101% | 100% | -0.32% | -0.04% | -0.37% | 102% | 100% |
| 4-2.1b | -0.40% | -0.02% | 0.02% | 100% | 101% | -0.27% | 0.02% | -0.21% | 101% | 100% |
| 4-2.1c | -0.46% | -0.05% | -0.06% | 100% | 100% | -0.35% | -0.06% | -0.21% | 101% | 100% |
| 4-2.3a | -0.32% | -0.06% | -0.05% | 100% | 100% | -0.14% | -0.02% | -0.26% | 103% | 100% |
| 4-2.3b | -0.29% | -0.03% | -0.07% | 101% | 101% | -0.10% | 0.08% | -0.26% | 103% | 100% |
| 4-2.3c | -0.53% | -0.10% | -0.05% | 103% | 101% | -0.34% | -0.25% | -0.18% | 105% | 102% |
| 4-2.3d | -0.54% | -0.09% | -0.05% | 103% | 102% | -0.33% | -0.13% | -0.25% | 106% | 103% |
| 4-2.4a | -0.32% | -0.05% | -0.03% | 105% | 102% | -0.11% | 0.00% | -0.17% | 108% | 104% |
| 4-2.4b | -0.28% | -0.09% | -0.07% | 106% | 102% | -0.15% | 0.06% | -0.18% | 108% | 103% |
| 4-2.5a | -0.39% | -0.51% | -0.50% | 101% | 99% | -0.18% | -0.16% | -0.22% | 101% | 99% |
| 4-2.5c | -0.36% | -0.48% | -0.53% | 104% | 99% | -0.15% | -0.17% | -0.69% | 108% | 104% |
| 4-2.5d | -0.38% | -0.50% | -0.56% | 102% | 100% | -0.21% | -0.19% | -0.30% | 103% | 101% |
| 4-2.5e | -0.59% | -0.47% | -0.47% | 103% | 100% | -0.38% | -0.31% | -0.56% | 105% | 105% |

4-2.1 uses PROF, which adds a value to the prediction of each sample that is determined from the optical flow equation and the gradient. This somehow mimics a pixel-wise MC without actually executing. In 4-2.1a, 4x4 subblocks are used for uni and bi pred, 4-2.1b/c uses 8x8 for bipred (where b uses 6-tap interpolation filters, whereas c uses 8-tap for 8x8 and 6-tap for 4x4 which is more consistent with the current VVC design). However, 4-2.1a is still more consistent with the current affine design, because that uses 4x4 subblocks for both uni and bi pred, which otherwise would need to be switched conditionally on PROF on or off.

4-2.3 uses interweaved prediction, which generates two predictions with two different blocks grids and averages them. 4-2.3a uses position-dependent weighting, 4-2.3b constant weighting. 4-2.3c/d are combining those with PROF, which shows that the gains are not additive. 4-2.4 re-uses the regular bi-prediction module which is only showing negligible difference.

4-2.5 uses phase-variant affine MC, which uses different filters for each line and for each column of the 4x4 block. There is a constraint in the variation of the phase, such that for a 4x4 block at most two more columns need to be fetched for performing the horizontal interpolation. For the vertical interpolation, padding is used. For 4-2.5d, padding is also used for horizontal interpolation, such that in this case the memory bandwidth is the same as in current affine MC. Additional loading of filter coefficients is needed for all cases of 4-2.5.

Whereas 4-2.1 and 4-2.3 require additional steps in generating the prediction signal, 4-2.5 has only one step for that.

Complexity analysis:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test#** | **Number of mults** | **Number of adds** | **Number of shifts** | **Additional memory access** | **Additional local buffer** | **Others** |
| VTM-5.0 | 400/800 | 350/700 | 74/172 | 0 | 0 | Results are shown for uni/bi-prediction separately |
| 4-2.1a | 432/864 | 430/860 | 106/236 | 0 | 96/96 bytes | Delta MV: 4x4x2x1 = 32 bytes Gradient: 4x4x2x2 = 64 bytes  CU level delta MV calculations per reference picture for both uni and bi-prediction: 4x4x2 additions + 4x4x2 shifts + 4x4x2 clippings |
| 4-2.1b | 432/744 | 430/760 | 106/216 | 0 | 96/96 bytes | Delta MV: 4x4x2x1 = 32 bytes Gradient: 4x4x2x2 = 64 bytes  CU level delta MV calculations per reference picture for uni-prediction is the same as 4-2.1a.  CU level delta MV calculations per reference picture for bi-prediction: 8x8x2 additions + 8x8x2 shifts + 8x8x2 clippings. |
| 4-2.1c | 432/976 | 430/984 | 106/224 | 0 | 96/96 bytes | Same as 4-2.1b |
| 4-2.3a | 728 / 800 | 626 / 700 | 164 / 172 | 0 | 20 bytes / 0 |  |
| 4-2.3b | 712 / 800 | 626 / 700 | 164 / 172 | 0 | 20 bytes / 0 |  |
| 4-2.3c | 786/864 | 768/860 | 224/236 | 0 | 20 bytes / 0 |  |
| 4-2.3d | 760/864 | 768/860 | 224/236 | 0 | 20 bytes / 0 |  |
| 4-2.4a | 728 / 800 | 626 / 700 | 164 / 172 | 0 | 20 bytes / 0 |  |
| 4-2.4b | 712 / 800 | 626 / 700 | 164 / 172 | 0 | 20 bytes / 0 |  |
| 4-2.5a | 401.5/803 | 370/740 | 94/212 | 2\*(CU\_Height +L-1) samples for a CU | 28.125 bytes | 4x4-level: 20 “&” operation + 4-sapme of padding  CU-level: 12 adds  + 1 shift + 12 clipping + 2 absolute operation + 2 comparison |
| 4-2.5c | 401.5/803 | 370/740 | 94/212 | 2\*(CU\_Height +L-1) samples for a CU | 28.125 bytes | 4x4-level: 20 “&” operation + 4-sapme of padding  CU-level: 12 adds  + 1 shift + 12 clipping |
| 4-2.5d | 401.5/803 | 370/740 | 94/212 | 0 | 28.125 bytes | 4x4-level: 20 “&” operation + 13-sapme of padding  CU-level: 12 adds  + 1 shift + 12 clipping + 2 absolute operation + 2 comparison |
| 4-2.5e | 433.5/867 | 450/900 | 126/276 | 2\*(CU\_Height +L-1) samples for a CU | 28.125 bytes | 4x4-level: 20 “&” operation + 4-sapme of padding  CU-level: 12 adds  + 1 shift + 12 clipping + 2 absolute operation + 2 comparison |

In terms of results, the methods of 4-2.1 have best compression benefit, with marginal increase of encoding time. Due to the OF solution, it is however less regular than 4-2.3, which can better be parallelized. In terms of computations, neither of the methods is critical. An OF stage is already existing for BDOF, which is however a different one.

From the results of the CE, 4-2.1a is the most convincing solution.

Decision: Adopt JVET-O0070 method 4-2.1a. Appropriateness of text and matching with SW is confirmed by cross-checker.

It is pointed out that there are non-CE contributions which try to align the OF operations between PROF and BDOF. This would be desirable unless it reduces the compression gain unreasonably.

CE4-3: Combination of LIC and affine MC

Test specification

|  |  |  |
| --- | --- | --- |
| **Test #** | **Description** | **Source** |
| 4-3.1a | Unidirectional LIC with affine MC | JVET-O0066 (Qualcomm, MediaTek, Huawei) |
| 4-3.1b | Test 4-3.1a + encoder fast algorithm | JVET-O0066 (Qualcomm, MediaTek, Huawei) |
| 4-3.2a | Test 4-3.1a + min/max simplification | JVET-O0086 (Huawei) |
| 4-3.2b | Test 4-3.1b + min/max simplification | JVET-O0086 (Huawei) |

Simulation results

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access** | | | | | **Low delay B** | | | | |
| **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 4-3.1a | -0.46% | -0.39% | -0.50% | 116% | 100% | -0.37% | 0.03% | -0.30% | 119% | 101% |
| 4-3.1b | -0.32% | -0.22% | -0.40% | 105% | 99% | -0.24% | -0.02% | -0.43% | 108% | 102% |
| 4-3.2a | -0.41% | -0.37% | -0.48% | 117% | 100% | -0.31% | -0.12% | -0.40% | 119% | 101% |
| 4-3.2b | -0.24% | -0.23% | -0.23% | 105% | 101% | -0.13% | -0.19% | -0.24% | 107% | 101% |

The promising gain reported in last meeting (about 0.7%) has dropped to around 0.45% (with approx. 15% encoder run time increase). This is likely due to the fact that the original proposal also used intra reconstruction for LIC (which was inhibited by purpose because it would additional dependencies between intra and inter processing pipelines). No good tradeoff performance versus complexity, also at the decoder the depedency from the neighbor inter reconstruction could be a new burden for parallel processing pipelines (though CIIP also has some similar dependency). No action.

The CE4 summary report also summarizes the CE related contributions. Two major topics are identified: Modifications in context of merge mode (approx. 60) and affine/LIC/BCW/MV coding (approx. 50). It is noted that in the latter category also coordination with CE9 is necessary for proposals that suggest aligning BDOF and PROF.

BoGs are mandated for a review to identify relevant contributions, identfy commonalities and suggest possible actions:

BoG (C,-C. Chen) on CE4 related contributions – merge modifications

BoG (H. Yang) on CE4 related contributions – general inter prediction

[JVET-O0051](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6655) CE4-2.5: Phase-variant affine MC [T.-D. Chuang, C.-Y. Lai, Z.-Y. Lin, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0901](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7523) Crosscheck of JVET-O0051 (CE4-2.5: Phase-variant affine MC) [H. Huang (Qualcomm)]

[JVET-O0057](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6661) CE4: Switchable interpolation filter [A. Henkel, I. Zupancic, B. Bross, M. Winken, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

Test 4-1.1, 4-1.2 and 4-1.3 in JVET-O0057 (HHI)

In JVET-N0309, a switched luma half-pel interpolation filter is proposed. The switching of the half-pel luma interpolation filter is done depending on the motion vector accuracy. In addition to the existing quarter-pel, full-pel, and 4-pel AMVR modes, a new half-pel accuracy AMVR mode is introduced. Only in case of half-pel motion vector accuracy, an alternative half-pel luma interpolation filter can be selected.

* **Half-pel AMVR mode:** An additional AMVR mode for non-affine non-merge inter-coded CUs is proposed which allows signaling of motion vector differences at half-pel accuracy. The existing AMVR scheme of the current VVC draft is extended straightforward in the following way: Directly following the syntax element amvr\_flag, if amvr\_flag == 1, there is a new context-modeled binary syntax element hpel\_amvr\_flag which indicates usage of the new half-pel AMVR mode if hpel\_amvr\_flag == 1. Otherwise, i.e. if hpel\_amvr\_flag == 0, the selection between full-pel and 4-pel AMVR mode is indicated by the syntax element amvr\_precision\_flag as in the current VVC draft.
* **Alternative luma half-pel interpolation filters:** In JVET-N0309, alternative luma half-pel interpolation filters are proposed. For a non-affine non-merge inter-coded CU which uses half-pel motion vector accuracy (i.e., the half-pel AMVR mode), an alternative luma half-pel interpolation filter is used. For test 4-1.2, one alternative luma half-pel interpolation filter is used. For test 4-1.3, a switching between two alternative half-pel interpolation filters is made based on the value of a new syntax element if\_idx. The syntax element if\_idx is only signaled in case of half-pel AMVR mode. In case of skip/merge mode using a spatial merging candidate, the information which interpolation filter is applied for the half-pel position is inherited from the neighbouring block.

Test 4-1.4 and 4-1.5 in JVET-O0057 (HHI)tests 4-1.4 and 4-1.5 correspond to tests 4-1.2 and 4-1.3, with the distinction that in tests 4-1.4 and 4-1.5 the information which interpolation filter is applied for the half-pel position is not inherited from the neighbouring block in case of skip/merge mode using a spatial merging candidate.

Test 4-1.6 and 4-1.7 in JVET-O0057 (HHI)tests 4-1.6 and 4-1.7 correspond to tests 4-1.2 and 4-1.3, with the distinction that in tests 4-1.6 and 4-1.7 the DMVR process is not applied to CUs which are encoded in spatial skip/merge mode and which have inherited the information from the neighbouring block that an alternative interpolation filter is applied for the half-pel position.

[JVET-O0066](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6670) CE4-3.1a and CE4-3.1b: Unidirectional local illumination compensation with affine prediction [V. Seregin, W.-J. Chien, T. Hsieh, N. Hu, M. Karczewicz (Qualcomm), C.-M. Tsai, C.-C. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek), H. Chen, X. Ma, H. Yang (Huawei)]

[JVET-O0069](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6673) CE4-2.3: Interweaved Prediction for Affine Motion Compensation [K. Zhang, L. Zhang, H. Liu, J. Xu, Y. Wang (Bytedance)]

[JVET-O0070](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6674) CE4-2.1: Prediction refinement with optical flow for affine mode [J. Luo, Y. He (InterDigital)]

[JVET-O0082](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6686) CE4-2.4: Simplifications of interweaved affine mode [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

[JVET-O0086](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6690) CE4-3.2a and CE4-3.2b: Unidirectional local illumination compensation with affine prediction and simplified linear model parameter derivation based on min / max method [A. Filippov, V. Rufitskiy, E. Alshina (Huawei)]

[JVET-O0890](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7512) Crosscheck of JVETO0086 (CE4-3.2a and CE4-3.2b: Unidirectional local illumination compensation with affine prediction and simplified linear model parameter derivation based on min / max method) [F. Henry (Orange), G. Clare (bcom)]

## CE5: Loop filtering (7)

Contributions in this category were discussed Thursday 4 July 0900–XXXX in Track B (chaired by JRO).

[JVET-O0025](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7295) CE5: Summary Report on Loop Filtering [A. Norkin, C.-Y. Chen] [miss] [late]

This document provides a summary report of Core Experiment 5 on Loop Filtering. There are two categories of the tests: deblocking filter (CE5-1, CE5-2, and CE5-3) and adaptive loop filter (CE5-4). The subjective testing for the deblocking filter category is planned to be performed at the meeting.

The corresponding compression performance of each coding tool evaluated in CE5 is summarized in this contribution. In addition, analysis of complexity of the proposals and cross-checking results are provided.

The software basis for this CE was VTM-5.0. Configurations and test conditions in JVET-N1010 [1] for SDR sequences are used. Results for additional configuration with ALF turned off are also reported. For the subjective viewing of deblocking proposals, additional encodes with different QPs have been generated, including two sequences in 4:4:4 chroma format.

CE5-1 Sub-PU deblocking and longer tap filter

Proposal in this sub-CE investigate changes to sub-PU deblocking and longer deblocking filter of VVC.

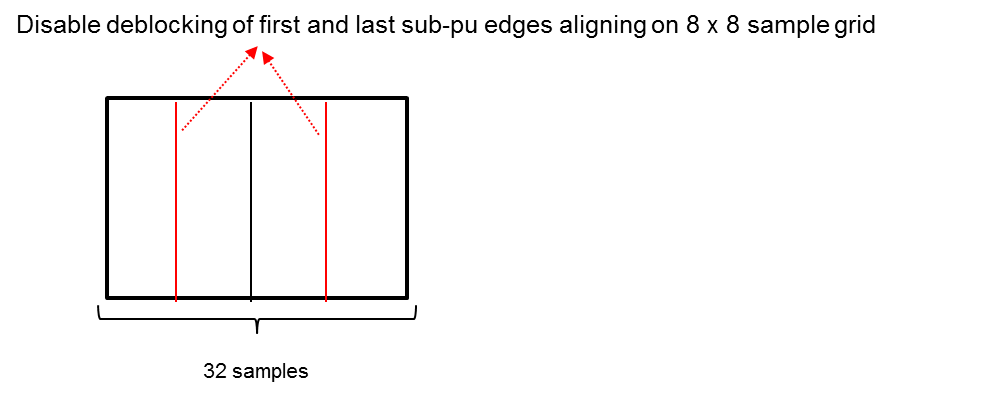
|  |  |  |
| --- | --- | --- |
| **Test** | **Proponent(s)** | **Cross-checker(s)** |
| CE5-1.1 | Anand Meher Kotra [Anand.meher.kotra@huawei.com](mailto:Anand.meher.kotra@huawei.com)  [JVET-O0083](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6687) | Chia-Ming Tsai  [chia-ming.tsai@mediatek.com](mailto:chia-ming.tsai@mediatek.com) |

*CE5-1.1: Modification of sub-PU deblocking and longer tap filter* [JVET-O0083](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6687)

This test proposes two modifications to the current deblocking filter design in VTM.

The first modification disables application of longer tap filter for implicit TU boundaries.

The second modification disables the filtering for first and last sub-PU edges for a block which uses sub-PU tools. This reportedly has an effect that the longer tap filter can directly be applied to the coding unit edge without any further checks.



The target of this proposal is simplification, in particular avoiding switching between different tap numbers for the long filters under certain conditions.

Some concern is expressed that this might cause artifacts under certain conditions (for both modifications). Two questions arise:

- Is the current switching to a 5-tap filter critical in terms of complexity, i.e. how large is the benefit of simplification?

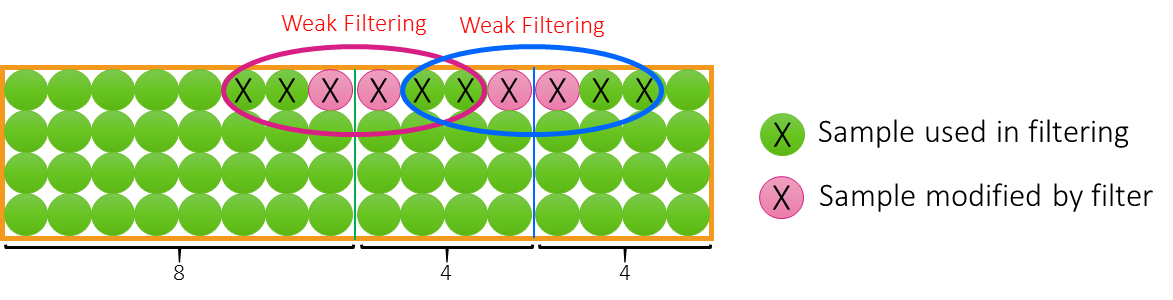
- How useful would a subjective test be, when it only happens rarely with the current test material?

From the discussion, it appears that in general the experts don’t believe that there is a serious complexity problem with the longer tap deblocking filters. The specific switching is necessary to support parallelism which is of prior importance, and the suggested changes would not provide a big benefit in reducing implementation complexity, whereas some concern exists that it might cause artifacts for some specific partitioning cases. More discussion is needed under which circumstances we would like to change the current design (after it had been clearly proven that the longer filters have subjective benefit). Some experts express that such changes should be considered extremely carefully, as deblocking has evolved as proven concept where it is sometimes difficult to foresee how small changes may impact other cases that are not commonly tested in CTC. Proof of “no subjective loss” with the current test material may not be sufficient, if the special cases don’t occur frequently. No action on this specific proposal.

CE5-2 Deblocking at 4x4 block boundaries

|  |  |  |
| --- | --- | --- |
| **Test** | **Proponent(s)** | **Cross-checker(s)** |
| CE5-2.1  (without chroma) | Kenneth Andersson [kenneth.r.andersson@ericsson.com](mailto:kenneth.r.andersson@ericsson.com)  Anand Meher Kotra [Anand.meher.kotra@huawei.com](mailto:Anand.meher.kotra@huawei.com)  Chia-Ming Tsai  [chia-ming.tsai@mediatek.com](mailto:chia-ming.tsai@mediatek.com)  [JVET-O0060](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6664) | Hyeongmun Jang  [hm.jang@lge.com](mailto:hm.jang@lge.com) |
| CE5-2.2 (with chroma) | Kenneth Andersson [kenneth.r.andersson@ericsson.com](mailto:kenneth.r.andersson@ericsson.com)  Anand Meher Kotra [Anand.meher.kotra@huawei.com](mailto:Anand.meher.kotra@huawei.com)  Chia-Ming Tsai  [chia-ming.tsai@mediatek.com](mailto:chia-ming.tsai@mediatek.com)  [JVET-O0060](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6664) | Hyeongmun Jang  [hm.jang@lge.com](mailto:hm.jang@lge.com) |
| CE5-2.3 (without chroma) | Hyeongmun Jang  [hm.jang@lge.com](mailto:hm.jang@lge.com)  [JVET-O0091](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6695) | Kenneth Andersson [kenneth.r.andersson@ericsson.com](mailto:kenneth.r.andersson@ericsson.com) |
| CE5-2.4 (with chroma) | Hyeongmun Jang  [hm.jang@lge.com](mailto:hm.jang@lge.com)  [JVET-O0091](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6695) | Kenneth Andersson [kenneth.r.andersson@ericsson.com](mailto:kenneth.r.andersson@ericsson.com) |
| CE5-2.5 Chroma on 4x4 chroma grid | Hyeongmun Jang  [hm.jang@lge.com](mailto:hm.jang@lge.com)  [JVET-O0092](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6696) | Misra Kiran  [misrak@sharplabs.com](mailto:misrak@sharplabs.com) |

*CE5-2.1* Deblocking for 4xN, Nx4, 8xN and Nx8 blocks [JVET-O0060](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6664)



As shown in the figure above, the proposed method enforces the Luma weak filter with one or no sample modification, when any of the blocks sharing the edge has a size of 4 samples (i.e. width = 4 samples for vertical edge, height = 4 samples for horizontal edge).

The different steps performed for a vertical edge are illustrated below:

* Check if filter on/off condition is evaluated to true i.e. d < *Beta*, where d = d0 + d3 and d0 = dp0 + dq0 and d3= dp3 + dq3) is evaluated to true for the respective edge. If true then
* Check if the one of the blocks has a block width of 4 samples, if true, then
* Enforce weak filter with maximum one sample modification. Therefore the following condition is checked, and if the condition is evaluated to true, then samples and are modified, otherwise no filtering is applied.

*CE5-2.2* Deblocking for 4xN, Nx4, 8xN and Nx8 blocks [JVET-O0060](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6664)

This test would check the CE5-2.1 + chroma deblocking performed on the 4x4 chroma grid.

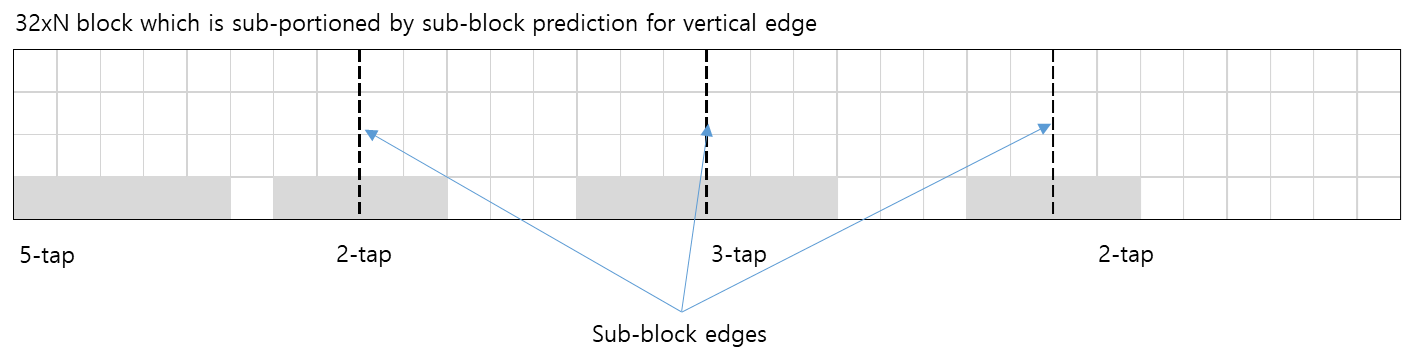
*CE5-2.3* Parallel deblocking filter [JVET-O0091](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6695)

Deblocking filter can be processed in parallel because it is not applied to 4x4 TU and PU boundaries. Within this CE, the performance of the parallel deblocking method described in JVET-D0044 is studied in terms of subjective quality and computational complexity. Chroma deblocking is performed in the same way as in the current deblocking. [Cross-checker points out that chroma is also modified and may be filtered more often, e.g. if at an 8x8 chroma position a 4xN or Nx4 block boundary exists, see cross-checkers notes]

Filter length decision process for luma is as follows:

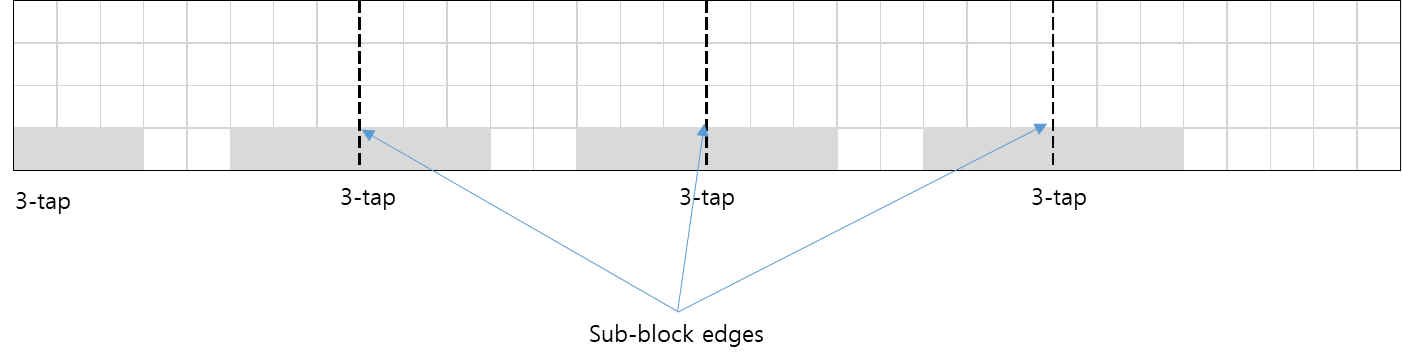
* If the distance of Q side is smaller than or equal to 4, filter length is set equal to 0.
* Otherwise, if the distance of the each side is smaller than or equal to 8, filter length is equal to 3.
* Otherwise if the distance of the each side is smaller than or equal to 16, filter length is equal to 5.
* Otherwise, filter length is set equal to 7.

In the proposal, different filter lengths than in VTM5.0 be derived in some cases as shown in the example below.



Example filter length for VTM-5.0 (different filter lengths).

The filter length of the proposed method is only decided based on the distance between neighboring blocks as shown in the figure below.



Same filter length for blocks of the same size by the proposed method.

For the latter change, some concern is expressed that the change of the long filter at the left might have subjective impact under certain cases (similar arguments as made on CE5-1.2).

Due to the fact that various modifications are combined, it might be difficult to identify what the individual impacts are.

*CE5-2.4* Parallel deblocking filter [JVET-O0091](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6695)

This test study the CE5-2.3 + some more chroma deblocking changes as in JVET-N0463.

* If the distance of Q side is smaller than or equal to 2, filter length is set equal to 0
* Otherwise, if the distance of the each side is smaller than or equal to 4, filter length is set equal to 1.
* Otherwise, filter length is set equal to 3.

To support various color formats, distance condition for filter length decision is adaptively applied. For example, chroma filter length decision for 4:4:4 chroma format is applied as bellow.

* If the distance of Q side is smaller than or equal to 4, filter length is set equal to 0
* Otherwise, if the distance of the each side is smaller than or equal to 8, filter length is equal to 1.
* Otherwise, filter length is set equal to 3.

*CE5-2.5* Deblocking chroma on 4x4 chroma grid [JVET-O0092](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6696)

Chroma deblocking is performed on the 4x4 chroma grid (current VTM chroma deblocking is done on the 8x8 chroma grid).

In this proposal, three parts are modified compared with deblocking filtering of VTM-5.0.

1. Enable filtering for chroma sub-pu edge.
2. Enable filtering for chroma edge whose boundary strength is not 0.
3. Perform filtering on 4x4 chroma sample grid.

Reportedly, filtering process is applied at edges which are aligned with 8x8 grid for luma and edges which are aligned with 4x4 grid for chroma component, which makes filtering process aligned between luma and chroma component for 4:2:0 format.

This is conceptually similar to the chroma deblocking of CE5-2.2, but uses the VTM5 luma deblocking. THis way, it may be concluded from here what the standalone benefit of 4x4 chroma deblocking is. Some implementation details (e.g. BS condition, and choice of weak/strong filter) may be different from the method of CE5-2.2

CE5-3 MV difference threshold in deblocking decisions

|  |  |  |
| --- | --- | --- |
| **Test** | **Proponent(s)** | **Cross-checker(s)** |
| CE5-3.1 | Kenneth Andersson  [kenneth.r.andersson@ericsson.com](mailto:kenneth.r.andersson@ericsson.com)  [JVET-O0061](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6665) | Chia-Ming Tsai  [chia-ming.tsai@mediatek.com](mailto:chia-ming.tsai@mediatek.com) |

*CE5-3.1 Sub-sample MV threshold for* deblocking *decisions* [JVET-O0061](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6665)

It has been shown in JVET-N0359 that block artifacts can occur between two blocks for a magnitude difference in horizontal or vertical motion vector component smaller than one luma sample.

The test investigates the effect of different sub-sample thresholds in deblocking decisions. It is proposed to set the MV component difference threshold for determination of boundary strength to 2 in units of quarter luma samples to enable more efficient reduction of blocking artifacts.

Luma deblocking complexity

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests** | **Samples from block boundary modified** | **Samples from block boundary for deblocking decision** | **Max number of operations for filtering per line (add/mult/compar/shift)** | **Max number of operations for filtering per \*sample\* (add/mult/compar/shift)** | **Max. num. oper., filtering and decsion (Per \*Sample\*)** | **Max oper. for decis. per line (add/mult/compar/shift)** | **Number of line buffers** | **Worst case complexity increased (Y/N)** |
| CE5-1.1 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | N |
| CE5-2.1 | All 4x4: 1+1 | All 4x4: 3+3 | All 4x4: 16 (6/2/5/3) | All 4x4: 4 (6/2/5/3)/4 | ~4 + 1.1875= 5.1875 | All 4x4: 4.75 (2.1875/0.5/1.5625/0.5) | same as VTM-5.0 | N |
| CE5-2.2 | All 4x4: 1+1 | All 4x4: 3+3 | All 4x4: 16 (6/2/5/3) | All 4x4: 4 (6/2/5/3)/4 | ~4 + 1.1875= 5.1875 | All 4x4: 4.75 (2.1875/0.5/1.5625/0.5) | same as VTM-5.0 | N |
| CE5-2.3 | All 4x4: 0 Other : same as VTM-5.0 | All 4x4: 0 Other : same as VTM-5.0 | All 4x4: 0 Other : same as VTM-5.0 | All 4x4: 0 Other : same as VTM-5.0 | All 4x4 : 0 Other : same as VTM-5.0 | All 4x4 : 0 Other : same as VTM-5.0 | same as VTM-5.0 | N |
| CE5-2.4 | All 4x4: 0 Other : same as VTM-5.0 | All 4x4 : 0 Other : same as VTM-5.0 | All 4x4 : 0 Other : same as VTM-5.0 | All 4x4 : 0 Other : same as VTM-5.0 | All 4x4 : 0 Other : same as VTM-5.0 | All 4x4 : 0 Other : same as VTM-5.0 | same as VTM-5.0 | N |
| CE5-2.5 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | N |
| CE5-3.1 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | N |

Chroma deblocking complexity

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests** | **samples from block boundary modified** | **samples from block boundary for deblocking decision** | **Max number of operations for filtering per line (add/mult/compar/shift)** | **Max number of operations for filtering per \*sample\* (add/mult/compar/shift)** | **Max number of operations including filter and decision per \*sample\* (add/mult/compar/shift)** | **Max number of oper. for decision for 8-sample boundary (add/mult/compar/shift)** | **Number of line buffers** | **Worst case complexity increased (Y/N)** |
| CE5-1.1 | longer tap filters on 7 + 7, 3 + 7 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 |  | same as VTM-5.0 |
| CE5-2.1 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | N |
| CE5-2.2 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | N |
| CE5-2.3 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | N |
| CE5-2.4 | all 2x2 : 0 same as VTM-5.0 | all 2x2 : 0 same as VTM-5.0 | all 2x2 : 0 same as VTM-5.0 | all 2x2 : 0 same as VTM-5.0 | all 2x2 : 0 same as VTM-5.0 | all 2x2 : 0 same as VTM-5.0 | same as VTM-5.0 | N |
| CE5-2.5 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | N |
| CE5-3.1 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | same as VTM-5.0 | N |

Subjective tests on CE5-2: Cactus, Christen&Sara, Kayak, FourPeople, Kimono444, LupoCandle444. QP32 and 37

Subjective tests on CE5-3: Foodmarket, Campfire, Cactus, Christen&Sara, Kayak, Johnny. QP32 and 37

Mathias and Kenneth will set up the test equipment. Minimum of 12 experts needed for around 2.5 hrs.

Revisit 5-2 and 5-3 after the test.

Tests should be run with ALF-on

CE5-4 Adaptive loop filter [JVET-O0090](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6694)

In the JVET-N0415 proposal, which was adopted for VTM5.0, ALF process can now either use filter sets of previously received APS (temporal filter sets) or use predefined luma filter sets. However it is not possible to signal more than one new luma filter set in a given APS. In ALF tool, the filter coefficients of one new luma filter set can be predicted by using the coefficients of one of the predefined luma filter set. For chroma filter, it is possible to choose one temporal filter or signaling one new filter, but it is not possible to switch between chroma filters at CTU level.

In JVET-N0243, alternative luma filter sets are signaled at tile group level, so that more than one luma filter set can be signaled at once per tile group (i.e. they could be put in a same APS). JVET-N0243 also contained some syntax reduction mechanism that enables to further merge filter indexes between successive filter sets. Filters from different filter sets defined at tile group level can be mixed in a CTU specific filter set, through an additional signaling in the CTU data that enables to indicate an alternative luma filter set index for each luma filter index.

In JVET-N0243, alternative chroma filters can be also signaled at tile group level, so that more than one chroma filter can be signaled at once per tile group (i.e. they could be put in the same APS). One alternative chroma filter can be thus selected per chroma component and per CTU through an additional signaling in the CTU data that enables to indicate one alternative chroma filter index per chroma component processed by ALF.

In JVET-N0243, there are no pre-trained fixed filter sets, nor temporal filter sets, which are introduced in VTM5.0 with adoption of JVET-N0415. The following tests would allow clarifying gains of each sub-tool of JVET-N0243 and their potential overlap with adopted JVET-N0415.

Five tests were planned to be performed (according to the CE5 description).

1. CE5-4.1 will provide results of mixing different luma filters at CTU level coming from the different filters signaled in the APS(s).
2. CE5-4.2 will provide results when enabling the signaling of additional luma filter sets in APS.
3. CE5-4.3 will provide combined results of CE5-4.1 and CE5-4.2.
4. CE5-4.4 will provide results when enabling alternative chroma filters in VTM5.0 at CTU level.
5. CE5-4.5 will provide results of the combination of tests CE5-4.1, CE5-4.2 and CE5-4.4.

In the final CE5-4 results, the proponents of CE5-4 decided to withdraw the CE5-4.1 and CE5-4.3 tests. Accordingly, the tests CE5-4.2, CE5-4.4 and CE5-4.5 were renamed are CE5-4.1, CE5-4.2 and CE5-4.3. The following names and subtests are reported in this summary report.

The proposed modifications are summarized in the following.

CE5-4.1:

1. Allow one additional luma filters set in one APS   
   (totally up to two luma filter sets in one APS)
2. Signal the filter selection from different luma filter sets in one APS for each class at CTB level

CE5-4.2:

1. Allow at most seven additional chroma filters in one APS   
   (totally up to eight chroma filters in one APS)
2. Signal the filter selection from different chroma filters in one APS for each chroma component at CTB level

CE5-4.3:

1. The combination of CE5-4.1 + CE5-4.2

|  |  |  |  |
| --- | --- | --- | --- |
| **Test** | **Description** | **Tester** | **Cross-checker** |
| CE5-4.1 | VTM5.0 + additional luma filter sets signalled in APS [JVET-O0090](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6694) | Canon | Nan Hu  <nanh@qti.qualcomm.com> |
| CE5-4.2 | VTM5.0 + alternative chroma filters + CTU chroma filter selection [JVET-O0090](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6694) | Canon | Nan Hu  <nanh@qti.qualcomm.com> |
| CE5-4.3 | Combination of test 5-4.3 and 5-4.4 [JVET-O0090](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6694) | Canon | Nan Hu  <nanh@qti.qualcomm.com> |

Results:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | | **Random Access** | | | | | | | | |
| **Test#** | **Y** | **U** | **V** | **EncT** | | **DecT** | **Y** | | **U** | | **V** | | **EncT** | | **DecT** |
| CE5-4.1 | 0.01 | 0.00 | -0.01 | 101% | 98% | | -0.08 | 0.09 | | 0.06 | | 101% | | 101% | |
| CE5-4.2 | 0.08 | -0.88 | -1.23 | 100% | 99% | | 0.09 | -1.96 | | -2.36 | | 100% | | 100% | |
| CE5-4.3 | 0.08 | -0.88 | -1.23 | 100% | 100% | | 0.01 | -1.91 | | -2.28 | | 101% | | 100% | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low Delay B** | | | | | | | | | **Low Delay P** | | | | | | | | |
| **Test#** | **Y** | | **U** | | **V** | | **EncT** | | **DecT** | **Y** | | **U** | | **V** | | **EncT** | | **DecT** |
| CE5-4.1 | -0.15 | 0.28 | | 0.04 | | 104% | | 98% | | -0.19 | 0.26 | | 0.04 | | 105% | | 100% | |
| CE5-4.2 | 0.08 | -2.43 | | -2.78 | | 101% | | 100% | | 0.04 | -2.33 | | -2.59 | | 100% | | 101% | |
| CE5-4.3 | -0.12 | -2.45 | | -2.64 | | 104% | | 100% | | -0.17 | -2.51 | | -2.62 | | 104% | | 99% | |

Complexity:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test #** | **Time complexity**  N = num. classes | **Filter sets** | **Filters storage (bits)** | **CTB level storage** |
| VTM5.0 |  |  | 3060 bits |  |
| CE5-4.1 | O (N) | x2 luma filter set | 6060 bits | 25 indices (1 bit each) |
| CE5-4.2 | O (1) | x8 chroma filter | 3480 bits | 2 indices (3 bits each) |
| CE5-4.3 | O (N) | x2 luma filter set +  x8 chroma filter | 6480 bits | 25 luma indices (1 bit each) + 2 indices (3 bits each) |

Filters are switched at CTU level. Having more choice of filters does not have much effect on luma (except for low delay). The benefit for chroma (5-4.2) is larger. Chroma filters are still not based on classification, only one filter is selected for each CTU. Also here, the additional need for storage is small.

It is noted that in the non-CE category there is no proposal that directly competes with the approach of improving chroma ALF by increasing the number of filters that can be selected at CTU level.

Decision: Adopt JVET-O0090 variant CE5-4.2. From the CE, the adoption relates to the desire of having a mechanism that allows adapting the chroma ALF at CTU level. The harmonization of the specific way of APS signalling with the overall APS concept shall be coordinated with HLS decisions (e.g. JVET-O0247 also suggests an APS modification with multiple chroma filter APSs aligned with luma). Revisit – report on the coordination of the signalling method.

[JVET-O0060](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6664) CE5-2.1 and CE5-2.2: Deblocking on 4x4 sample grids [K. Andersson, J. Enhorn, Z. Zhang, R. Sjöberg (Ericsson), A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei), C.-M. Tsai, C.-W. Hsu, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0061](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6665) CE5-3.1 Sub-sample MV threshold for deblocking decisions [K. Andersson, J. Enhorn (Ericsson)]

[JVET-O0083](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6687) CE5-1.1: Modification of sub-pu deblocking and longer tap filter [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)]

[JVET-O0090](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6694) CE5-4: alternative luma filter sets and alternative chroma filters for ALF [J. Taquet, P. Onno, C. Gisquet, G. Laroche (Canon)]

[JVET-O0091](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6695) CE5-2.3 and CE5-2.4: filter length decision which support parallel processing and aligned filtering block edge [H. Jang, J. Nam, N. Park, J. Lim, S. Kim (LGE)]

[JVET-O0092](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6696) CE5-2.5: De-block filtering with 4x4 chroma sample grid [H. Jang, J. Nam, N. Park, J. Lim, S. Kim (LGE)]

## CE6: Transforms and transform signalling (4)

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

[JVET-O0026](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7166) CE6: Summary Report on Transforms and Transform Signalling [X. Zhao, H.E. Egilmez]

This contribution was discussed Thursday 4 July 0900 (GJS)

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

(1) CE6-1: Primary transformation (10 tests)

(2) CE6-2: Secondary transformation (2 tests)

In this CE all experiments were done using based on the VTM-5.0 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-O0076 | MTS design with both encoder changes | C.-H. Hung (Qualcomm) | M. Siekmann  (HHI) |
| 6-1.1b | Both encoder changes | C.-H. Hung (Qualcomm) | M. Siekmann  (HHI) |
| 6-1.1c | Encoder change 1 only | C.-H. Hung (Qualcomm) | M. Siekmann  (HHI) |
| 6-1.1d | Encoder change 2 only | C.-H. Hung (Qualcomm) | M. Siekmann  (HHI) |
| 6-1.1e | MTS design without encoder changes | C.-H. Hung (Qualcomm) | M. Siekmann  (HHI) |
| 6-1.2a | JVET-O0062 | The sorting algorithm as proposed in JVET-N0491 based on the intra mode, compared against CTC anchor | C. Hollmann (Ericsson) | X. Zhao (Tencent) |
| 6-1.2b | The sorting algorithm without the described intra prediction mode dependency, compared against CTC anchor | C. Hollmann (Ericsson) | X. Zhao (Tencent) |
| 6-1.2c | Reducing the number of fully evaluated transform candidates to 2 without the sorting algorithm, compared against CTC anchor | C. Hollmann (Ericsson) | X. Zhao (Tencent) |
| 6-1.2d | Test CE6-1.2a versus test CE6-1.2c as an anchor (which uses 2 candidates) | C. Hollmann (Ericsson) | X. Zhao (Tencent) |
| 6-1.2e | Test CE6-1.2b versus test CE6-1.2c as an anchor (which uses 2 candidates) | C. Hollmann (Ericsson) | X. Zhao (Tencent) |
| 6-2.1a | JVET-O0094 | Simplification of the Reduced Secondary Transform using 48x16 RST matrices | M. Siekmann  (HHI) | C.-H. Hung (Qualcomm) |
| 6-2.1b | Simplification of the Reduced Secondary Transform using 64x16 RST matrices | M. Siekmann  (HHI) | C.-H. Hung (Qualcomm) |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | **Random Access** | | | | | **Low Delay B** | | | | |
| **Test #** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| CE6-1.1a | 0.00% | 0.00% | 0.01% | 104% | 101% | -0.01% | -0.07% | -0.04% | 102% | 102% | -0.03% | 0.29% | -0.05% | 100% | 99% |
| CE6-1.1b | 0.00% | 0.00% | 0.00% | 104% | 101% | 0.00% | 0.00% | 0.00% | 102% | 101% | 0.00% | 0.12% | 0.17% | 100% | 99% |
| CE6-1.1c | 0.24% | 0.11% | 0.22% | 96% | 101% | 0.14% | 0.23% | 0.21% | 96% | 101% | 0.01% | -0.02% | 0.10% | 100% | 100% |
| CE6-1.1d | 0.00% | 0.00% | 0.00% | 101% | 100% | 0.00% | 0.00% | 0.00% | 101% | 101% | -0.04% | 0.08% | 0.56% | 100% | 97% |
| CE6-1.1e | 0.00% | 0.00% | 0.01% | 101% | 100% | -0.01% | -0.07% | -0.04% | 101% | 101% | 0.03% | 0.07% | 0.26% | 100% | 99% |
| CE6-1.2a | 0.00% | -0.01% | 0.01% | 98% | 100% | 0.01% | -0.02% | -0.03% | 99% | 98% | 0.01% | 0.23% | -0.03% | 99% | 100% |
| CE6-1.2b | 0.00% | -0.01% | 0.00% | 100% | 101% | 0.00% | -0.05% | -0.07% | 98% | 95% | 0.05% | 0.12% | 0.17% | 98% | 100% |
| CE6-1.2c | 0.00% | -0.02% | 0.01% | 98% | 99% | 0.00% | -0.02% | -0.05% | 101% | 101% | 0.06% | -0.02% | 0.22% | 98% | 98% |
| CE6-2.1a | 0.06% | -0.02% | 0.05% | 90% | 99% | 0.02% | 0.01% | -0.01% | 97% | 100% |  |  |  |  |  |
| CE6-2.1b | 0.21% | 0.75% | 0.84% | 76% | 99% | 0.13% | 0.43% | 0.44% | 93% | 99% |  |  |  |  |  |

The following table summarizes the results of CE6-1.2d and CE6-1.2e tests using CTC configuration and CE6-1.2c as anchor, the test methods are CE6-1.2a and CE6-1.2b, respectively.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | **Random Access** | | | | | **Low Delay B** | | | | |
| **Test #** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| CE6-1.2d | 0.00% | 0.01% | 0.00% | 100% | 101% | 0.01% | 0.00% | 0.02% | 98% | 97% | -0.05% | 0.25% | -0.25% | 102% | 102% |
| CE6-1.2e | 0.00% | 0.01% | -0.01% | 102% | 101% | 0.00% | -0.03% | -0.02% | 97% | 94% | -0.01% | 0.14% | -0.04% | 100% | 103% |

The following table summarizes the results of CE6 tests using CTC configuration and VTM-5.0 with inter MTS enabled (--MTS=3) as anchor.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access** | | | | | **Low Delay B** | | | | |
| **Test #** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| CE6-1.1a | 0.01% | 0.04% | 0.04% | 102% | 102% | -0.03% | -0.06% | 0.18% | 101% | 104% |
| CE6-1.1b | 0.00% | 0.00% | 0.00% | 101% | 101% | -0.03% | -0.03% | 0.11% | 100% | 105% |
| CE6-1.1c | 0.12% | 0.24% | 0.23% | 97% | 101% | 0.02% | 0.08% | 0.38% | 100% | 105% |
| CE6-1.1d | 0.00% | 0.00% | 0.00% | 101% | 102% | -0.05% | -0.05% | 0.39% | 101% | 104% |
| CE6-1.1e | 0.01% | 0.04% | 0.04% | 101% | 101% | 0.01% | -0.06% | 0.49% | 101% | 105% |
| CE6-1.2a |  |  |  |  |  |  |  |  |  |  |
| CE6-1.2b |  |  |  |  |  |  |  |  |  |  |
| CE6-1.2c |  |  |  |  |  |  |  |  |  |  |
| CE6-1.2d |  |  |  |  |  |  |  |  |  |  |
| CE6-1.2e |  |  |  |  |  |  |  |  |  |  |
| CE6-2.1a | 0.02% | 0.04% | 0.07% | 97% | 99% |  |  |  |  |  |
| CE6-2.1b | 0.14% | 0.50% | 0.53% | 93% | 100% |  |  |  |  |  |

The following table summarizes the results of CE6 tests using Low QP configuration and VTM-5.0, as specified in JVET-N1026.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | **Random Access** | | | | |
| **Test #** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| CE6-2.1a | 0.11% | 0.14% | 0.11% | 83% | 102% | 0.03% | 0.00% | 0.01% | 95% | 100% |
| CE6-2.1b | 0.12% | 0.18% | 0.18% | 67% | 98% | 0.04% | 0.00% | 0.04% | 84% | 98% |

The 6-1 category is for techniques trying to get coding gain. None of the methods seem to show compelling gain. It was commented that a change of the encoding search method that was adopted with the secondary transform may have had some effect on the coding gain that was observed.

For the 6-2 category:

* In VTM5, the secondary transform operates on an L-shaped area of 48 primary transform coefficients and produces a 4x4 region of potentially non-zero secondary transform coefficients (with zeroing out of the remaining 32 coefficients). The coefficients of the primary transform that are outside of the L-shaped 48-coefficient area may be nonzero. The VTM has two candidates for the secondary transform kernel, and the encoder needs to choose whether to use the secondary transform and which kernel to use.
* The benefit of having two candidate 48-coefficient secondary transform kernels rather than one 64-coefficient secondary transform kernel was said to be about 0.25% for AI (less for RA).
* The evaluated proposal is intended to have a cleaner design and some complexity reduction. It sets all coefficients outside of the 48-coefficient area to zero. As tested, it reduces encoder runtime. These proposals also eliminate a need to count nonzero coefficients in the decoding process. Variant 6-2.1a is otherwise basically the same as in the VTM, and variant 6-2.1b uses a single 64-coefficient secondary transform kernel. The 6-2.1b variant has less decoder memory (but more multiplies).
* It was commented that there is a pipeline problem, such that it is necessary to determine at the CU whether to apply the secondary transform or not, which requires excess data buffering for large CUs. This was said to be an orthogonal issue relative to this proposal.
* It was commented that there could be some subjective effect of zeroing out. This may be too small to measure, and it was commented that it is not clear whether such a subjective effect might be positive or negative.
* There were said to be some non-CE related proposals that affect some of this.

Decision (simplification): Adopt 6-2.1a from JVET-O0094.

Further study the need to have two selectable kernels.

The summary report also listed 50 related proposals in the following categories:

* Context reduction for transform signaling (10 Proposals)
* Simplification on LFNST (24 Proposals)
* Transform kernel selection (12 Proposals)
* Maximum TU size for chroma format 4:2:2 and 4:4:4 (1 proposal)
* Mismatch between text specification and reference software on MTS for IBC-coded block (1 proposal)
* Configurable maximum transform size (1 proposal)
* Modified DCT8/DST7 Transform Matrices for Faster Implementation (1 proposal)

[JVET-O0062](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6666) CE6-1.2 Transform Candidate Ordering [C. Hollmann, D. Saffar, P. Wennersten, J. Ström (Ericsson)]

[JVET-O0076](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6680) CE6-1.1: An Explicit MTS Design with Fast Encoder [C.-H. Hung, H. E. Egilmez, N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0094](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6698) CE6-2.1: Simplification of Low Frequency Non-Separable Transform [M. Siekmann, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

## CE7: Quantization and coefficient coding (8)

[JVET-O0027](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6795) CE7: Summary report on quantization and coefficient coding [H. Schwarz, M. Coban]

This contribution was discussed Thursday 4 July 1100 (chaired by GJS).

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 topics of transform coefficient coding, joint chroma residual coding, transform skip residual coding, and CBF coding.

The purpose of this core experiment is to explore the coding efficiency and complexity impact of proposed algorithms for quantization and transform coefficient/residual coding.

The following tools were considered in this CE.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Proponent** | **Document** | **Tool description** |
| 1 | Mediatek | JVET-N0091 | TB-level constraints on context-coded bins for coefficient coding |
| 2 | Qualcomm | JVET-N0106 | TU-level limits on context-coded bins for coefficient coding |
| 3 | HHI | JVET-N0282 | Joint chroma residual coding with multiple modes |
| 4 | Qualcomm | JVET-N0347 | Joint coding of chroma residuals |
| 5 | Mediatek | JVET-N0094 | Context modelling of transform skip mode |
| 6 | HHI | JVET-N0357 | Context modelling of sign for TS residual coding |
| 7 | Tencent | JVET-N0366 | Modified limitation on context coded bins for TS residual coding |
| 8 | Qualcomm | JVET-N0455 | Sign context modelling and level mapping for TS residual coding |
| 9 | Kwai | JVET-N0326 | Simplification of cbf coding |

The following related contribution documents were submitted.

|  |  |  |
| --- | --- | --- |
| **document** | **authors** | **title** |
| JVET-O0052 | T.-D. Chuang, C.-Y. Chen, S.-T. Hsiang, Y.-W. Huang, S.-M. Lei (MediaTek), M. Coban, M. Karczewicz (Qualcomm) | CE7-1: TB-level constraints on context-coded bins for coefficient coding |
| JVET-O0089 | T. Nguyen, B. Bross, H. Schwarz., D. Marpe, T. Wiegand (HHI) | CE7-3.3/4: Context Modelling of sign for TS residual coding |
| JVET-O0104 | X. Zhao, X. Li, X. Xu, S. Liu (Tencent) | CE7: Modified limitation on context coded bins for residual coding of Transform Skip mode (CE7-3.5 and CE7-3.6) |
| JVET-O0105 | C. Helmrich, H. Schwarz, T. Nguyen, C. Rudat, D. Marpe, T. Wiegand (Fraunhofer HHI), B. Ray, G. Van der Auwera, A. K. Ramasubramonian, M. Coban, M. Karczewicz (Qualcomm) | CE7: Joint chroma residual coding with multiple modes (tests CE7-2.1, CE7-2.2) |
| JVET-O0110 | Y.-W. Chen, X. Xiu, T.-C. Ma, X. Wang (Kwai Inc.) | CE7-4.1: Simplification of cbf coding |
| JVET-O0115 | B. Ray, G. Van der Auwera, A. K. Ramasubramonian, M. Coban, M. Karczewicz (Qualcomm) | CE7-2.3: Joint coding of chroma residuals |
| JVET-O0122 | M. Karczewicz, H. Wang, M. Coban, Y.-H. Chao, Y. Han (Qualcomm) | CE7: Sign context, level mapping, and bitplane coding for TS residual coding (CE7-3.7, CE7-3.8, CE7-3.9, CE7-3.10, and CE7-3.11) |
|  | | |
| **CE related contributions (excluding crosschecks)** | | |
| JVET-O0068 | M. Zhou (Broadcom) | AHG16/Non-CE7: A study of bin to bit ratio for VTM5.0 |
| JVET-O0193 | Y. Zhao, H. Yang (Huawei) | CE7-related: Remove transform depth in cbf coding |
| JVET-O0223 | P. de Lagrange, F. Le Léannec, E. François, K. Naser (InterDigital) | Non-CE7: Quantization matrices with single identifier and prediction from larger ones |
| JVET-O0231 | S. Esenlik, Y. Zhao, A. M. Kotra, H. Gao, B. Wang, E. Alshina (Huawei) | Non-CE7: Modified chroma coded block flag signalling |
| JVET-O0295 | S.-T. Hsiang, S.-M. Lei (MediaTek) | CE7-related: Modified subblock coding passes for coding TS residual |
| JVET-O0375 | A. Nalci, H. E. Egilmez, A. Said, M. Coban, V. Seregin, M. Karczewicz (Qualcomm) | Non-CE7: A Simplified CBF Coding for Luma and Chroma |
| JVET-O0383 | T. Hashimoto, E. Sasaki, T. Chujoh, T. Ikai (Sharp) | Non-CE7: Harmonization of scaling matrix and LFNST |
| JVET-O0400 | J. Choi, S. Yoo, J. Heo, J. Choi, J. Lim, S. Kim (LGE) | CE7-related: Context-coded bin restriction |
| JVET-O0406 | Y. Kato, K. Abe, T.Toma (Panasonic) | Non-CE7: Unification of syntaxes after CCB count exceeds the maximum number between transform residual and transform skip residual |
| JVET-O0409 | Y. Kato, K. Abe, T. Toma (Panasonic) | Non-CE7: Unification of CCB count method between transform residual and transform skip residual |
| JVET-O0527 | P. de Lagrange, Y. Chen (InterDigital) | Non-CE7: Use INTER quantization matrices for IBC |
| JVET-O0543 | C. Helmrich, H. Schwarz, T. Nguyen, C. Rudat, D. Marpe, T. Wiegand (Fraunhofer HHI) | CE7-related: Alternative configuration for joint chroma residual coding |
| JVET-O0556 | M. Karczewicz, Y. Han, Y.-H. Chao, M. Coban (Qualcomm) | CE7-related: Alternative method to RDPCM with TS level mapping |
| JVET-O0557 | Y.-H. Chao, M. Coban, M. Karczewicz (Qualcomm) | Non-CE7: Context modeling unification in significant flag of coefficient group |
| JVET-O0558 | M. Karczewicz, Y.-H. Chao, H. Wang, M. Coban (Qualcomm) | CE7-related: Reduction of Gtx passes in transform skip residual coding |
| JVET-O0559 | M. Karczewicz, Y.-H. Chao, M. Coban (Qualcomm | CE7-related: QP dependent binarization in TS residual coding |
| JVET-O0575 | W. Zhu, L. Zhang, J. Xu, K. Zhang, H. Liu (Bytedance) | CE7-related: Reduction for Context Coded Bins in Transform Skip Mode |
| JVET-O0596 | X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.) | CE7-related: On chroma CBF signaling of subblock transform mode |
| JVET-O0613 | C. Auyeung, X. Li, S. Liu (Tencent) | CE7-related: Unification of Rice parameter tables in residual coding |
| JVET-O0617 | C. Auyeung, X. Zhao, X. Li, S. Liu (Tencent) | CE7-related: Context reduction of transform coefficient significance flag |
| JVET-O0619 | M. G. Sarwer, Y. Ye (Alibaba) | Non-CE7: Simplification of transform skip residual coding |
| JVET-O0623 | M. Karczewicz, H. Wang, M. Coban, Y.-H. Chao (Qualcomm) | CE7-related: Interleaved coefficient coding for transform-skip mode |
| JVET-O0670 | B. Ray, G. Van der Auwera, M. Karczewicz (Qualcomm) | CE7-related: Alternative joint coding of chroma residuals |
| JVET-O0928 | S.-T. Hsiang, S.-M. Lei (MediaTek) | CE7-related: Context reduction for entropy coding sig\_coeff\_flag |
| JVET-O0935 | C. Helmrich, H. Schwarz, T. Nguyen, C. Rudat, D. Marpe, T. Wiegand (Fraunhofer HHI, B. Ray, G. Van der Auwera, A. K. Ramasubramonian, M. Coban, M. Karczewicz (Qualcomm) | CE7-related: Alternative configuration of CE7-2.2 joint chroma residual coding |

**Category 1: Transform coefficient coding**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tester** | **Tool** | **Cross checker** |
| CE7-1.1 | T.-D. Chuang, M. Coban (Mediatek / Qualcomm) | TB-level constraints on context-coded bins for coefficient coding based on the non-zero out region size of TB. | Yi-Wen Chen (Kwai) |
| CE7-1.2 | T.-D. Chuang, M. Coban (Mediatek / Qualcomm) | TB-level constraints on context-coded bins for coefficient coding based on the last coded subblock position (area covered in non-zero out region up to the last subblock position) of TB. | Yi-Wen Chen (Kwai) |

**Category 2: Joint chroma residual coding**

|  |  |  |  |
| --- | --- | --- | --- |
| CE7-2.1 | Christian Helmrich (HHI) | Joint chroma residual coding with multiple modes: JVET-N0282 configuration 1 (three modes with single chroma residual) | Ray Bappaditya (Qualcomm) |
| CE7-2.2 | Christian Helmrich (HHI / Qualcomm) | Joint chroma residual coding with multiple modes: JVET-N0282, configuration 2 (two modes with single chroma residual and one mode with Hadamard transform) | Jani Lainema (Nokia) |
| CE7-2.3 | Ray Bappaditya (Qualcomm) | Joint coding of chroma residuals: JVET-N0347 | Jani Lainema (Nokia) |

**Category 3: Transform skip residual coding**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tester** | **Tool** | **Cross checker** |
| CE7-3.1 | [test withdrawn] | | |
| CE7-3.2 | [test withdrawn] | | |
| CE7-3.3 | Tung Nguyen (HHI) | Context modelling of sign for TS residual coding: Configuration as in JVET-N0357 | Muhammed Coban (Qualcomm) |
| CE7-3.4 | Tung Nguyen (HHI) | Context modelling of sign for TS residual coding: Alternative configuration using different parameters | Muhammed Coban (Qualcomm) |
| CE7-3.5 | Xin Zhao (Tencent) | Modified limitation on context coded bins for TS residual coding, parity flag signaled after gt2 flag and up to 8 contexts coded gt2 flags per coefficient | Yi-Wen Chen (Kwai) |
| CE7-3.6 | Xin Zhao (Tencent) | Modified limitation on context coded bins for TS residual coding, parity flag is bypass coded and signaled after gt2 flag, up to 8 contexts coded gt2 flags per coefficient | Yi-Wen Chen (Kwai) |
| CE7-3.7 | Muhammed Coban (Qualcomm) | Sign context for TS residual coding | Tung Nguyen (HHI) |
| CE7-3.8 | Muhammed Coban (Qualcomm) | Level mapping for TS residual coding | Tung Nguyen (HHI) |
| CE7-3.9 | Muhammed Coban (Qualcomm) | Bitplane coding for TS residual coding | Tung Nguyen (HHI) |
| CE7-3.10 | Muhammed Coban (Qualcomm) | Sign context and level mapping for TS residual coding | Tung Nguyen (HHI) |
| CE7-3.11 | Muhammed Coban (Qualcomm) | Sign context, level mapping, and bitplane coding for TS residual coding | Tung Nguyen (HHI) |

**Category 4: CBF coding**

|  |  |  |  |
| --- | --- | --- | --- |
| CE7-4.1 | Yi-Wen Chen (Kwai) | Two CABAC contexts could be utilized to coding the tu\_cbf\_luma and the context selection is derived based on trDepth | Guichun Li (Tencent) |

All proposals were integrated into the VTM-5 software (outcome of the Geneva meeting). Results were reported for the VTM-5 software and the common test conditions (standard configuration files).

All tools were tested against the VTM-5 anchor (same set of tools, except the tool to be tested).

Results were provided for two ranges of QP values:

* Standard QPs (37, 32, 27, 22): AI, RA, and LD configurations as specified in CTC (all frames);
* Low QPs (17, 12, 7, 2): AI, RA, and LD configurations with 100 frames only (i.e., by using the encoder option “--FramesToBeEncoded=100”).

For category 2 tests (joint chroma coding), additional HDR results according to JVET-N1011 have to be provided. For HDR, only tests for the standard QP set (22, 27, 32, 37) are required (visual testing is not required).

For category 3 tests (transform skip residual coding), additional results for screen coding content sequences (class TGM with YUV 4:2:0 format) have to be provided using class F CTC configuration. For category 3 tests, proponents are also encouraged to provide additional IBC off tests for screen content sequences (class F and TGM).

Category 1 focuses on reducing the worst-case number of context-coded bins.

**Average results of CE7-1 for Common Test Conditions (CTC) and low QP (QP values 2, 7, 12, 17).**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 |
| **CE7-1.1** | -0.01% | -0.06% | -0.03% | 102% | 104% | 0.00% | -0.07% | 0.02% | 102% | 100% | -0.01% | -0.17% | 0.35% | 102% | 102% |
| **CE7-1.2** | 0.00% | -0.02% | 0.00% | 102% | 103% | 0.02% | -0.04% | -0.09% | 103% | 99% | 0.01% | 0.39% | 0.29% | 100% | 99% |
| **CE7-1.2b** | -0.01% | -0.05% | -0.04% | 101% | 97% | 0.00% | -0.09% | -0.05% | 101% | 100% | 0.02% | 0.24% | 0.16% | 100% | 103% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **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 |
| **CE7-1.1** | 0.06% | -0.06% | -0.04% | 99% | 99% | 0.10% | 0.04% | 0.06% | 100% | 98% | 0.03% | 0.00% | 0.00% | 100% | 99% |
| **CE7-1.2** | 0.08% | -0.08% | -0.05% | 99% | 97% | 0.12% | 0.09% | 0.11% | 100% | 98% | 0.05% | 0.09% | 0.10% | 100% | 99% |
| **CE7-1.2b** | 0.01% | -0.06% | -0.05% | 100% | 96% | 0.03% | -0.06% | -0.03% | 102% | 99% | 0.00% | -0.09% | -0.10% | 102% | 104% |

**Bin-to-bit ratio analysis for CE7-1 and Common Test Conditions (CTC).**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **AI** | **Max B2B** | | | **TRF of Max B2B** | | | **Avg TRF B2B** | | | **Avg B2B** | | |
| ref | test | inc | ref | test | inc | ref | test | inc | ref | test | inc |
| **CE7-1.1** | 1.14 | 1.17 | 2.86% | 1.50 | 1.57 | 4.92% | 1.50 | 1.58 | 4.90% | 1.14 | 1.17 | 2.66% |
| **CE7-1.2** | 1.14 | 1.16 | 1.82% | 1.50 | 1.55 | 3.24% | 1.50 | 1.55 | 3.15% | 1.14 | 1.16 | 1.71% |
| **CE7-1.2b** | 1.14 | 1.16 | 2.06% | 1.50 | 1.56 | 3.72% | 1.50 | 1.55 | 3.50% | 1.14 | 1.17 | 1.89% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **RA** | **Max B2B** | | | **TRF of Max B2B** | | | **Avg TRF B2B** | | | **Avg B2B** | | |
| ref | test | inc | ref | test | inc | ref | test | inc | ref | test | inc |
| **CE7-1.1** | 1.12 | 1.15 | 2.93% | 1.46 | 1.53 | 4.89% | 1.62 | 1.69 | 3.91% | 1.16 | 1.18 | 1.72% |
| **CE7-1.2** | 1.12 | 1.14 | 1.65% | 1.46 | 1.51 | 2.99% | 1.62 | 1.66 | 2.41% | 1.16 | 1.17 | 1.07% |
| **CE7-1.2b** | 1.12 | 1.15 | 2.11% | 1.46 | 1.52 | 3.68% | 1.62 | 1.67 | 2.84% | 1.16 | 1.18 | 1.26% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **LB** | **Max B2B** | | | **TRF of Max B2B** | | | **Avg TRF B2B** | | | **Avg B2B** | | |
| ref | test | inc | ref | test | inc | ref | test | inc | ref | test | inc |
| **CE7-1.1** | 1.13 | 1.16 | 2.64% | 1.53 | 1.59 | 4.08% | 1.98 | 2.02 | 2.03% | 1.21 | 1.22 | 0.93% |
| **CE7-1.2** | 1.13 | 1.15 | 1.84% | 1.53 | 1.57 | 2.99% | 1.98 | 2.01 | 1.52% | 1.21 | 1.22 | 0.70% |
| **CE7-1.2b** | 1.13 | 1.15 | 1.84% | 1.53 | 1.57 | 2.74% | 1.98 | 2.01 | 1.58% | 1.21 | 1.22 | 0.72% |

**Bin-to-bit ratio analysis for CE7-1 and low QP configuration (QP values 2, 7, 12, 17).**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **AI** | **Max B2B** | | | **TRF of Max B2B** | | | **Avg TRF B2B** | | | **Avg B2B** | | |
| ref | test | inc | ref | test | inc | ref | test | inc | ref | test | inc |
| **CE7-1.1** | 0.95 | 0.94 | -1.71% | 1.14 | 1.12 | -1.39% | 1.14 | 1.13 | -1.20% | 0.96 | 0.94 | -1.59% |
| **CE7-1.2** | 0.95 | 0.93 | -2.77% | 1.14 | 1.10 | -2.81% | 1.14 | 1.11 | -2.62% | 0.96 | 0.93 | -2.64% |
| **CE7-1.2b** | 0.95 | 0.94 | -1.47% | 1.14 | 1.12 | -1.14% | 1.14 | 1.13 | -0.95% | 0.96 | 0.95 | -1.35% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **RA** | **Max B2B** | | | **TRF of Max B2B** | | | **Avg TRF B2B** | | | **Avg B2B** | | |
| ref | test | inc | ref | test | inc | ref | test | inc | ref | test | inc |
| **CE7-1.1** | 0.89 | 0.85 | -3.78% | 1.01 | 0.97 | -4.12% | 1.44 | 1.43 | -0.57% | 1.10 | 1.09 | -0.95% |
| **CE7-1.2** | 0.89 | 0.84 | -4.57% | 1.01 | 0.96 | -5.14% | 1.44 | 1.42 | -1.37% | 1.10 | 1.08 | -1.51% |
| **CE7-1.2b** | 0.89 | 0.86 | -2.98% | 1.01 | 0.98 | -3.08% | 1.44 | 1.44 | -0.15% | 1.10 | 1.09 | -0.58% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **LB** | **Max B2B** | | | **TRF of Max B2B** | | | **Avg TRF B2B** | | | **Avg B2B** | | |
| ref | test | inc | ref | test | inc | ref | test | inc | ref | test | inc |
| **CE7-1.1** | 0.93 | 0.91 | -1.86% | 1.09 | 1.07 | -1.61% | 1.49 | 1.49 | 0.33% | 1.12 | 1.11 | -0.27% |
| **CE7-1.2** | 0.93 | 0.91 | -2.88% | 1.09 | 1.06 | -3.11% | 1.49 | 1.48 | -0.50% | 1.12 | 1.11 | -0.82% |
| **CE7-1.2b** | 0.93 | 0.92 | -1.53% | 1.09 | 1.08 | -1.31% | 1.49 | 1.49 | 0.47% | 1.12 | 1.11 | -0.09% |

Category 1 focuses on reducing the worst-case number of context-coded bins. Currently there are at most 2 such bins per coefficient level value. HEVC had 1.56. One aspect is to move the constraint from the CG level to the TB level, which would be similar to what is done for transform skip. Another aspect is to reduce the worst-case number of context coded bins to a point similar to HEVC. The scheme was said not to make any aspect more complicated.

It was commented that CE7-1.1 is the most straightforward in this category. This has a little loss in the low-QP range, but the impact is small (and no loss in the ordinary QP range).

It was asked why this is different for luma and chroma. It was suggested to not have a difference between them, and thus to set the limit for chroma to be the same as luma.

Decision (throughput/worst-case): Adopt CE7-1.1 as in JVET-O0052 with the limit for chroma set the same as for luma.

Category 2 is for joint chroma residual coding for the two chroma channels.

**Average results of CE7-2 for SDR Common Test Conditions (CTC) and low QP (QP values 2, 7, 12, 17).**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 |
| **CE7-2.1** | -0.18% | -0.57% | 0.07% | 100% | 98% | -0.11% | -1.10% | 0.18% | 99% | 101% | 0.08% | -0.67% | 1.07% | 101% | 102% |
| **CE7-2.2** | -0.22% | -0.42% | -0.06% | 102% | 99% | -0.15% | -0.58% | 0.55% | 102% | 101% | 0.10% | 0.41% | 1.60% | 103% | 104% |
| **CE7-2.3** | -0.12% | -0.18% | 0.54% | 102% | 99% | -0.06% | 0.18% | 0.59% | 100% | 100% | -0.02% | 3.44% | 0.83% | 99% | 101% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **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 |
| **CE7-2.1** | -0.05% | -0.14% | 0.10% | 104% | 107% | -0.02% | -0.24% | -0.13% | 104% | 102% | -0.01% | -0.26% | -0.19% | 104% | 101% |
| **CE7-2.2** | -0.18% | 0.00% | -0.04% | 108% | 102% | -0.09% | -0.19% | -0.14% | 106% | 100% | -0.06% | -0.13% | -0.25% | 104% | 100% |
| **CE7-2.3** | -0.19% | 0.20% | 0.13% | 104% | 102% | -0.10% | 0.06% | 0.02% | 101% | 98% | -0.06% | 0.16% | -0.17% | 102% | 102% |

**Average results of CE7-2 for HDR Common Test Conditions.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **AI** |  |  | **wPSNR** | | | **PSNR** | | |  |  |
| DE100 | L100 | Y | Cb | Cr | Y | Cb | Cr | Enc | Dec |
| **CE7-2.1** | -3.05% | -0.05% | -0.06% | -4.26% | 0.75% | -0.07% | -3.33% | 0.42% | 100% | 100% |
| **CE7-2.2** | -2.98% | -0.06% | -0.04% | -3.85% | -0.85% | -0.05% | -2.81% | -0.96% | 103% | 100% |
| **CE7-2.3** | -1.69% | 0.00% | 0.01% | -2.52% | 0.89% | -0.01% | -2.05% | 0.91% | 101% | 103% |
|  |  |  |  |  |  |  |  |  |  |  |
| **RA** |  |  | **wPSNR** | | | **PSNR** | | |  |  |
| DE100 | L100 | Y | Cb | Cr | Y | Cb | Cr | Enc | Dec |
| **CE7-2.1** | -2.58% | -0.01% | -0.03% | -3.98% | 1.52% | -0.06% | -3.06% | 0.64% | 99% | 100% |
| **CE7-2.2** | -2.84% | -0.03% | -0.03% | -3.85% | -0.24% | -0.05% | -2.63% | -0.66% | 101% | 100% |
| **CE7-2.3** | -1.70% | -0.01% | 0.00% | -2.07% | 0.82% | -0.03% | -1.58% | 0.91% | 101% | 104% |

NOTE: For the test CE7-2.3, the HDR results of the crosschecker are listed in the table (the tester haven’t provided the HDR results).

This has three proposals aimed to improve coding gain. The existing version of this provides about 0.29% (luma) benefit for RA.

The CE7-2.1 variant adds a sign flag at the slice level. The CE7-2.2 and CE7-2.3 variants can send two residuals rather than one, using a Hadamard transform to reconstruct the final chroma residuals.

It was remarked that this mode is basically only helpful for intra.

It was remarked that it would be nice to bring up the gain for joint chroma coding, and that CE7-2.1 was the simplest approach to do that.

Decision (to improve the joint chroma mode coding efficiency): Adopt CE7-2.1 from JVET-O0105.

Category 3 is for transform skip residual coding.

**Average results of CE7-3 for 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 |
| **CE7-3.3** | 0.00% | -0.03% | -0.01% | 100% | 100% | -0.01% | -0.05% | -0.07% | 100% | 100% | 0.03% | 0.23% | 0.07% | 100% | 102% |
| **CE7-3.4** | 0.00% | 0.00% | -0.01% | 100% | 100% | 0.01% | -0.05% | -0.04% | 99% | 100% | 0.00% | 0.16% | 0.05% | 100% | 101% |
| **CE7-3.5** | 0.01% | -0.02% | 0.02% | 100% | 100% | -0.01% | -0.04% | -0.08% | 101% | 101% | -0.02% | 0.09% | -0.07% | 101% | 100% |
| **CE7-3.6** | 0.01% | -0.02% | 0.00% | 100% | 100% | 0.00% | -0.05% | -0.05% | 101% | 101% | 0.02% | -0.12% | 0.11% | 100% | 98% |
| **CE7-3.7** | -0.02% | -0.05% | -0.01% | 100% | 100% | -0.03% | -0.05% | -0.13% | 100% | 100% | -0.02% | 0.20% | -0.09% | 100% | 101% |
| **CE7-3.8** | 0.00% | -0.04% | 0.02% | 101% | 100% | 0.00% | 0.01% | -0.08% | 101% | 101% | 0.00% | 0.06% | -0.09% | 100% | 99% |
| **CE7-3.9** | 0.00% | -0.02% | -0.01% | 100% | 100% | 0.00% | -0.03% | -0.03% | 100% | 100% | 0.03% | 0.22% | 0.25% | 100% | 100% |
| **CE7-3.10** | -0.03% | -0.05% | -0.01% | 101% | 100% | -0.01% | -0.02% | -0.06% | 100% | 101% | 0.00% | 0.16% | -0.02% | 101% | 100% |
| **CE7-3.11** | -0.03% | -0.07% | -0.02% | 101% | 100% | -0.01% | -0.01% | -0.08% | 100% | 100% | -0.02% | 0.18% | -0.07% | 101% | 104% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **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 |
| **CE7-3.3** | -0.14% | -0.02% | -0.03% | 100% | 101% | -0.04% | -0.08% | 0.08% | 100% | 102% | -0.11% | 0.00% | -0.19% | 100% | 102% |
| **CE7-3.4** | -0.10% | -0.01% | 0.06% | 100% | 101% | -0.05% | -0.01% | 0.03% | 99% | 101% | -0.07% | 0.20% | 0.01% | 100% | 102% |
| **CE7-3.5** | -0.11% | -0.13% | -0.26% | 100% | 99% | -0.12% | -0.05% | 0.05% | 101% | 103% | 0.02% | 0.20% | -0.51% | 101% | 101% |
| **CE7-3.6** | -0.09% | -0.16% | -0.05% | 101% | 100% | -0.09% | -0.19% | 0.03% | 102% | 105% | 0.04% | -0.34% | 0.05% | 101% | 99% |
| **CE7-3.7** | -0.44% | -0.33% | -0.25% | 101% | 103% | -0.37% | -0.05% | -0.21% | 101% | 100% | -0.30% | -0.37% | -0.38% | 100% | 101% |
| **CE7-3.8** | -0.31% | -0.31% | -0.40% | 102% | 99% | -0.28% | -0.25% | -0.33% | 101% | 100% | -0.23% | -0.31% | -0.87% | 100% | 99% |
| **CE7-3.9** | -0.03% | 0.08% | 0.02% | 101% | 101% | -0.06% | 0.02% | 0.00% | 100% | 100% | -0.07% | 0.05% | -0.05% | 100% | 100% |
| **CE7-3.10** | -0.78% | -0.62% | -0.82% | 102% | 100% | -0.57% | -0.58% | -0.46% | 101% | 100% | -0.41% | -0.55% | -0.95% | 100% | 99% |
| **CE7-3.11** | -0.79% | -0.66% | -0.71% | 102% | 100% | -0.62% | -0.70% | -0.57% | 101% | 99% | -0.46% | -0.35% | -0.86% | 102% | 104% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **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 |
| **CE7-3.3** | -0.14% | -0.07% | -0.06% | 100% | 101% | -0.19% | -0.02% | -0.11% | 99% | 101% | -0.04% | -0.12% | 0.05% | 99% | 101% |
| **CE7-3.4** | -0.13% | -0.07% | -0.06% | 100% | 102% | -0.14% | -0.05% | -0.06% | 99% | 101% | -0.01% | -0.09% | 0.04% | 99% | 100% |
| **CE7-3.5** | -0.42% | -0.45% | -0.44% | 101% | 100% | -0.20% | -0.23% | -0.27% | 101% | 100% | -0.10% | -0.16% | -0.20% | 102% | 102% |
| **CE7-3.6** | -0.12% | -0.23% | -0.20% | 100% | 98% | 0.01% | -0.02% | -0.08% | 102% | 100% | 0.12% | 0.09% | 0.10% | 100% | 98% |
| **CE7-3.7** | -0.54% | -0.43% | -0.46% | 101% | 100% | -0.46% | -0.32% | -0.42% | 101% | 101% | -0.30% | -0.44% | -0.29% | 100% | 100% |
| **CE7-3.8** | -0.62% | -0.62% | -0.65% | 104% | 99% | -0.52% | -0.44% | -0.58% | 103% | 100% | -0.24% | -0.41% | -0.39% | 103% | 101% |
| **CE7-3.9** | -0.07% | -0.06% | -0.07% | 100% | 100% | -0.09% | -0.03% | -0.13% | 100% | 100% | 0.00% | -0.06% | 0.01% | 101% | 103% |
| **CE7-3.10** | -1.23% | -1.13% | -1.15% | 104% | 99% | -0.89% | -0.83% | -0.93% | 103% | 98% | -0.57% | -0.79% | -0.71% | 104% | 100% |
| **CE7-3.11** | -1.30% | -1.24% | -1.20% | 104% | 99% | -0.92% | -0.78% | -0.87% | 102% | 98% | -0.67% | -0.76% | -0.83% | 104% | 104% |

**Average results of CE7-3 for low QP configuration (QP values 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 |
| **CE7-3.3** | 0.00% | 0.01% | 0.01% | 100% | 100% | 0.00% | -0.01% | 0.00% | 100% | 103% | 0.00% | 0.00% | -0.03% | 100% | 99% |
| **CE7-3.4** | 0.00% | 0.01% | 0.00% | 100% | 100% | 0.00% | 0.01% | 0.01% | 100% | 100% | 0.00% | 0.02% | -0.03% | 100% | 100% |
| **CE7-3.5** | 0.00% | -0.01% | 0.00% | 100% | 100% | 0.00% | -0.01% | -0.01% | 100% | 100% | 0.00% | 0.01% | -0.03% | 100% | 100% |
| **CE7-3.6** | 0.01% | 0.00% | 0.00% | 100% | 100% | 0.00% | -0.01% | 0.00% | 100% | 100% | 0.00% | 0.01% | -0.01% | 100% | 99% |
| **CE7-3.7** | -0.01% | 0.00% | 0.00% | 100% | 100% | -0.01% | 0.00% | 0.02% | 100% | 101% | -0.02% | -0.01% | -0.03% | 102% | 104% |
| **CE7-3.8** | 0.02% | 0.01% | 0.01% | 101% | 100% | 0.02% | 0.00% | 0.04% | 101% | 102% | 0.02% | 0.00% | -0.02% | 102% | 102% |
| **CE7-3.9** | 0.00% | 0.00% | 0.00% | 100% | 100% | 0.00% | -0.01% | -0.01% | 100% | 100% | -0.01% | 0.01% | -0.04% | 100% | 102% |
| **CE7-3.10** | 0.01% | 0.01% | 0.01% | 102% | 101% | 0.02% | 0.00% | 0.02% | 101% | 101% | 0.01% | 0.01% | -0.02% | 102% | 103% |
| **CE7-3.11** | 0.01% | 0.01% | 0.01% | 101% | 100% | 0.02% | 0.00% | 0.01% | 101% | 101% | 0.01% | 0.00% | -0.03% | 101% | 100% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **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 |
| **CE7-3.3** | -0.01% | -0.05% | -0.05% | 101% | 101% | -0.12% | 0.01% | -0.02% | 100% | 103% | 0.08% | 0.16% | 0.17% | 101% | 102% |
| **CE7-3.4** | -0.02% | -0.01% | -0.06% | 101% | 102% | -0.19% | 0.02% | -0.06% | 101% | 103% | 0.01% | 0.06% | 0.12% | 102% | 102% |
| **CE7-3.5** | 0.17% | 0.11% | 0.08% | 100% | 100% | 0.33% | 0.11% | 0.10% | 100% | 100% | 0.09% | 0.00% | 0.04% | 100% | 100% |
| **CE7-3.6** | 0.10% | 0.03% | 0.02% | 100% | 100% | 0.28% | 0.18% | 0.13% | 100% | 99% | 0.21% | 0.14% | 0.21% | 100% | 100% |
| **CE7-3.7** | -0.14% | -0.12% | -0.15% | 100% | 99% | -0.66% | -0.15% | -0.09% | 100% | 100% | -0.12% | -0.10% | -0.05% | 100% | 100% |
| **CE7-3.8** | -0.13% | -0.21% | -0.24% | 103% | 103% | 0.08% | -0.09% | -0.15% | 102% | 101% | 0.03% | -0.15% | -0.10% | 102% | 103% |
| **CE7-3.9** | -0.10% | -0.16% | -0.09% | 100% | 100% | -0.12% | -0.07% | -0.13% | 100% | 101% | -0.04% | 0.00% | -0.05% | 100% | 100% |
| **CE7-3.10** | -0.26% | -0.38% | -0.38% | 103% | 100% | -0.56% | -0.23% | -0.34% | 102% | 99% | -0.22% | -0.13% | -0.26% | 103% | 103% |
| **CE7-3.11** | -0.39% | -0.43% | -0.47% | 103% | 102% | -0.92% | -0.30% | -0.33% | 101% | 100% | -0.30% | -0.35% | -0.37% | 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 |
| **CE7-3.3** | -0.12% | -0.07% | -0.06% | 100% | 101% | -5.53% | -0.05% | -0.05% | 100% | 101% | -0.32% | -0.11% | -0.19% | 100% | 100% |
| **CE7-3.4** | -0.08% | -0.07% | -0.06% | 100% | 102% | 1.14% | -0.15% | -0.12% | 100% | 101% | -0.30% | 0.03% | 0.00% | 99% | 101% |
| **CE7-3.5** | 0.42% | 0.19% | 0.20% | 101% | 100% | -23.69% | 0.22% | 0.22% | 101% | 100% | 0.37% | 0.37% | 0.33% | 101% | 101% |
| **CE7-3.6** | 0.36% | 0.13% | 0.12% | 101% | 99% | -5.40% | 0.06% | 0.08% | 101% | 98% | 0.03% | 0.15% | 0.08% | 100% | 98% |
| **CE7-3.7** | -0.38% | -0.30% | -0.30% | 101% | 101% | -15.55% | -0.17% | -0.16% | 100% | 98% | -0.63% | -0.33% | -0.31% | 100% | 101% |
| **CE7-3.8** | -1.22% | -0.89% | -0.93% | 104% | 97% | -1.53% | -0.81% | -0.85% | 103% | 100% | -1.00% | -0.64% | -0.71% | 105% | 101% |
| **CE7-3.9** | -0.37% | -0.29% | -0.29% | 100% | 102% | -0.81% | -0.37% | -0.35% | 101% | 101% | -0.92% | -0.39% | -0.41% | 100% | 101% |
| **CE7-3.10** | -1.63% | -1.27% | -1.28% | 105% | 99% | -1.07% | -1.19% | -1.21% | 103% | 99% | -1.19% | -0.95% | -1.03% | 104% | 102% |
| **CE7-3.11** | -1.94% | -1.55% | -1.57% | 105% | 100% | -1.74% | -1.44% | -1.45% | 103% | 99% | -1.50% | -1.19% | -1.30% | 103% | 101% |

Since this is for transform skip, the coding efficiency differences are basically only for class F and TGM.

It was remarked that the design has an issue at very low QP, when the quantization step size becomes smaller than 1.

It was suggested that CE7-3.10 (a combination of CE7-3.7 and CE7-3.8) is promising. It was said to be simple and provide coding gain.

A participant remarked in favour of CE7-3.9 (or CE7-3.11, which includes that) as a cleaner approach, to avoid having different ways of scanning bins – always using bit plane scanning. Others said it would be more conservative to just take CE7-3.10 and do further study, considering the number of scanning loops.

Decision (coding efficiency for SCC): Adopt CE7-3.10 of JVET-O0122.

Category 4 is a modification for coding the CBF.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CE7-4.1** | **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 |
| **CTC** | 0.01% | -0.05% | -0.01% | 100% | 100% | 0.01% | -0.08% | 0.00% | 100% | 100% | 0.00% | 0.04% | 0.17% | 100% | 99% |
| **lowQP** | 0.00% | -0.01% | 0.01% | 100% | 100% | 0.00% | -0.01% | 0.00% | 100% | 100% | -0.01% | 0.01% | -0.02% | 100% | 100% |

The motivation of this is to reduce the number of contexts.

It was commented that we should not focus on removing contexts at this time, so no action was taken on this at this time.

[JVET-O0052](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6656) CE7-1: TB-level constraints on context-coded bins for coefficient coding [T.-D. Chuang, C.-Y. Chen, S.-T. Hsiang, Y.-W. Huang, S.-M. Lei (MediaTek), M. Coban, M. Karczewicz (Qualcomm)]

[JVET-O0089](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6693) CE7-3.3/4: Context Modelling of sign for TS residual coding [T. Nguyen, B. Bross, H. Schwarz., D. Marpe, T. Wiegand (HHI)]

[JVET-O0104](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6708) CE7: Modified limitation on context coded bins for residual coding of Transform Skip mode (CE7-3.5 and CE7-3.6) [X. Zhao, X. Li, X. Xu, S. Liu (Tencent)]

[JVET-O0105](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6709) CE7: Joint chroma residual coding with multiple modes (tests CE7-2.1, CE7-2.2) [C. Helmrich, H. Schwarz, T. Nguyen, C. Rudat, D. Marpe, T. Wiegand (Fraunhofer HHI), B. Ray, G. Van der Auwera, A. K. Ramasubramonian, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-O0110](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6714) CE7-4.1: Simplification of cbf coding [Y.-W. Chen, X. Xiu, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-O0115](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6719) CE7-2.3: Joint coding of chroma residuals [B. Ray, G. Van der Auwera, A. K. Ramasubramonian, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-O0122](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6726) CE7: Sign context, level mapping, and bitplane coding for TS residual coding (CE7-3.7, CE7-3.8, CE7-3.9, CE7-3.10, and CE7-3.11) [M. Karczewicz, H. Wang, M. Coban, Y.-H. Chao, Y. Han (Qualcomm)]

[JVET-O0692](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7312) Crosscheck of JVET-O0122: CE7-3.9 + parity plane change [T. Nguyen (HHI)]

## CE8: Screen content coding tools (16)

Contributions in this category were discussed Thursday 4 July 1140–1330 and 1430-1800 in Track B (chaired by JRO).

[JVET-O0028](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7052) CE8: Summary Report on 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 screen content coding tools. 20 tests have been tested in CE8 in between JVET-N and JVET-O meetings, to study and evaluate technologies related to screen content coding. In this report, coding performance and complexity of these tests are reported and analyzed. In particular, test results against VTM-5.0 anchors (CTC 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 or 444 testing conditions. Crosschecking results for the performed tests are integrated in this contribution.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test** | **Tester** | **Document** | **Tool description** | **Cross checker** |
| CE8-1.1 | S.-T. Hsiang (MediaTek) | JVET-O0053 | Coding BVDs and MVDs | J. Li  (Panasonic) |
| CE8-1.2a | M. Salehifar (LGE) | JVET-O0114 | MVD coding with 3 additional context coded bins | Y. Han  (Qualcomm) |
| CE8-1.2b | M. Salehifar (LGE) | JVET-O0114 | MVD coding with 1 additional context coded bin | Y. Han  (Qualcomm) |
| CE8-1.3a | J. Nam  (LGE) | JVET-O0093 | Context modelling and binarization process for BVD coding | Y. Sun  (Hikvision) |
| CE8-1.3b | J. Nam  (LGE) | JVET-O0093 | Context modeling and binarization process for both BVD and MVD coding | Y. Sun  (Hikvision) |
| CE8-1.4 | J. Li  (Panasonic)  Y. Han  (Qualcomm)  H. Jang  (LGE) | JVET-O0117 | Default IBC mode in case of invalid vector | Y.-W. Chen  (Kwai) |
| CE8-1.5a | J. Li  (Panasonic)  Y. Han  (Qualcomm)  H. Jang  (LGE) | JVET-O0117 | CE8-1.4 + CU based Chroma BV | Y.-W. Chen  (Kwai) |
| CE8-1.5b | J. Li  (Panasonic)  Y. Han  (Qualcomm)  H. Jang  (LGE)H. Jang  (LGE) | JVET-O0117 | CE8-1.4  + Subblock based Chroma BV with default BV | Y.-W. Chen  (Kwai) |
| CE8-1.6b | J. Xu  (ByteDance) | JVET-O0073 | Dedicated IBC buffer with 96x128 in 8-bit precision | X. Xu  (Tencent) |
| CE8-1.6c | J. Xu  (ByteDance) | JVET-O0073 | Dedicated IBC buffer with 96x128 in 10-bit precision | X. Xu  (Tencent) |
| CE8-1.7 | L. Zhang  (ByteDance)  X. Li  (Tencent)  S. H. Wang (PKU) | JVET-O0078 | Single HMVP table for all CUs inside the shared merge list region for IBC | C.-C. Chen  (MediaTek) |
| CE8-2.1 | Y.-H. Chao  (Qualcomm)  Y.-C. Sun  (Alibaba)  W. Zhu  (ByteDance) | JVET-O0119 | Palette mode in HEVC SCC + palette flag signaling improvement | J. Lai (MediaTek) |
| CE8-2.2 | Y.-C. Sun  (Alibaba) | JVET-O0059 | Palette mode and with neighboring pixel copy | W. Zhu  (ByteDance) |
| CE8-2.3 | W. Zhu  (ByteDance) | JVET-O0071 | Palette PLT mode and IBC combination | Y.-C. Sun  (Alibaba) |
| CE8-2.4 | Y.-H. Chao  (Qualcomm) | JVET-O0120 | Line-based CG Palette mode | Y.-C. Sun  (Alibaba) |
| CE8-2.5 | Y.-C. Sun  (Alibaba)  W. Zhu  (ByteDance) | JVET-O0072 | Combination test of CE8-2.2 and CE8-2.3 | C.-H. Hung (Qualcomm) |
| CE8-3.1a | Santiago de Luxán (HHI)  T.-C. Ma (Kwai Inc.) | JVET-O0097 | Enable TS for ISP TUs at the TU level | Y.-H. Chao (Qualcomm) |
| CE8-3.2 | T. Tsukuba, Y. Yagasaki (Sony) | JVET-O0081 | Chroma TS support | T. Nguyen (HHI) |
| CE8-4.2 | Y.-H. Chao (Qualcomm) | JVET-O0121 | Dual tree disabled for YUV4:4:4 format | W. Zhu  (ByteDance) |
|  |  |  |  |  |

Table 3: CE8 test results with VTM-5.0 CTC

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **AI Over VTM-5.0** | | | | | **RA Over VTM-5.0** | | | | |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| CTC | VTM+IBC | -0.62% | -0.62% | -0.65% | 146% | 100% | 0.01% | -0.32% | -0.25% | 107% | 100% |
| CE8-1.1 | -0.67% | -0.69% | -0.69% | 149% | 100% | -0.04% | -0.28% | -0.35% | 107% | 98% |
| CE8-1.2a | -0.64% | -0.64% | -0.68% | 148% | 103% | -0.01% | -0.31% | -0.23% | 108% | 103% |
| CE8-1.2b | -0.64% | -0.62% | -0.67% | 148% | 103% | 0.00% | -0.23% | -0.28% | 108% | 103% |
| CE8-1.3a | -0.64% | -0.63% | -0.67% | 147% | 98% | 0.01% | -0.24% | -0.22% | 106% | 100% |
| CE8-1.3b | -0.64% | -0.63% | -0.67% | 147% | 98% | 0.17% | -0.18% | -0.07% | 105% | 100% |
| CE8-1.4 | -0.62% | -0.62% | -0.65% | 149% | 99% | 0.01% | -0.32% | -0.25% | 107.00% | 99% |
| CE8-1.5a | -0.64% | -0.68% | -0.73% | 150% | 99% | 0.00% | -0.38% | -0.29% | 107% | 99% |
| CE8-1.5b | -0.64% | -0.67% | -0.70% | 150% | 99% | 0.00% | -0.31% | -0.28% | 106% | 99% |
| CE8-1.6b | -0.56% | -0.57% | -0.57% | 151% | 100% | 0.03% | -0.24% | -0.21% | 109% | 100% |
| CE8-1.6c | -0.57% | -0.57% | -0.60% | 151% | 98% | 0.03% | -0.25% | -0.21% | 109% | 99% |
| CE8-1.7 | -0.62% | -0.59% | -0.64% | 144% | 99% | 0.01% | -0.28% | -0.18% | 105% | 89% |
| CE8-2.1 | 0.04% | 0.03% | 0.02% | 108% | 105% | 0.03% | -0.06% | -0.08% | 102% | 102% |
| CE8-2.2 | 0.04% | 0.03% | 0.03% | 110% | 108% | 0.03% | 0.00% | -0.06% | 101% | 101% |
| CE8-2.3 | 0.04% | 0.03% | 0.04% | 107% | 100% | 0.03% | -0.02% | -0.06% | 103% | 98% |
| CE8-2.4 | 0.04% | 0.03% | 0.01% | 112% | 103% | 0.03% | -0.06% | -0.09% | 101% | 101% |
| CE8-2.5 | 0.04% | 0.03% | 0.02% | 107% | 99% | 0.03% | -0.02% | -0.05% | 103% | 97% |
| CE8-3.1a | 0.00% | 0.00% | 0.02% | 100% | 100% | -0.02% | -0.05% | -0.05% | 100% | 100% |
| CE8-3.2 | 0.02% | 0.04% | 0.02% | 101% | 100% | 0.03% | -0.01% | 0.15% | 102% | 100% |
| CE8-4.2 |  |  |  |  |  |  |  |  |  |  |
| Class F | CE8-1.1 | -0.50% | -0.29% | -0.41% | 101% | 100% | -0.40% | -0.31% | -0.25% | 101% | 99% |
| CE8-1.2a | -0.31% | -0.37% | -0.30% | 102% | 107% | -0.26% | -0.35% | -0.09% | 101% | 104% |
| CE8-1.2b | -0.24% | -0.27% | -0.21% | 102% | 106% | -0.20% | -0.17% | -0.10% | 101% | 105% |
| CE8-1.3a | -0.34% | -0.24% | -0.28% | 101% | 97% | -0.30% | -0.17% | -0.13% | 101% | 102% |
| CE8-1.3b | -0.34% | -0.24% | -0.28% | 101% | 97% | -0.16% | -0.15% | -0.04% | 100% | 101% |
| CE8-1.4 | 0.00% | 0.00% | 0.00% | 99% | 99% | 0.00% | 0.00% | 0.00% | 98% | 97% |
| CE8-1.5a | -0.04% | -0.07% | -0.06% | 101% | 99% | 0.00% | -0.10% | -0.02% | 98% | 97% |
| CE8-1.5b | -0.06% | -0.13% | -0.14% | 101% | 98% | -0.08% | -0.09% | -0.07% | 98% | 97% |
| CE8-1.6b | 0.14% | 0.16% | 0.21% | 102% | 101% | 0.13% | 0.15% | 0.27% | 101% | 99% |
| CE8-1.6c | 0.13% | 0.07% | 0.08% | 102% | 98% | 0.11% | 0.16% | 0.12% | 101% | 98% |
| CE8-1.7 | 0.00% | 0.01% | 0.08% | 100% | 99% | 0.00% | 0.08% | 0.09% | 94% | 83% |
| CE8-2.1 | -0.72% | -0.56% | -0.83% | 107% | 108% | -0.55% | -0.83% | -0.77% | 107% | 107% |
| CE8-2.2 | -0.75% | -0.76% | -0.75% | 109% | 107% | -0.67% | -0.89% | -0.87% | 104% | 102% |
| CE8-2.3 | -0.76% | -0.63% | -0.75% | 106% | 101% | -0.60% | -0.79% | -0.74% | 105% | 99% |
| CE8-2.4 | -0.81% | -0.73% | -0.94% | 109% | 107% | -0.65% | -1.01% | -0.76% | 111% | 107% |
| CE8-2.5 | -0.78% | -0.76% | -0.82% | 106% | 101% | -0.72% | -0.91% | -0.83% | 106% | 98% |
| CE8-3.1a | 0.02% | 0.05% | -0.05% | 101% | 99% | -0.01% | 0.12% | 0.10% | 100% | 101% |
| CE8-3.2 | 0.02% | -0.10% | -0.09% | 101% | 100% | 0.05% | -0.09% | -0.11% | 102% | 100% |
| CE8-4.2 |  |  |  |  |  |  |  |  |  |  |
| SCC TGM | CE8-1.1 | -1.19% | -1.07% | -1.06% | 100% | 102% | -1.14% | -0.89% | -0.94% | 100% | 100% |
| CE8-1.2a | -0.81% | -0.79% | -0.77% | 101% | 105% | -0.82% | -0.74% | -0.75% | 101% | 106% |
| CE8-1.2b | -0.67% | -0.61% | -0.63% | 102% | 105% | -0.59% | -0.60% | -0.63% | 102% | 106% |
| CE8-1.3a | -0.83% | -0.82% | -0.83% | 99% | 99% | -0.46% | -0.38% | -0.40% | 100% | 100% |
| CE8-1.3b | -0.83% | -0.82% | -0.83% | 99% | 99% | -0.38% | -0.38% | -0.41% | 100% | 101% |
| CE8-1.4 | 0.00% | 0.00% | 0.00% | 99% | 99% | 0.00% | 0.00% | 0.00% | 98% | 98% |
| CE8-1.5a | -0.16% | -0.21% | -0.19% | 98% | 99% | 0.01% | -0.06% | -0.11% | 98% | 97% |
| CE8-1.5b | -0.33% | -0.43% | -0.47% | 99% | 98% | -0.14% | -0.20% | -0.27% | 98% | 97% |
| CE8-1.6b | 0.68% | 0.71% | 0.71% | 101% | 101% | 0.47% | 0.44% | 0.43% | 103% | 101% |
| CE8-1.6c | 0.52% | 0.54% | 0.53% | 101% | 100% | 0.25% | 0.25% | 0.23% | 102% | 102% |
| CE8-1.7 | -0.02% | -0.01% | -0.01% | 100% | 101% | -0.07% | -0.03% | -0.08% | 100% | 101% |
| CE8-2.1 | -4.29% | -4.53% | -3.89% | 102% | 102% | -1.71% | -2.54% | -2.15% | 102% | 102% |
| CE8-2.2 | -5.02% | -4.95% | -4.32% | 103% | 96% | -2.02% | -2.78% | -2.43% | 102% | 101% |
| CE8-2.3 | -4.65% | -4.69% | -4.04% | 101% | 98% | -1.84% | -2.56% | -2.20% | 101% | 98% |
| CE8-2.4 | -4.35% | -4.70% | -4.04% | 104% | 99% | -1.60% | -2.46% | -2.04% | 104% | 101% |
| CE8-2.5 | -5.29% | -5.12% | -4.47% | 103% | 97% | -2.13% | -2.80% | -2.45% | 102% | 98% |
| CE8-3.1a | -0.02% | 0.02% | 0.03% | 102% | 102% | -0.04% | 0.01% | -0.09% | 100% | 100% |
| CE8-3.2 | 0.02% | -0.57% | -0.85% | 102% | 101% | -0.03% | -0.72% | -0.98% | 103% | 99% |
| CE8-4.2 |  |  |  |  |  |  |  |  |  |  |

CE8-1.1 … CE8-1.3 target improving the BV and MV coding for screen content. This is achieved by increasing the number of context coded bins and modifying contexts. Whereas CE8-1.1 suggests doing this in a switchable way (depending on enabling IBC), CE8-1.2 and CE8-1.3 would also use this in regular MV coding. Generally, for CTC the methods are no giving benefit.

The question is raised if same coding for MV and BV is still necessary. Why should MV coding become more complicated than necessary just for the purpose of “harmonization”? It is likely that due to the different role of IBC also the BV coding could be improved if it is done different from MV coding (to show this, was exactly the purpose of this CE). In a perfect world, BV coding could even be simpler than MV coding without losing performance or even gaining. The current proposals make it more complicated (by increasing number of context coded bins), where the results show gain for classes F and TGM – compared to the gain that IBC itself gives (e.g. 35% for TGM in AI), the modified BV coding gives relatively low gain (1.2%). Proponents are asked to provide additional results where the modified coding is only applied for BV, not for MV. The current results are not showing how much of the gain in RA is due to also modifying the MV coding (as modifying the MV coding without benefit for regular content or switching it would be undesirable). Even then, it is still to be decided if the gain (0.5% for class F AI 1.2% for TGM) would justify 3 additional context coded bins per BV. Revisit.

CE8-1.4 proposes to make a validity check of the BV at the decoder. This would put an additional burden on decoder manufacturers as a kind of “normative concealment” (except very simple checks such as clipping). E.g. complicated checks such as BV availability depending on scan order are undesirable, whereas simple range checks and subsequent conversion as clipping are probably appropriate. It would require additional conformance test (with “invalid” BVs) to check if a decoder performs these checks, which would to be generated by JVET as part of the confromance package. Decoder manufacturers are free to implement such checks, they might also want to combine it with other concealment mechanisms. No action here, leave it as is (with bitstream/encoder constraint). This is agreed in spirit and should be used as a guideline also in the review of CE related proposals.

It is also pointed out that the VTM SW IBC encoder implementation may produce invalid BV for chroma in the dual-tree case. JVET-O0706 mentions this issue, proponents are asked to submit a bug report to make SW coordinators aware.

CE8-1.5 is based on 8-1.4. This method in its current implementation benefits from turning off the encoder restriction (as done in 8-1.4) and therefore getting better suitable BV for chroma in the dual tree case. The gain is relatively low, and might even be lower without 8-1.4. No action.

CE8-1.6b/c is targeting a more regular structure of the local memory with the goal of simplifying availability check. CE8-1.b reduces the bit depth to 8, and therefore reduces the dedicated memory for IBC by 20% compared to VTM5. Both 8-1.6b and c come with some loss (0.7%/0.5% for TGM) Additional results are given for b in low QP range, which has slightly more loss.

There is a CE related proposal (JVET-O0074) related to case b, which uses 8 bit precision and a memory size of 120x128, which is equal to the current memory size and comes with some gain.

It is suggested that the complexity impact in terms of the management of the local buffer is studied in more detail. Even though the availability check becomes simpler, the memory read/write processes need some additional operations compared to VTM5, where the 64x64 regions are aligned with the VPDU boundaries. Furthermore, the conversion from 10 bit to 8 bit requires some additional effort.

It is agreed that further reduction of the dedicated memory is not needed.

No action on 8-1.6 methods.

CE8-1.7 simplifies the HMVP process for the case of the BVs of IBC, by using only one buffer. It comes with no loss (neither in CTC+IBC, nor for screen content), and also simplifies the spec text.

Decision: Adopt JVET-O0078, Single HMVP table for all CUs inside the shared merge list region for IBC. Revisit: Matching of text and SW to be confirmed by crosscheckers.

8-2: Palette related proposals:

CE8-2.1 is the basic palette (similar as HEVC, with modifications for dual-tree plus CU-level signalling modification) – giving 4.3% for TGM in AI (0.7% for class F)

CE8-2.2 uses the neighbored sample across CU boundary with special palette index, adds another 0.7% on top of base configuration (<0.1% for class F)

CE8-2.3 has a special palette index to use the colocated sample from an IBC predictor, adds another 0.4% on top of base configuration (<0.1% for class F). The gain appears rather small, and it introduces some more operations in addressing the IBC samples.

CE8-2.4 is line-based palette which allows parsing/reconstruction line by line instead of the entire CU as in HEVC (which is due to the grouping of index and escape). No loss. It is noted that the grouping was introduced in HEVC for better CABAC throughput, which is not as severe anymore. On the other hand, as VVC has larger CUs, the issue of saving local memory is more important.

CE8-2.5 combines 2.2 and 2.3, giving a total of 1% for TGM (gains are almost additive) (<0.1% for class F)

Additional results are reported for 4:4:4 YUV materials. For natural video, palette has no benefit. For dual-tree case, the results of TGM1080 are slightly higher than 4:2:0 (6.5% for base configuration, with similar additional gains as above). Higher gains are reported for TGM1080 class in case of single-tree configuration (HEVC palette plus CU level signalling modification). Results are -16.4% for CE8-2.1, -17.8% for CE8-2.2, 17.4% for CE8-2.3, and no loss for CE8-2.4. CE8-2.5 again shows that gains of 8-2.2 and 8-2.3 are almost additive. These gains are relative to dual-tree-off without palette (which by itself already gives 6.2% compared to dual tree).

It is noted that the gain is much lower (slightly more than 4% for the base conf.) for the TGM720 4:4:4 class, and the additional elements of CE8-2.2/3 provide almost no additional gain. It is however noted that these are extremely simple sequences.

Preliminary conclusion:

* Palette mode shows interesting gain for 4:4:4 (tested so far with YUV), and here it provides in particular more gain for the single-tree case, which is likely due to less overhead and ability to utilize the redundancy between the components in a single palette
* For 4:2:0, the gain is not large enough (even with the additional tools of CE8-2.2/3/5) to justify a complete different sample coding at CU level. It is noted that the gain of the baseline has even become lower in VTM5.
* Investigation of palette on 4:2:0 should be discontinued in CE
* It is suggested to include a palette mode in VVC, which shall only be invoked for coding of 4:4:4 content. This should be the well-understood “base palette mode” from CE8-2.1, which can be used for both single tree and dual tree cases. Further investigation should be performed in CE to verify the gains with more 4:4:4 material, and further study improvements or simplifications. There is no need to stick to the HEVC palette method.

Revisit: Further discussion in the plenary and potentially follow up (w.r.t. profiling specific support for different chroma sampling formats with parent bodies).

CE8-3.1a enables transform skip for TUs that exist due to ISP. This had previously been reported to give gain of around 0.4% for TGM, which is now no longer the case (no gain / no loss). It is argued that this could also be seen as a simplification, as the current syntax at TU level has an exception that the TS flag is not parsed in case of ISP. However, for SBT still this exception would be there, and furthermore the encoding runtime is increased, as otherwise the additional signalling of the flag causes loss. No action.

CE8-3.2 introduces TS for chroma. It is shown to have benefit at low QP. However, it is mentioned that there may be a problem with the interpretation of the results, as for QP less than 4 and 8 bit video (as in the TGM class) already the lossless coding is reached for TS blocks. This may result in a saturation of quality at the highest and second highest rate point. As QP 2 is used here as lowest QP, this effect is likely present. Proponents are asked to provide BD results for the range of QP 7, 12, 17, 22 which is still fairly low, to get an understanding for the true benefit at high rates. Revisit.

CE8-4.2 is disabling dual tree for the case of 4:4:4 content, which gives 6.2% rate reduction for TGM, and still 1.7% for mixed content, but loss for natural video (in AI). This information is interesting to see that 4:4:4 screen content coding benefits from using single tree. Pure encoder choice, no action necessary (except that experimentation with 4:4:4 screen content and mixed content should use single tree.

The CE8 related proposals to be further discussed in BoG (X. Xu) after an initial review and identification of issues in track B.

[JVET-O0053](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6657) CE8-1.1: Unified MVD coding for inter and IBC [S.-T. Hsiang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0989](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7625) Crosscheck of JVET-O0053 (CE8-1.1: Unified MVD coding for inter and IBC) [J. Li (Panasonic)]

[JVET-O0059](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6663) CE8: Palette mode with neighboring pixel copy (CE8-2.2) [Y.-C. Sun, T.-S. Chang, J. Lou (Alibaba)]

[JVET-O0071](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6675) CE8-2.3: Compound Palette Mode [W. Zhu, J. Xu, L. Zhang, K. Zhang, H. Liu, Y. Wang (Bytedance)]

[JVET-O0072](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6676) CE8-2.5: Combined test of CE8-2.2 and CE8-2.3 [W. Zhu, J. Xu, L. Zhang, K. Zhang, H. Liu (Bytedance), Y.-C. Sun, T.-S. Chang, J. Lou (Alibaba)]

[JVET-O0073](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6677) CE8-1.6: Dedicated IBC Buffer [J. Xu, L. Zhang, K. Zhang, H. Liu, Y. Wang (Bytedance)]

[JVET-O0074](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6678) CE8-1.6-related: IBC Dedicated Buffer with 120x128 8-bit Setting [J. Xu, L. Zhang, K. Zhang, H. Liu, Y. Wang (Bytedance)]

[JVET-O0078](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6682) CE8-1.7: Single HMVP table for all CUs inside the shared merge list region for IBC [S.H. Wang (PKU), X. Zheng (DJI), S.S. Wang, S.W. Ma (PKU), L. Zhang, K. Zhang, H. Liu, J. Xu, Y. Wang (Bytedance), X. Xu, X. Li, G. Li, S. Liu (Tencent)]

[JVET-O0081](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6685) CE8-3.2: Chroma Transform Skip [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

[JVET-O0093](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6697) CE8-1.3: BVD coding method [J. Nam, H. Jang, J. Choi, J. Heo, J. Lim, S. Kim (LGE)]

[JVET-O0097](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6701) CE8-3.1: Enable Transform Skip in CUs using ISP [S. De-Luxán-Hernández, T. Nguyen, B. Bross, H. Schwarz, D. Marpe, T. Wiegand (HHI), T.-C. Ma, X.-Y. Xiu, Y.-W. Chen, X. Wang (Kwai)]

[JVET-O0114](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6718) CE8: Unified MVD and Block Vector Difference Coding (CE8-1.2) [M. Salehifar, S. Paluri, S. Kim (LGE)]

[JVET-O0117](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6721) CE8-1.4 and CE8-1.5: Default Processing for IBC Mode [Y. Han, W.-J. Chien, M. Karczewicz (Qualcomm), J. Li, C. Lim (Panasonic), H. Jang, J. Nam, J. Lim (LGE)]

[JVET-O0119](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6723) CE8-2.1: Palette mode in HEVC [Y.-H. Chao, C.-H. Hung, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm), Y.-C. Sun, T.-S. Chang, J. Lou (Alibaba), W. Zhu, L. Zhang, J. Xu, K. Zhang, H. Liu (Bytedance)]

[JVET-O0120](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6724) CE8-2.4: Line-based CG Palette Mode [Y.-H. Chao, C.-H. Hung, W.-J. Chien, T. Hsieh, M. Karczewicz (Qualcomm)]

[JVET-O0121](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6725) CE8-4.2: Dual tree disabled for YUV4:4:4 format [Y.-H. Chao, C.-H. Hung, H. Wang, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm)]

## CE9: Decoder motion vector derivation (7)

Contributions in this category were discussed Thursday 4 July 1800–1915 in Track B (chaired by JRO).

[JVET-O0029](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7161) CE9: Summary report on decoder motion vector derivation [S. Esenlik, X. Xiu]

The tools in the scope of this CE include bi-directional optical flow (BDOF) and decoder motion vector refinement (DMVR).

The core experiment summary report is organized into 2 sub-tests as follows:

* CE9-1: BDOF early termination (5 tests)
* CE9-2: DMVR/BDOF enabling conditions (4 tests)

This report summarises the status of each experiment. Crosscheck results are integrated in the report.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Description** | **Y** | **U** | **V** | **EncT** | **DecT** | **Doc#** |
| CE9-1.1 | Use integer-distance DMVR cost to disable BDOF with threshold equal to 4x4 level TH/32 (only keep BDOF early termination when DMVR is disabled) | -0.02% | 0.00% | -0.02% | 100% | 98% | [JVET-O0054](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6658) |
| CE9-1.2 | Use integer-distance DMVR cost to disable BDOF with threshold equal to 4x4 level TH/32 and disable BDOF early termination in all cases. | -0.02% | 0.00% | -0.02% | 100% | 100% | [JVET-O0055](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6659) |
| CE9-1.3 | withdrawn | | | | | | |
| CE9-1.4 | Difference from CE9-1.2 is only threshold value.  BDOF early termination by using the min SAD in DMVR first SAD stage or in integer search stage | 0.01% | -0.05% | -0.03% | 100% | 98% | [JVET-O0055](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6659) |
| CE9-1.5a | Disabling application of BDOF based on best cost computed or derived in DMVR, when both DMVR and BDOF are applied.  Use only best SAD cost obtained from integer distance refinement positions.  When only BDOF is applied, VTM5 16x16 early termination is applied.  Threshold used is same as that will be used in VTM5 for 16x16  4x4 early termination check is disabled for all cases | -0.01% | 0.01% | -0.02% | 100% | 100% | [JVET-O0096](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6700) |
| CE9-1.5b | Use a derived best cost from parametric error surface when applicable. Otherwise, same as (CE9-1.5a). | -0.02% | 0.02% | -0.02% | 100% | 100% | [JVET-O0096](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6700) |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **the SAD calculated in DMVR used to disable BDOF** | **Threshold** | **SAD comp. for Early Termination of BDOF, when DMVR is enabled** | **Early Termination of BDOF, when DMVR is disabled** |
| CE9-1.1 | integer-distance SAD | BDOF 4x4Level TH | None / reuse DMVR | Subblock level, 4x4 level |
| CE9-1.2 | integer-distance SAD | BDOF 4x4Level TH | None / reuse DMVR | Disable |
| CE9-1.3 | integer-distance SAD | 4\*W\*(H>>1) for center position, otherwise 8\*W\*(H>>1) (=4x4 block level TH for BDOF) | None / reuse DMVR | Disable |
| CE9-1.4 | integer-distance SAD | 16\*W\*(H>>1) | None / reuse DMVR | Disable |
| CE9-1.5a | integer-distance SAD | BDOF Subblock-level  TH | None / reuse DMVR | Subblock level |
| CE9-1.5b | fractional-distance SAD;  integer-distance SAD, if no fractional-distance SAD | BDOF Subblock-level TH | None / reuse DMVR | Subblock level |

No significant impact on compression. In terms of simplification, CE9-1.2 and CE9-1.4 would be the preferable solutions by completely removing the separate BDOF SAD computation. On the other hand, these would give up any early termination of BDOF in case where DMVR is disabled, and the runtime of BDOF would decrease (which is not the case in CTC, as the combination of DMVR and BDOF is used frequently). The case of disabling DMVR is not the worst complexity case of decoder, therefore the increase of BDOF runtime should not be a big issue.

CE9-1.2 is agreed to be the better choice, also with slightly better results.

Decision: Adopt JVET-O0055, version CE9-1.2. The alignment of text and SW implementation was confirmed by cross-checker.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Description** | **Y** | **U** | **V** | **EncT** | **DecT** | **Doc#** |
| CE9-2.1a | Harmonization of DMVR and MMVD with MMVD distance threshold (for reference). | -0.10% | -0.10% | -0.15% | 104% | 101% | [JVET-O0077](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6681) |
| CE9-2.1b | CE9-2.1.a + encoder speed up | -0.10% | -0.10% | -0.13% | 102% | 100% | [JVET-O0077](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6681) |
| CE9-2.2 | The CIIP with disabled DMVR and BDOF. | -0.01% | -0.02% | -0.01% | 99% | 98% | [JVET-O0108](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6712) |
| CE9-2.3 | The CIIP with disabled BDOF | 0.00% | -0.01% | -0.02% | 99% | 98% | [JVET-O0103](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6707) |

CE9-2.1 uses DMVR in combination with MMVD (this is where the encoder runtime increase comes in place). Compared to the encoder runtime vs compression benefit of DMVR itself (which was about 1% versus 0.8% gain, the encoder time increase of 2% for another 0.1% appears low. On the other hand, the decoder was more significantly increased by DMVR. There is some logic that here DMVR improves MMVD, where for the larger range the precision of the MV is worse. It is noted that the benefit of MMVD has recently decreased to approx. 0.6% (was >1% originally).

There is some support from experts on adopting this, whereas others expressed concern about the tradeoff. This is obviously meant for coding efficiency improvement, not for unification. Not possible to reach consensus on adoption.

CE9-2.2 and CE9-2.3 are disabling DMVR and/or BDOF in case of CIIP. This comes without change of compression performance, indicating that the combination of these tools is not beneficial. It slightly decreases SW run time. For hardware, does not have much impact in terms of reducing complexity. The text change is straighforward.

(it is noted that JVET-O0103 covers a subset of this, by only disabling BDOF)

Decision: Adopt JVET-O0108, disabling DMVR and BDOF when CIIP is used.

BoG (S. Esenlik) for reviewing CE9 related proposals and suggest actions from these.

[JVET-O0054](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6658) CE9-1.1: BDOF early termination [C.-Y. Lai, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek), K. Kondo, M. Ikeda, T. Suzuki (Sony)]

[JVET-O0055](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6659) CE9-1.2 and CE9-1.4: BDOF early termination [C.-Y. Lai, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek), K. Kondo, M. Ikeda, T. Suzuki (Sony), K. Unno, K. Kawamura, S. Naito (KDDI), T. Chujoh, T. Ikai (Sharp)]

[JVET-O0077](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6681) CE9-2.1: Harmonization of DMVR and MMVD [E.Sasaki, T. Hashimoto, T. Chujoh, T. Ikai (Sharp)]

[JVET-O0096](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6700) CE9-1.5: Best DMVR cost based early termination for BDOF [S. Sethuraman (Ittiam)]

[JVET-O0103](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6707) CE9-2.3: CIIP with disabled BDOF [L. Zhao, X. Li, X. Zhao, S. Liu (Tencent)]

[JVET-O0108](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6712) CE9-2.2: Disabled decoder-side motion refinement (DMVR) and bidirectional optical flow (BDOF) for combined inter and intra prediction (CIIP) [X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

## CE10: Neural network based loop filtering (9)

Contributions in this category were discussed Thursday 4 July 1915–2020 in Track B (chaired by JRO).

[JVET-O0030](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7063) CE10: Summary Report on Neural Network based Filter for Video Coding [Y. Li, S. Liu, K. Kawamura]

This contribution provides a summary report of Core Experiment 10 on neural network based filter for video coding. 21 tests have been tested in CE10 in between JVET-N and JVET-O meetings, to study and evaluate technologies related to neural network based filter. In this report, coding performance and complexity of these tests are reported and analyzed. Crosschecking results for the performed tests are integrated in this contribution.

CE10-1.x is online training (sequence adaptive with signalling of network parameters)

CE10-2.x is offline training

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Test #** | **Test Part** | **Description** | **Source** | **Tester** | **Crosschecker** |
| CE10-1.2a | in-loop/ post filter | CNNLF as in-loop filter | JVET-N0110 | Y.-L. Hsiao (Mediatek) | R. Yang (Intel) |
|  |  |  |  |
| CE10-1.7a | in-loop/ post filter | NN Filter as in-loop filter | JVET-N0480 | H. Yin (Intel) | Y.-L. Hsiao (Mediatek) |
| CE10-1.7b | NN Filter as post filter | Y.-L. Hsiao (Mediatek) |
| CE10-1.10a | bit-depth | 6-bit(int) weights | JVET-N0712 | K. Kawamura (KDDI) | H. Yin (Intel) |
| CE10-1.10b | 14-bit(int) weights | H. Yin (Intel) |
| CE10-1.11a | in-loop/ post filtering | CNNF as in loop filter | K. Kawamura (KDDI) | H. Yin (Intel) |
| CE10-1.11b | CNNF as post filter | H. Yin (Intel) |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CE10-2.1a | bit-depth | 32-bit(float) weights | JVET-N0133 | Shuai Wan (NPU) | T. Ouyang (Wuhan Univ) |
| CE10-2.1b | 8-bit(int) weights |
| CE10-2.2a | in-loop/ post filter | CNNF as in-loop filter | C.-Y Lin (Hikvision) |
| CE10-2.2b | CNNF as post filter |
|  | generalization capability (QP) |  |  |
| CE10-2.3b | CTC QP+5 | T. Ouyang (Wuhan Univ) |
| CE10-2.5a | bit-depth | 32-bit(float) weights | JVET-N0254 | Y. Wang  (Wuhan Univ.) | M. Wang (NPU) |
| CE10-2.5b | 8-bit(int) weights | M. Wang (NPU) |
| CE10-2.7a | generalization capability (QP) | CTC QP-5 | M. Wang (NPU) |
| CE10-2.7b | CTC QP+5 | M. Wang (NPU) |
| ~~CE10-2.8a~~ | bit-depth | ~~4-bit(int) weights~~ | JVET-N0513 | Y. Dai(USTC)  H. Zhao(USTC) |  |
| ~~CE10-2.8b~~ | ~~6-bit(int) weights~~ |  |
| CE10-2.8c | 8-bit(int) weights | C.-Y Lin (Hikvision) |
| ~~CE10-2.8d~~ | ~~16-bit(int) weights~~ |  |
| CE10-2.10a | bit-depth | 8-bit(int) weights | JVET-N0710 | K. Kawamura (KDDI) | H. Yin (Intel) |
| CE10-2.10b | 16-bit(int) weights | H. Yin (Intel) |
| CE10-2.11a | in-loop/ post filtering | CNNF as in loop filter | K. Kawamura (KDDI) | H. Yin (Intel) |
| CE10-2.11b | CNNF as post filter | H. Yin (Intel) |

Specifically, this CE shall use the following these test conditions:

- Test Condition1: Common Test Conditions (CTC).

- Test Condition2: CTC, but short test, which only need to test the first intra period.

- Test Condition3: Based on Test Condition2, test QP=CTC QP +/- 5

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

Table 1: CE10 test results with VTM-5.0+ Test Condition 1 (CTC)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | **AI Over VTM-5.0** | | | | | **RA Over VTM-5.0** | | | | |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| CTC Full test | CE10-1.2a |  |  |  |  |  | -1.20% | -14.17% | -14.11% | 100% | 117% |
| CE10-1.7a |  |  |  |  |  | -0.80% | -10.56% | -9.93% | 100% | 129% |
| CE10-1.7b |  |  |  |  |  | -0.95% | -10.78% | -10.39% | 100% | 158% |
| CE10-1.11a |  |  |  |  |  | -0.04% | -15.54% | -15.17% | 99% | 190% |
| CE10-1.11b |  |  |  |  |  | 0.25% | -5.04% | -6.01% | 100% | 213% |
| CE10-2.2a | -3.93% | -7.89% | -7.29% | 134% | 74517% | -0.26% | -3.86% | -2.91% | 139% | 132513% |
| CE10-2.2b | -3.05% | -9.02% | -10.47% | 136% | 74083% | -1.89% | -11.91% | -8.90% | 139% | 135869% |
| CE10-2.8c | -0.51% | -0.30% | -0.60% | 92% | 188% |  |  |  |  |  |
| CE10-2.11a |  |  |  |  |  | -1.10% | -2.94% | -3.35% | 127% | 56667% |
| CE10-2.11b |  |  |  |  |  | -0.32% | -0.66% | -0.81% | 100% | 64536% |

Table 2: CE10 test results with VTM-5.0+ Test Condition 2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | |  |  | **RA Over VTM-5.0** | | | | |
|  | **Test#** | | **Description** | **Y** | **U** | **V** | **EncT** | **DecT** |
| Test Condition2 | CE10-1.10a | | 6-bit(int) weights | 0.04% | -0.97% | -2.30% | 100% | 127% |
| CE10-1.10b | | 14-bit(int) weights | 0.23% | -15.24% | -13.66% | 100% | 190% |
| CE10-2.1a | | 32-bit(float) weights | -0.46% | -4.11% | -2.80% | 142% | 134684% |
| CE10-2.1b | | 8-bit(int) weights | 0.79% | -5.06% | -4.73% | 192% | 306401% |
| CE10-2.5a | | 32-bit(float) weights | -1.01% | -5.01% | -4.24% | 105% | 5652% |
| CE10-2.5b | | 8-bit(int) weights | -0.84% | -4.13% | -2.92% | 107% | 5515% |
| ~~CE10-2.8c~~ | | ~~8-bit(int) weights~~ |  |  |  |  |  |
| CE10-2.10a | | 8-bit(int) weights | -1.00% | -2.98% | -3.46% | 128% | 57777% |
| CE10-2.10b | | 16-bit(int) weights | -1.16% | -3.21% | -3.59% | 129% | 59072% |

Table 3: CE10 test results with VTM-5.0+ Test Condition 3

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | |  |  | **RA Over VTM-5.0** | | | | |
|  | **Test#** | | **Description** | **Y** | **U** | **V** | **EncT** | **DecT** |
| Test Condition3 | CE10-2.2a | | CTC QP for testing | -0.46% | -4.11% | -2.80% | 142% | 134684% |
| CE10-2.3b | | CTC QP+5 | -1.52% | -6.15% | -4.31% | 166% | 154379% |
| CE10-2.5a | | CTC QP for testing | -1.01% | -5.01% | -4.24% | 105% | 5652% |
| CE10-2.7a | | CTC QP-5 | -0.63% | -3.83% | -3.34% | 105% | 5026% |
| CE10-2.7b | | CTC QP+5 | -1.15% | -5.01% | -4.47% | 111% | 5525% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Information in the Inference Stage Combining with Codec** | | | | | | | | |
|  | **Network Details** | | | | | | | |
| Total Conv. Layers | Total FC Layers | Framework | Param. Num | Param. Precision | Mem.P(MB) | Mem.T(MB)(e.g., 4K input) |
| CE10-1.2 | 3 | 0 | NA | 1506 | 6(I), 32(I) | 0.001282 | 0.344 (128x128, CTU based) |
| CE10-1.7 | 2 | 0 | NA | 732x3 (Luma), 402x3 (Chroma) | 6(I), 32(I) | 0.0028 | 0.0448 |
| CE10-1.10 | 3 | 0 | Caffe | 1478 | CE10-1.10a: 6(I), 15(I) CE10-1.10b: 14(I), 15(I) | CE10-1.10a: 0.001152 CE10-1.10b: 0.002592 | 0.344 (128x128, CTU based) |
| CE10-2.1 | 39 | 36 | Tensorflow | 519112 | 32(F) | 4.93 | H\*W\*2.68\*10e-3 |
| CE10-2.5 | 21 | 0 | PyTorch | 22371 | CE10-2.5a: 32(F),  CE10-2.5b: 8(I) | CE10-2.5a: 0.09,  CE10-2.5b: 0.02 | 196.23(block based, 80000pixels) |
| CE10-2.8 | 11 | 0 | cuDNN | 7521 | 8(I)32(I) | 0.01 | 3659(4K as input) |
| CE10-2.10 | 4 | 0 | Caffe | 56481 | CE10-2.10a: 8(I), 15(I) CE10-2.10b: 16(I), 15(I) | CE10-1.10a: 0.056762 CE10-1.10b: 0.112922 | 10.063 (128x128, CTU based) |

Observations / from the discussion in track B:

- The gain is typically higher for the chroma components. This may be due to ths fact that the chroma benefits more from cross-component effects.

- It is noted that the encoding time for CE10-1.x does not consider the time for the online training.

- Post filtering seems to give similar gains (and in some cases better) than in-loop filtering. The performance of post filtering versus loop filtering should be also investigated subjectively. Post filtering would not need normative description, unless parameters would need to be transmitted to the decoder.

- Quantization of network parameters incurs some loss.

- It is well possible to use the same network for a larger range of QPs.

- The complexity in terms of computation and memory need of decoder is quite high for the CE10-2.x category (though it had been largely reduced here compared to some of the initially proposed approaches) – except 10-2.8 which achieves 0.5% for 90% decoder run time increase.

- For CE10-1.x category, the decoder complexity tradeoff is in a more acceptable range, such as 1.2% luma gain (and considerably higher chroma gain) with 17% run time increase, and very shallow network with compact parameter representation. On the other hand, this requires excessive encoding time for offline training, and in terms of benefit might be better compared to some approach of lookahead encoding.

- From the results, better gains are achieved in AI case. This may be due to the fact that the training is performed by using intra coded pictures.

* To do as action during the meeting - Informal viewing to identify:Whether the NN based approaches are providing subjective benefit
* Whether it is equivalent to operate them as a post filter or a loop filter

Revisit to review the outcome of subjective viewing, and further decide how to continue this investigation, and what next steps would be useful. Might be better as AHG study rather than CE.

[JVET-O0056](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6660) CE10-1.2: Convolutional neural network loop filter [Y.-L. Hsiao, O. Chubach, C.-Y. Chen, T.-D. Chuang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0346](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6951) Crosscheck of JVET-O0056 (CE 10-1.2: Convolutional neural network loop filter) [H. Yin, R. Yang, X. Fang, S. Ma (Intel)]

[JVET-O0063](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6667) CE10-1.7: Adaptive convolutional neural network loop filter [H. Yin, R. Yang, X. Fang, S. Ma (Intel)]

[JVET-O0079](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6683) CE10: Integrated in-loop filter based on CNN (Tests 2.1, 2.2 and 2.3) [S. Wan, M.-Z.Wang, H. Gong, C.-Y. Zou (NPU), Y.-Z. Ma, J.-Y. Huo (Xidian Univ.), Y.-F. Yu, Y. Liu (OPPO)]

[JVET-O0101](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6705) CE10: Dense Residual Convolutional Neural Network based In-Loop Filter (Tests 2.5 and 2.7) [Y. Wang, T. Ouyang, C. Zou, Y. Li, Z. Chen (Wuhan Univ.), L. Zhao, S. Liu, X. Li (Tencent)]

[JVET-O0175](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6779) Crosscheck of JVET-O0101 (CE10: Dense Residual Convolutional Neural Network based In-Loop Filter (Tests 2.5 and 2.7)) [S. Wan, M.-Z.Wang, H. Gong, C.-Y. Zou (NPU), Y.-Z. Ma, J.-Y. Huo (Xidian Univ.), Y.-F. Yu, Y. Liu (OPPO)]

[JVET-O0131](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6735) CE10-1.10/CE10-1.11: Evaluation results of CNN-based filtering with on-line learning model [Y. Kidani, K. Kawamura, K. Unno, S. Naito (KDDI)]

[JVET-O0132](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6736) CE10-2.10/CE10-2.11: Evaluation results of CNN-based filtering with off-line learning model [Y. Kidani, K. Kawamura, K. Unno, S. Naito (KDDI)]

[JVET-O0347](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6952) CE10: Neural Network based Filter for Video Coding [H. Zhao, Y. Dai, D. Liu, N. Yan, H. Li (USTC)] [miss] [late]

## CE11: Gradual random access (6)

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

[JVET-O0031](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7308) CE11: Summary Report on Gradual Random Access [K. Kazui, J.-M. Thiesse, Hendry, K. Kawamura] [miss] [late]

A summary of Core Experiment 11 (CE11) on Gradual Random Access (GRA) is reported. The goal of CE11 is to study GRA tools/methods, for potential inclusion into the VVC standard.

Eight tests were defined in CE11:

* CE11-1: Encoder-only scheme (1 test)
* CE11-2: Virtual boundary (4 tests) (1 test was withdrawn)
* CE11-3: Tile/sub-picture (2 tests)
* CE11-4: Distributed IDR picture (1 test)

All tests are evaluated based on the common test conditions defined in JVET-N1031. All tests and crosscheck results are integrated in this report.

The report was somewhat late, as some results were uploaded late. The v2 version was presented, while some cross-checking was still under way.

CTC conditions for SDR as agreed at the 14th JVET meeting are used for the evaluation of objective performance The following constraints are further applied as specified in the CE11 document.

* Low-delay B configuration only
* Interval of GRA 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 immediate preceding pictures in decoding order

The anchor is the ‘VVC Test Model’ or VTM. The VTM version 5.0 software is used with ‘vtm’ configuration files to produce the VTM anchor. Tools are implemented into the VTM version 5.0 software. Proposals are primarily compared with respect to objective compression efficiency while bitrate fluctuation and “exact match” aspects are also assessed.

Defined tests in CE11

|  |  |  |  |
| --- | --- | --- | --- |
| Test # | Short description | Doc. # | Cross-checker |
| CE11-1 | Encoder-only scheme   * No explicit signalling of refresh boundary * Encoder-side restriction on MV and intra prediction mode * Redundant intra-coded region for disabling in-loop filter at refresh boundary | JVET-N0080  JVET-O0057  (Fujitsu) | Huawei |
| CE11-2.1.a | Virtual boundary   * Refresh boundary = virtual boundary signalled at slice level * Encoder-side restriction on MV * Restriction on intra prediction with CIP at picture level * Disabling in-loop filter at refresh boundary | JVET-N0391  JVET-O0100  (VITEC) | KDDI |
| CE11-2.1.b | Virtual boundary   * CE11-2.1.a * Enabling CIP locally with slice-level signalling | Huawei |
| CE11-2.1.c | Virtual boundary   * CE11-2.1.b * Treating virtual boundary as picture boundary   [Withdrawn] | *n/a* |
| CE11-2.2 | Virtual boundary   * CE11-2.1.b * Dedicated signalling of GRA position with associated constraint derivation, and CU-level flags skipping. | Kimihiko Kazui  (Fujitsu) |
| CE11-3.1 | Tile   * Refresh boundary = tile boundary * Asymmetric MV restriction by treating tile boundary as picture boundary * Disabling intra prediction across tile boundary. This is inherited from tile, not particularly new for this test. * Disabling in-loop filtering across tile boundary | JVET-N0115  JVET-O0124  (Futurewei) | VITEC |
| CE11-3.2 | Sub-picture   * Asymmetric MV restriction at sub-picture boundary * Refresh boundary = sub-picture boundary * Disabling intra prediction across tile boundary * Disabling in-loop filtering across tile boundary | JVET-N0310  JVET-O0063  (Nokia) | Huawei |
| CE11-4 | Distributed IDR   * Extra intra-coded picture as reference for random access picture * Extra intra-coded picture is transmitted “slowly” and not output | JVET-N0116  JVET-O0116  (Huawei) | Nokia |

**Refreshing scheme**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Test # | Shape of refreshed area | Signalling of area | Precision of boundary position | Spatial direction of refresh |
| CE11-1 | Vertically striped | *n/a* | 8 luma samples | Left to right |
| CE11-2 | Vertically striped | Virtual boundary | 8 luma samples | Left to right |
| CE11-3.1 | Vertically striped | Tile | New refresh area is coded as 1 tile (i.e., 1 intra slice) with width 1 CTU column | Left to right |
| CE11-3.2 | Vertically striped | Sub-picture | 8 luma samples | Left to right |
| CE11-4 | Picture | *n/a* | *n/a* | *n/a* |

**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 |
| CE11-1 | Encoder-side mode restriction | Encoder-side MV restriction | Disabled at random access picture | Redundant intra-coded area |
| CE11-2 | Constrained intra prediction | Encoder-side MV restriction | Constrained by limiting the reference frame buffer when recycling (encoder-side) | Disabled at virtual boundary |
| CE11-3.1 | Disabled at tile boundary by default | Intrinsically constrained by treating clean area in the reference picture as picture boundary. This will effectively make blocks in the clean area never takes information (e,g., pel values, MV, etc) from non-clean area in the reference picture(s) | Intrinsically constrained by treating clean area in the reference picture as picture boundary | Disabled at tile boundary |
| CE11-3.2 | Disabled at sub-picture boundary by default | Encoder constraint such that blocks in clean area refer to clean area in the reference pictures. | Constrained by limiting area within the reference picture | Intrinsically disabled |
| CE11-4 | *n/a* | *n/a* | *n/a* | *n/a* |

**Other aspects**

|  |  |  |
| --- | --- | --- |
| Test # | Additional normative changes | Decoding unit |
| CE11-1 | *n/a* | One tile = One decoding unit = 1 CTU row |
| CE11-2 | CIP signalling (CE11-2.1.a)  Virtual boundaries slice signalling (CE11-2.1.a)  CIP enabled only at refreshed area and adjacent to refresh boundary coded in intra (CE11-2.1.b)  Dedicated signalling method of CIP and virtual boundary (CE11-2.2)  No explicit signalling of pred\_mode\_flag and cu\_skip\_flag of CU in in refreshed area (CE11-2.2) | If DU operation is desired, each CTU column can be coded as one tile. One tile one slice. |
| CE11-3.1 | Signalling of clean area in slice header  Treating clean area boundary as picture boundary | If DU operation is desired, each CTU column can be coded as one tile. One tile one slice. |
| CE11-3.2 | Clean area and dirty areas are two different sub-pictures, width and height are signalled separately. |  |
| CE11-4 | Two NAL unit types are proposed with corresponded definitions | One tile = One decoding unit |

**Other aspects**

|  |  |  |
| --- | --- | --- |
| Test # | Encoding condition | Cross-checker’s comment |
| CE11-1 | Hash ME is disabled for Class-F  GRA cycle of “BQSquare” is exceptionally set to 52. |  |
| CE11-2 | Hash ME is disabled for Class F |  |
| CE11-3.1 | ALF and LMCS are disabled | ALF and LCMS are disabled in both the anchor and the CE test. |
| CE11-3.2 | Class F case needs further investigation. | Slight mismatch between Windows and Linux simulations. Class F need more investigations. |
| CE11-4 | Encoder side ReuseCU is switched off (anchor doesn’t work with ReuseCU off) |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Low-delay B – Over VTM-5.0 with CE11 condition | | | | | | | | | |
|  | Tester | | | | | Cross-checker | | | | |
| Test # | Y | U | V | EncT | DecT | Y | U | V | EncT | DecT |
| CE11-1 | 19.13% | 15.50% | 17.61% | 95% | 102% | (\*1) |  |  |  |  |
| CE11-2.1.a | 9.54% | 11.28% | 16.61% | 96% | 114% |  |  |  |  |  |
| CE11-2.1.b | 7.96% | 8.66% | 13.02% | 101% | 115% | 7.99% | 8.60% | 13.02% | 98% | 102% |
| CE11-2.2 | 6.69% | 6.72% | 10.89% | 100% | 115% | 6.67% | 6.75% | 10.95% | 97% | 102% |
| CE11-3.1 | 2.41% | 7.25% | 11.27% | 139% | 125% | (\*2) |  |  |  |  |
| CE11-3.2 | 6.26% | 4.05% | 7.90% | 98% | 109% | 6.26% | 4.05% | 7.90% | 97% | 98% |
| CE11-4 | 3.51% | -2.41% | -2.31% | 99% | 100% | (\*2) |  |  |  |  |

(\*1) Only Class D sequences are tested so far and reportedly matched.

(\*2) Only Class C, D and E sequences are tested so far and reportedly matched.

Due to the bug reported in ticket #281, there is a mismatch between on Windows and Linux. In the CE11 anchor case, the error is within 0.1% (Class-D, U component). In each subtest, the error within the similar range is observed if the tester and cross-checker use different platform. Some BD-rate and runtime numbers are obtained on Windows. Others are on Linux.

**Bitrate fluctuation**

|  |  |  |
| --- | --- | --- |
| Test # | Tester | Cross-checker |
| CE11-1 |  |  |
| CE11-2 | Fully smooth with fluctuation only due to content. |  |
| CE11-3.1 |  |  |
| CE11-3.2 |  |  |
| CE11-4 | Spikes after RA points are near to mean value of average bit-stream. Few times less than IRAP pictures |  |

**Exact match at recovery point picture**

|  |  |  |
| --- | --- | --- |
| Test # | Tester | Cross-checker |
| CE11-1 | 1st GRA, matched  Note: 4 mismatches at 2nd, 3rd, 5th GRA | Matched (Class-D) |
| CE11-2.1.a | 1st GRA, matched |  |
| CE11-2.1.b | 1st GRA, matched |  |
| CE11-2.2 | 1st GRA, matched | 1st GRA, matched |
| CE11-3.1 | Matched. | 1st GRA, matched for Class C D E and F |
| CE11-3.2 | 1st GRA, matched |  |
| CE11-4 | Matched |  |

It was asked whether block-wise areas predicted from “clean” regions were considered “clean”. This was sometimes not done.

CE11-2 schemes use a “virtual boundary” (horizontal or vertical) for ALF/SAO/deblock disable, with syntax at the slice level. The tested schemes also use some form of constrained intra prediction (CIP). We do not currently have CIP in VVC. There was no test that used the virtual boundary and did not use CIP.

Virtual boundaries are already supported (for 360° reasons).

It was commented that extending the ME search area into the clean area would help, whereas this test just restricted the search to a part of the ordinary ME seach area.

VVC does not have CIP. CE11-2.1a uses whole-slice (whole-picture) CIP. CE11-2.1b has a block level flag for CIP. CIP may not be easy to support in VVC, at least in an implementation if not in the text. The group was reluctant to consider supporting CIP because of this implementation issue.

It was commented that it may not be necessary to have an exact match. Allowing some “drift” may be possible.

It was commented that at the previous meeting there had been substantial interest in being able to treat tile boundaries as picture boundaries, and software was contributed for this meeting for such an approach.

It was commented that refreshes with horizontal boundaries rather than vertical boundaries are also possible.

It was commented that the tested schemes were basically for picture-level operation, rather than DU-level operation.

CE11-3.1 uses tiles, while CE11-3.2 concerns sub-pictures. A sub-picture is proposed to be a rectangular arrangement of tiles. The boundary of a sub-picture is treated as a picture boundary. Each reference picture has its own sub-picture structure that needs to be accounted for when referencing it. As proposed, each sub-picture would have its own PPS.

CE11-4 uses non-output reference pictures to build up a reference picture that sent in fragments and is not referred to by other pictures until all fragments have been sent. It was commented that this is somewhat similar in concept to the “composite reference picture” concept that had previously been investigated. A participant commented that, the way this was proposed, it requires buffering too much state information for partially decoded pictures. It also requires an increase of “pixel processing rate”. Another participant commented that this produces bit rate fluctuations, since when that picture becomes used, it is temporally distant from the current picture being predicted.

Revisit for further discussion of treating tile boundaries as picture boundaries after discussion of that in other contexts. We may also want to move the syntax for virtual boundaries to the slice level.

[JVET-O0075](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6679) CE11-1: GRA support by restriction to encoder operation [K. Kazui (Fujitsu)]

[JVET-O0100](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6704) CE11: Gradual Random Access (GRA) using encoder and normative restrictions (Tests CE11-2.1.a, CE11-2.1.b and CE11-2.2) [D. Gommelet, J.-M. Thiesse, D. Nicholson (VITEC)]

[JVET-O0116](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6720) CE11-4: Distributed decoding refresh DDR [M. Sychev (Huawei)]

[JVET-O0124](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6728) CE11/AHG14: Test 3.1 − Support of gradual random access / gradual decoding refresh [Hendry, Y.-K. Wang, J. Chen, S. Hong (Futurewei)] [late]

[JVET-O0663](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7280) CE11-3.2: Gradual Random Access (GRA) with Sub-Pictures [K. K. Sreedhar, M. M. Hannuksela, A. Aminlou (Nokia)] [late]

# Non-CE Technology proposals

## CE1 related – CABAC initialization (3)

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

[JVET-O0191](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6796) CE1-related: Simplified CABAC initialization method [F. Bossen (Sharp)]

[JVET-O0677](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7296) Crosscheck of JVET-O0191 (CE1-related: Simplified CABAC initialization method) [J. Dong (Qualcomm)]

[JVET-O0741](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7362) Non-CE1: Context memory reduction via selective adaptation [A. Said, T. Hsieh, J. Dong (Qualcomm)] [late]

[JVET-O1015](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7652) Crosscheck of JVET-O0741 (Non-CE1: Context memory reduction via selective adaptation) [H. Kirchhoffer (HHI)]

[JVET-O0946](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7573) CE1-related: Simplification of JVET-O0191 using 4 or 6 bit per initialization value [H. Kirchhoffer, D. Marpe, H. Schwarz, T. Wiegand (HHI)] [late] [miss]

## CE2 related – Luma/chroma dependency reduction (23)

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

[JVET-O0129](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6733) Non-CE2: CCLM with Chroma Separate Tree [C.-W. Kuo, J. Li, C. Lim (Panasonic)]

[JVET-O0797](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7418) Crosscheck of JVET-O0129 on CCLM with Chroma Separate Tree [C. Chevance (Interdigital)]

[JVET-O0130](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6734) Non-CE2: CRS with Chroma Separate Tree [C.-W. Kuo, J. Li, C. Lim (Panasonic)]

[JVET-O0723](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7343) Crosscheck of JVET-O0130 (Non-CE2: CRS with Chroma Separate Tree) [T. Biatek (Qualcomm)]

[JVET-O0798](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7419) Crosscheck of JVET-O0130 on CRS with Chroma Separate Tree [C. Chevance (Interdigital)]

[JVET-O0196](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6801) CE2-related: CCLM for dual tree with 32x32 latency [Y. Zhao, H. Yang (Huawei)]

[JVET-O0805](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7426) Crosscheck of JVET-O0196 (CE2-related: CCLM for dual tree with 32x32 latency) [C.-M. Tsai (MediaTek)]

[JVET-O0212](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6817) On an enable condition for LMCS [T.Chujoh, T.Ikai (Sharp)]

[JVET-O0715](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7335) Crosscheck of JVET-O0212 (On an enable condition for LMCS) [P. Bordes (InterDigital)]

[JVET-O0232](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6837) CE2-related: No-latency LMCS Chroma Residual Scaling [J. Zhao, S. Kim (LGE)]

[JVET-O0745](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7366) Crosscheck of JVET-O0232 (CE2-related: No-latency LMCS Chroma Residual Scaling) [T. Lu (Dolby)]

[JVET-O0233](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6838) CE2-related: Linear LMCS [J. Zhao, S. Paluri, S. Kim (LGE)]

[JVET-O0796](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7417) Crosscheck of JVET-O0233 on Linear LMCS [C. Chevance (Interdigital)]

[JVET-O0262](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6867) Non-CE2: Removal of division operations in LMCS [K. Zhang, L. Zhang, H. Liu, J. Xu, Y. Wang (Bytedance)]

[JVET-O0746](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7367) Crosscheck of JVET-O0262 (Non-CE2: Removal of division operations in LMCS) [T. Lu (Dolby)]

[JVET-O0271](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6876) CE2-related: Chroma scaling for CIIP [Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0781](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7402) Crosscheck of JVET-O0271: CE2-related: Chroma scaling for CIIP [X. Xiu (Kwai Inc.)]

[JVET-O0272](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6877) CE2-related: Simplified inverse luma mapping [Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0910](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7532) Crosscheck of JVET-O0272: CE2-related: Simplified inverse luma mapping [W. Zhu (Bytedance)]

[JVET-O0273](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6878) CE2-related: Luma-chroma latency reduction for chroma separate tree [C.-M. Tsai, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O1013](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7649) Crosscheck of JVET-O0273: CE2-related: Luma-chroma latency reduction for chroma separate tree [T. Poirier (InterDigital)]

[JVET-O0274](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6879) CE2-related: Luma-chroma dependency reduction for chroma separate tree by constraining CCLM usage [C.-M. Tsai, T.-D. Chuang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0754](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7375) Crosscheck of JVET-O0274 (CE2-related: Luma-chroma dependency reduction for chroma separate tree by constraining CCLM usage) [Y. Zhao (Huawei)]

[JVET-O0427](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7032) Non-CE2: Remove differential coding for ALF coefficients [X. W. Meng (PKU), X. Zheng (DJI), S. S. Wang, S. W. Ma (PKU)]

[JVET-O0895](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7517) Crosscheck of JVET-O0427 (Non-CE5: Remove differential coding for ALF coefficients) [N. Hu (Qualcomm)]

[JVET-O0428](file:///D:\2019\JVET\JVET-O\current_document.php%3fid=7033) AHG16/AHG17: LMCS related clean-ups [T. Lu, F. Pu, P. Yin, S. McCarthy, W. Husak, T. Chen (Dolby), J. Zhao, S.H. Kim (LGE)]

Note that if the 3rd part of this proposal is agreed, the specification text for that part should be reviewed and confirmed by HLS experts.

[JVET-O0842](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7463) Crosscheck of JVET-O0428: AHG16/AHG17: LMCS related clean-ups [J. Chen (Alibaba)]

[JVET-O0429](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7034) Non-CE2: alternative solutions for chroma residual scaling factors derivation for dualTree [T. Lu, P. Yin (Dolby), E. François, F. Hiron (InterDigital)]

[JVET-O0744](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7365) Crosscheck of JVET-O0429 (Non-CE2: alternative solutions for chroma residual scaling factors derivation for dualTree) [K. Zhang (Bytedance)]

[JVET-O1044](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7681) Crosscheck of JVET-O0429 (Non-CE2: alternative solutions for chroma residual scaling factors derivation for dualTree) [Y. Zhang, D. Rusanovskyy (Qualcomm)]

[JVET-O0448](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7054) Non-CE2: Inverse LUT carriage for LMCS [P. Andrivon, E. François, C. Chevance, H. Hiron, R. Jullian (InterDigital)]

[JVET-O0992](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7628) Crosscheck of JVET-O0448 (Non-CE2: Inverse LUT carriage for LMCS) [C.-W. Kuo (Panasonic)]

[JVET-O0524](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7131) Non-CE2: alternative solutions for reducing the luma-chroma latency [T. Poirier, E. François, F. Le Léannec (InterDigital)]

[JVET-O0806](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7427) Crosscheck of JVET-O0524 (Non-CE2: Alternative solutions for reducing the luma-chroma latency) [C.-M. Tsai (MediaTek)]

[JVET-O0550](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7163) CE2-related: Further simplification of chroma residual scaling factors derivation [M. Sychev, E. Alshina (Huawei)]

[JVET-O1064](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7701) Crosscheck of JVET-O0550 (CE2-related: Further simplification of chroma residual scaling factors derivation) [S.-T. Hsiang (MediaTek)]

[JVET-O0603](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7218) CE2-related: Prediction dependent luma residual scaling for adaptive in-loop re-shaper [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, S. Ye, X. Wang (Kwai Inc.)]

[JVET-O0844](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7465) Crosscheck of JVET-O0603: CE2-related: Prediction dependent luma residual scaling for adaptive in-loop re-shaper [J. Chen (Alibaba)]

[JVET-O0608](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7223) CE2-related: On latency reduction for chroma residual scaling [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, S. Ye, X. Wang (Kwai Inc.)]

[JVET-O1026](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7663) Crosscheck of JVET-O0608 (CE2-related: On latency reduction for chroma residual scaling) [Z.-Y. Lin (MediaTek)]

[JVET-O0611](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7226) CE2-3 related: On CCLM restriction for 32x32 luma latency [K. Kawamura, K. Unno, S. Naito (KDDI)]

[JVET-O0708](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7328) Crosscheck of JVET-O0611 (CE2-3 related: On CCLM restriction for 32x32 luma latency) [K. Abe (Panasonic)]

[JVET-O0618](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7233) CE2-related: Removal of luma-chroma dependency in LMCS [Z. Deng, L. Zhang, H. Liu, K. Zhang, Y. Wang (Bytedance)]

[JVET-O0767](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7388) Crosscheck of JVET-O0618: CE2-related: Removal of luma-chroma dependency in LMCS [J. Zhao (LGE)]

[JVET-O0627](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7242) CE2-related: luma-chroma dependency reduction on chroma scaling [J. Chen, R.-L. Liao, Y. Ye, J. Luo (Alibaba)]

[JVET-O0691](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7311) Crosscheck of JVET-O0627 (CE2-related: luma-chroma dependency reduction on chroma scaling) [Y. Sun, S. Ye, F. Chen, L. Wang (Hikvision)]

[JVET-O0747](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7368) Crosscheck of JVET-O0627 (CE2-related: luma-chroma dependency reduction on chroma scaling) [T. Lu (Dolby)]

[JVET-O0668](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7285) Non-CE2: CCLM latency reduction for single tree [T. Biatek, G. Van Der Auwera, M. Karczewicz (Qualcomm)]

## CE3 related – Intra prediction and mode coding (96)

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

[JVET-O0084](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6688) 8-bit implementation and simplification of MIP [J. Pfaff, T. Hinz, P. Helle, P. Merkle, B. Stallenberger, M. Schäfer, H. Schwarz, D. Marpe, T. Wiegand (Fraunhofer HHI)]

[JVET-O1049](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7686) Crosscheck of JVET-O0084 (8-bit implementation and simplification of MIP) [F. Bossen (Sharp)]

[JVET-O0111](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6715) Non-CE3: Modified CABAC Coding for Intra Prediction Mode [B. Wang, A. M. Kotra, S. Esenlik, H. Gao, E. Alshina (Huawei)]

[JVET-O1003](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7639) Crosscheck of JVET-O0111 (Non-CE3: Modified CABAC Coding for Intra Prediction Mode) [L. Li (LGE)]

[JVET-O0139](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6743) CE3 Related: Low Memory and Computational Complexity Matrix Based Intra Prediction (MIP) [M. Salehifar, S. Kim (LGE)]

[JVET-O0721](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7341) Crosscheck of JVET-O0139 (CE3 Related: Low Memory and Computational Complexity Matrix Based Intra Prediction (MIP)) [T. Biatek (Qualcomm)]

[JVET-O0957](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7587) Crosscheck of JVET-O0139 (CE3 Related: Low Memory and Computational Complexity Matrix Based Intra Prediction (MIP)) [J. Pfaff, B. Stallenberger (HHI)]

[JVET-O0160](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6764) Non-CE3: Sample value clipping on MIP reduced prediction [Z. Zhang, K. Andersson, R. Sjöberg, J. Ström, P. Wennersten, R. Yu (Ericsson)]

[JVET-O0961](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7591) Crosscheck of JVET-O0160 (Non-CE3: Sample value clipping on MIP reduced prediction) [J. Pfaff, M. Schäfer (HHI)]

[JVET-O0161](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6765) Non-CE3: Simplification on MIP boundary sample downsampling process [Z. Zhang, K. Andersson, R. Sjöberg, J. Ström, P. Wennersten, R. Yu (Ericsson)]

[JVET-O0960](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7590) Crosscheck of JVET-O0161 (Non-CE3: Simplification on MIP boundary sample downsampling process) [J. Pfaff, M. Schäfer (HHI)]

[JVET-O0168](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6772) Non-CE3: MIP low resolution clipping [T. Biatek, G. Van der Auwera, M. Karczewicz (Qualcomm)]

[JVET-O0882](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7504) Crosscheck of JVET-O0168 (Non-CE3: MIP low resolution clipping) [Z. Zhang (Ericsson)]

[JVET-O0169](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6773) CE3 Related: No MPM Derivation for Matrix Based Intra Prediction (MIP) [M. Salehifar, S. Kim (LGE)]

[JVET-O0722](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7342) Crosscheck of JVET-O0169, (CE3 Related: No MPM Derivation for Matrix Based Intra Prediction (MIP)) [T. Biatek (Qualcomm)]

[JVET-O0958](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7588) Crosscheck of JEVT-O169 (CE3 Related: No MPM Derivation for Matrix Based Intra Prediction (MIP)) [J. Pfaff, B. Stallenberger (HHI)]

[JVET-O0170](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6774) Non-CE3: Simplification on Matrix-based intra prediction [B. Wang, A. M. Kotra, S. Esenlik, H. Gao, E. Alshina (Huawei)]

[JVET-O0883](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7505) Crosscheck of JVET-O0170 (Non-CE3: Simplifications of Intra Mode Coding for Matrix-based Intra Prediction) [Z. Zhang (Ericsson)]

[JVET-O0171](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6775) Non-CE3: Simplifications for MIP [L. Zhao, X. Zhao, X. Li, S. Liu (Tencent)]

[JVET-O0850](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7471) Crosscheck of JVET-O0171 (Non-CE3: Simplifications for MIP) [Jie Yao (Fujitsu)]

[JVET-O0943](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7570) Crosscheck of JVET-O0171 (Non-CE3: Simplifications for MIP) [T.-C. Ma (Kwai Inc.)]

[JVET-O0187](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6791) Non-CE3: MIP simplifications [A. K. Ramasubramonian, G. Van der Auwera, T. Biatek, L. Pham van, M. Karczewicz (Qualcomm)]

[JVET-O0192](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6797) Non-CE3: MPM flag first signaling for intra luma mode coding [Jie Yao, Jianqing Zhu, Wenting Cai, Kimihiko Kazui (Fujitsu)]

[JVET-O0768](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7389) Crosscheck of JVET-O0192: Non-CE3: MPM flag first signaling for intra luma mode coding [L. Pham Van, G. Van der Auwera, M. Karczewicz (Qualcomm)]

[JVET-O0197](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6802) Non-CE3: cleanup for ISP flag and MRL index signalling [H. Liu, L. Zhang, K. Zhang, N. Zhang, J. Xu, Y. Wang (Bytedance)]

[JVET-O0851](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7472) Crosscheck of JVET-O0197 (Non-CE3: Cleanup for ISP flag and MRL index signalling) [Jie Yao (Fujitsu)]

[JVET-O0202](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6807) Non-CE3: MIP Modifications [Y.-U. Yoon, D.-H. Park, J.-G. Kim (KAU), J. Lee, J. Kang (ETRI)]

[JVET-O1024](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7661) Crosscheck of JVET-O0202 (Non-CE3: MIP Modifications) [Z.-Y. Lin (MediaTek)]

[JVET-O0203](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6808) CE3-related: Simplification of Matrix-Based Intra Prediction (MIP) [A. Filippov, V. Rufitskiy, B. Wang, S. Esenlik, E. Alshina (Huawei)]

[JVET-O0811](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7432) Crosscheck of JVET-O0203 (CE3-related: Simplification of Matrix-based Intra Prediction (MIP)) [[T.-H. Li](mailto:thli@fginnov.com), J.-Y. Deng (Foxconn)]

[JVET-O0224](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6829) CE3-related: Further simplifications of the unified MPM list for intra mode coding [G. Rath, F. Racapé, F. Urban (InterDigital)]

[JVET-O0968](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7599) Crosscheck of JVET-O0224 (Non-CE3: Further simplifications of the unified MPM list for intra mode coding) [S. De-Luxán-Hernández (HHI)]

[JVET-O0229](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6834) CE3-related: Simplifications of PDPC for diagonal and adjacent diagonal directions [G. Rath, F. Racapé, F. Urban (InterDigital)]

[JVET-O0533](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7140) Crosscheck of JVET-O0229 (CE3-related: Simplifications of PDPC for diagonal and adjacent diagonal directions)) [L. Zhao (Tencent)] [miss] [late]

[JVET-O0230](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6835) CE3-related: Interpolation filtering for intra prediction in non-diagonal directions [G. Rath, F. Racapé, F. Urban, F. Le Léannec (InterDigital)]

[JVET-O1030](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7667) Crosscheck of JVET-O0230 (Non-CE3: Interpolation filtering for intra prediction in non-diagonal directions) [J. Lee, S.-C. Lim, H. Lee, J. Kang (ETRI)]

[JVET-O0255](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6860) Non-CE3: Fixed MPMs for MIP [K. Zhang, Z. Deng, L. Zhang, H. Liu, N. Zhang (Bytedance)]

[JVET-O1005](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7641) Crosscheck of JVET-O0255 (Non-CE3: Fixed MPMs for MIP) [J. Choi (LGE)]

[JVET-O0260](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6865) Non-CE3: Rounding offset removal for intra prediction [Z. Deng, H. Liu, L. Zhang, K. Zhang, Y. Wang (Bytedance)]

[JVET-O0862](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7483) Cross-check of JVET-O0260: "Non-CE3: Rounding offset removal for intra prediction" [F. Le Léannec (Interdigital)]

[JVET-O0261](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6866) Non-CE3: MIP with one-stage boundary sample downsampling [Z. Deng, H. Liu, K. Zhang, L. Zhang, Y. Wang (Bytedance)]

[JVET-O0826](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7447) Crosscheck of JVET-O0261 (Non-CE3: MIP with one-stage boundary sample downsampling) [H. Chen (Huawei)]

[JVET-O0275](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6880) CE3-related: Chroma DM derivation for IBC and PCM [M.-S. Chiang, O. Chubach, C.-W. Hsu, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0823](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7444) Crosscheck of JVET-O0275 (CE3-related: Chroma DM derivation for IBC and PCM) [S. Yoo, J. Lim (LGE)]

[JVET-O0276](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6881) CE3-related: Simplifications for MIP [Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0827](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7448) Crosscheck of JVET-O0276 (CE3-related: Simplifications for MIP) [H. Chen (Huawei)]

[JVET-O0277](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6882) CE3-related: Simplification and unification for intra reference sample filtering [C.-M. Tsai, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0825](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7446) Crosscheck of JVET-O0277 (CE3-related: Simplification and unification for intra reference sample filtering) [J. Shingala (Ittiam)]

[JVET-O0311](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6916) CE3-related: Intra sub-partition improvement for low decoding latency and hardware implementation efficiency [[H. Yang](mailto:Hua.Yang@InterDigital.com), [Y. He (InterDigital)](mailto:Yuwen.He@InterDigital.com)]

[JVET-O0974](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7607) Crosscheck of JVET-O0311 (CE3-related: Intra sub-partition improvement for low decoding latency and hardware implementation efficiency) [L. Zhao (Tencent)]

[JVET-O0312](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6917) Non-CE3: Simplifications of MIP [P.-H. Lin (Foxconn)]

[JVET-O1001](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7637) Crosscheck of JVET-O0312 (Non-CE3: Simplifications of MIP) [C.-C. Kuo, C.-H. YauLin, C.-L. Lin (ITRI)]

[JVET-O0316](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6921) Non-CE3：Unification of ISP and Non-ISP [D. Jiang, J. Lin, F. Zeng, C. Fang (Dahua)]

[JVET-O0317](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6922) CE3-related: MPM List Modification for Zero Reference Line [D. Jiang, J. Lin, F. Zeng, C. Fang (Dahua)]

[JVET-O0318](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6923) Non-CE3: Intra Combined predict [D. Jiang, J. Lin, F. Zeng, C. Fang (Dahua)]

[JVET-O0320](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6925) Non-CE3: CCLM simplification [J.-Y. Huo, Y.-Z. Ma, X.-W. Li, F.-Z. Yang (Xidian Univ.), S. Wan (NPU), Y.-F. Yu, Y. Liu, M. Li (OPPO)]

[JVET-O0978](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7613) Crosscheck of JVET-O0320 (Non-CE3: CCLM simplification) [X. Ma (Huawei)]

[JVET-O0321](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6926) Non-CE3: Removal of MIP mapping table [J.-Y. Huo, Y.-Z. Ma, X.-W. Li, H.-X. Wang, F.-Z. Yang (Xidian Univ.), S. Wan (NPU), Y.-F. Yu, Y. Liu, M. Li (OPPO)]

[JVET-O1007](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7643) Crosscheck of JVET-O0321 (Non-CE3: Removal of MIP mapping table) [J. Choi (LGE)]

[JVET-O0322](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6927) Non-CE3: Simplification of PDPC for chroma component [J.-Y. Huo (Xidian Univ.), S. Wan (NPU), Y.-Z. Ma (Xidian Univ.), J.-K. Guo (NPU), F.-Z. Yang (Xidian Univ.), Y.-F. Yu, Y. Liu, M. Li (OPPO)]

[JVET-O0980](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7616) Crosscheck of JVET-O0322 (Non-CE3: Simplification of PDPC for chroma component) [X. Ma (Huawei)]

[JVET-O0323](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6928) Non-CE3: Unification of shifting for MIP mode [J.-Y. Huo (Xidian Univ.), S. Wan (NPU), Y.-Z. Ma (Xidian Univ.), J.-K. Guo (NPU), H.-X. Wang, F.-Z. Yang (Xidian Univ.), Y.-F. Yu, Y. Liu, M. Li (OPPO)]

[JVET-O0717](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7337) Crosscheck of JVET-O0323 (CE3-related: Unification of shifting for MIP mode) [L. Xu, F. Chen, L. Wang (Hikvision)]

[JVET-O0324](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6929) Non-CE3: MIP Simplification [J.-Y. Huo (Xidian Univ.), S. Wan (NPU), Y.-Z. Ma (Xidian Univ.), J.-K. Guo (NPU), F.-Z. Yang (Xidian Univ.), Y.-F. Yu, Y. Liu, M. Li (OPPO)]

[JVET-O0718](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7338) Crosscheck of JVET-O0324 (Non-CE3: MIP Simplification) [L. Xu, F. Chen, L. Wang (Hikvision)]

[JVET-O0341](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6946) Non-CE3: Unification of intra interpolation filter selection [J. Lee, J. Kang, H. Lee, S.-C. Lim, H. Y. Kim (ETRI)]

[JVET-O0765](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7386) Crosscheck of JVET-O0341: Non-CE3: Unification of intra interpolation filter selection [F. Racapé, G. Rath (Interdigital)]

[JVET-O0343](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6948) CE3-related: Simplification on CCLM process [D.-Y. Kim, J.-O. Lee (Chips&Media), S.-C. Lim, J. Lee, J. Kang (ETRI)]

[JVET-O0845](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7466) Crosscheck of JVET-O0343 (CE3-related: Simplification on CCLM process) [M. Ikeda (Sony)]

[JVET-O0345](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6950) Non-CE3: MIP simplification [C.-H. Yau, C.-C. Lin, C.-L. Lin (ITRI)]

[JVET-O0971](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7603) Crosscheck of JVET-O0345 (Non-CE3: MIP simplification) [M.-S. Chiang (MediaTek)]

[JVET-O0351](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6956) Non-CE3: Clean-up intra type signaling [J. Heo, J. Nam, J. Choi, J. Lim, S. Kim (LGE)]

[JVET-O0353](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6958) Non-CE3: Simplification on transform selection for multiple reference line (MRL) [J. Heo, M. Koo, J. Choi, J. Lim, S. Kim (LGE)]

[JVET-O0707](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7327) Crosscheck of JVET-O0353 (Non-CE3: Simplification on transform selection for multiple reference line (MRL)) [L. Zhao (Tencent)]

[JVET-O0355](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6960) Non-CE3: MRL restriction [J. Heo, J. Choi, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-O0942](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7569) Crosscheck of JVET-O0355 (Non-CE3: MRL restriction) [T.-C. Ma (Kwai Inc.)]

[JVET-O0356](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6961) Non-CE3: Restriction on WAIP for MRL and ISP intra prediction [J. Heo, J. Choi, L. Li, J. Lim, S. Kim (LGE)]

[JVET-O0836](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7457) Crosscheck of JVET-O0356 (Non-CE3: Restriction on WAIP for MRL and ISP intra prediction) [A. Tamse (Samsung)]

[JVET-O0363](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6968) CE3-related: Context reduction for intra MPM related syntax element [L. Xu, X. Cao, F. Chen, L. Wang (Hikvision)]

[JVET-O0816](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7437) Crosscheck of JVET-O0363 (CE3-related: Context reduction for intra MPM related syntax element) [T. Ikai (Sharp)]

[JVET-O0364](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6969) On general intra sample prediction [F. Bossen (Sharp)]

[JVET-O0365](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6970) CE3-related: Simplification of Multi-reference line prediction scheme [L. Xu, X. Cao, F. Chen, L. Wang (Hikvision)]

[JVET-O0749](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7370) Crosscheck of JVET-O0365 (CE3-related: Simplification of Multi-reference line prediction scheme) [?? (??)]

[JVET-O0369](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6974) CE3-related: Context reduction for ISP related syntax element [L. Xu, X. Cao, F. Chen, L. Wang (Hikvision)]

[JVET-O0817](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7438) Crosscheck of JVET-O0369 (CE3-related: Context reduction for ISP related syntax element) [T. Ikai (Sharp)]

[JVET-O0371](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6976) CE3-related: On 1xN and 2xN sub-partition in ISP [Y. Sun, L. Xu, X. Cao (Hikvision)]

[JVET-O0771](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7392) Crosscheck of JVET-O0371 (CE3-related: On 1xN and 2xN sub-partition in ISP) [Y.-W. Chen (Kwai Inc.)]

[JVET-O0377](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6982) CE3-related: Context reduction for CCLM syntax element [L. Xu, X. Cao, F. Chen (Hikvision)]

[JVET-O0818](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7439) Crosscheck of JVET-O0377 (CE3-related: Context reduction for CCLM syntax element) [T. Ikai (Sharp)]

[JVET-O0396](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7001) Non-CE3: Simplified mode mapping in MIP [J. Choi, J. Heo, J. Lim, S. Kim (LGE)]

[JVET-O0750](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7371) Crosscheck of JVET-O0396 (Non-CE3: Simplified mode mapping in MIP) [?? (??)]

[JVET-O0397](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7002) Non-CE3: MIP mode reduction [J. Choi, J. Heo, J. Lim, S. Kim (LGE)]

[JVET-O0918](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7540) Crosscheck of JVET-O0397 (Non-CE3: MIP mode reduction) [K. Zhang (Bytedance)]

[JVET-O0399](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7004) Non-CE3: CCLM block size restriction [J. Choi, J. Heo, J. Lim, S. Kim (LGE)]

[JVET-O1014](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7651) Crosscheck of JVET-O0399 (Non-CE3: CCLM block size restriction) [F. Chen (Hikvision)]

[JVET-O0401](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7006) Non-CE3: MIP mode simplifications [[C. Rosewarne](mailto:chris.rosewarne@canon.com.au), J. Gan (Canon)]

[JVET-O0404](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7009) Non-CE3: Linear Model-based Intra Prediction [R. Ghaznavi-Youvalari (Nokia)]

[JVET-O0407](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7012) Non-CE3: On adaptive rounding offset of MIP [K. Kondo, M. Ikeda, T. Suzuki (Sony)]

[JVET-O1006](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7642) Crosscheck of JVET-O0407 (Non-CE3: On adaptive rounding offset of MIP) [J. Pfaff, M. Schäfer (HHI)]

[JVET-O0408](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7013) Non-CE3: On rounding shift of MIP [K. Kondo, M. Ikeda, T. Suzuki (Sony)]

[JVET-O1011](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7647) Crosscheck of JVET-O0408 (Non-CE3: On rounding shift of MIP) [J. Pfaff, M. Schäfer (HHI)]

[JVET-O0412](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7017) CE3-related: Sampling point extension for CCLM [M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)] [miss] [late]

[JVET-O0833](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7454) Crosscheck of JVET-O0412 (CE3-related: Sampling point extension for CCLM) [S.-C. Lim, J. Lee, H. Lee, J. Kang (ETRI)]

[JVET-O0416](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7021) Non-CE3: Removal of CCLM context derivation dependency [J. Q. Zhang (PKU), X. Zheng (DJI), S. S. Wang, S. W. Ma (PKU)]

[JVET-O0841](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7462) Crosscheck of JVET-O0416: Non-CE3: Removal of CCLM context derivation dependency [J. Chen (Alibaba)]

[JVET-O0426](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7031) Non-CE3: DC intra prediction mode alignment [A. K. Ramasubramonian, G. Van der Auwera, L. Pham Van, M. Karczewicz (Qualcomm)]

[JVET-O0762](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7383) Crosscheck of JVET-O0426 (Non-CE3: DC intra prediction mode alignment) [H.-J. Jhu (Kwai Inc.)]

[JVET-O0449](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7055) Non-CE3: Decoder-side Intra Mode Derivation (DIMD) with prediction fusion using Planar [M. Abdoli, T. Guionnet, E. Mora, M. Raulet (ATEME), S. Blasi, A. Seixas Dias, G. Kulupana (BBC)]

[JVET-O0720](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7340) Crosscheck of JVET-O0449 Decoder-side Intra Mode Derivation with Prediction Fusion Using Planar [V. Drugeon (Panasonic)]

[JVET-O0464](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7071) Non-CE3: Unification of Neighbouring Location for MPM List Construction [D. Kim, J. Jung, G. Ko, J. Son, J. Kwak (WILUS)]

[JVET-O0467](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7074) Non-CE3: simplified MRL and ISP mode coding [F. Le Léannec, Y. Chen, T. Poirier (InterDigital)]

[JVET-O0856](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7477) Crosscheck of JVET-O0467 (Non-CE3: simplified MRL and ISP mode coding) [H. Liu (Bytedance)]

[JVET-O0469](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7076) Non-CE3: Simplification of MIP MPM Derivation [D. Kim, J. Jung, G. Ko, J. Son, J. Kwak (WILUS)]

[JVET-O0477](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7084) Non-CE3: Simplified entropy coding for intra prediction mode [D. Park, Y.-U. Yoon, J. Do, J.-G. Kim (KAU), J. Lee, J. Kang (ETRI)]

[JVET-O1009](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7645) Crosscheck of JVET-O0477 (Non-CE3: Simplified entropy coding for intra prediction mode) [J. Choi (LGE)]

[JVET-O0481](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7088) Variations of the 8-bit implementation of MIP [P. Helle, J. Pfaff, T. Hinz, P. Merkle, B. Stallenberger, M. Schäfer, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

[JVET-O0484](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7091) CE3-related: Improved intra mode coding based on unified MPM list generation [J. Pfaff, T. Hinz, P. Merkle, P. Helle, B. Stallenberger, M. Schäfer, H. Schwarz, D. Marpe, T. Wiegand (HHI), B. Wang, S. Esenlik, A. M. Kotra, H. Gao, E. Alshina (Huawei)]

[JVET-O0938](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7563) Crosscheck of JVET-O0484 (CE3-related: Improved intra mode coding based on unified MPM list generation) [M. Salehifar (LGE)]

[JVET-O0485](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7092) Non-CE3: Harmonization of 8-Bit MIP with Unified-MPM and LFNST [J. Pfaff, T. Hinz, P. Helle, P. Merkle, B. Stallenberger, M. Schäfer, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

[JVET-O0885](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7507) Crosscheck of JVET-O0485 (Non-CE3: Harmonization of 8-Bit MIP with Unified-MPM and LFNST) [Z. Zhang (Ericsson)]

[JVET-O0486](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7093) Non-CE3: Harmonization of 8-Bit MIP with Unified-MPM and LFNST using a single type of MIP prediction modes [J. Pfaff, T. Hinz, P. Helle, P. Merkle, B. Stallenberger, M. Schäfer, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

[JVET-O0886](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7508) Crosscheck of JVET-O0486 (Non-CE3: Harmonization of 8-Bit MIP with Unified-MPM and LFNST using a single type of MIP prediction modes) [Z. Zhang (Ericsson)]

[JVET-O0502](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7109) Non-CE3: Proposed ISP cleanup [S. De-Luxán-Hernández, V. George, G. Venugopal, J. Brandenburg, B. Bross, T. Nguyen, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

[JVET-O0944](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7571) Crosscheck of JVET-O0502 (Non-CE3: Proposed ISP cleanup) [T.-C. Ma (Kwai Inc.)]

[JVET-O0507](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7114) Non-CE3: Intra-sub-partition coding mode only performing on non-square blocks [W. Gwun, W. Lee, D. Y. Lee, T. H. Kim, G. H. Park (KHU), G. Bang, W. Lim, H.Y. Kim (ETRI)]

[JVET-O0988](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7624) Cross-check of Non-CE3: Intra-sub-partition coding mode only performing on non-square blocks (JVET-O0507) [M. W. Park (Samsung)]

[JVET-O0509](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7116) Non-CE3: MPM flag signaling first [D. Y. Lee, W. Gwun, W. Lee, T. H. Kim, G. H. Park (KHU), J. Lee, J. Kang (ETRI)]

[JVET-O1056](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7693) Cross-check of Non-CE3: MPM flag signaling first (JVET-O0509) [M. W. Park (Samsung)]

[JVET-O0510](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7117) CE3-related: Extensions to CCLM reference sample filtering in CE3-3.2.1 [S. Keating, K. Sharman (Sony)]

[JVET-O0512](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7119) Non-CE3: CCLM Coding bug fix [S. Keating, K. Sharman (Sony)]

[JVET-O0716](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7336) Crosscheck of JVET-O0512 (Non-CE3: CCLM Coding bug fix) [L. Xu, F. Chen, L. Wang (Hikvision)]

[JVET-O0514](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7121) Non-CE3: Analysis of Matrix-based Intra Prediction (Informative) [S. Keating, K. Sharman (Sony)]

[JVET-O0515](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7122) Non CE3: Intra mode coding of non-MPM modes [S. Blasi, G. Kulupana, A. Seixas Dias (BBC)]

[JVET-O0523](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7130) CE3-related: simplification of Matrix Intra Prediction [T. Dumas, F. Galpin, G. Rath, F. Racapé (InterDigital)]

[JVET-O1051](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7688) Crosscheck of JVET-O0523 (CE3-related: simplification of Matrix Intra Prediction (MIP)) [C. Rosewarne (Canon)]

[JVET-O0535](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7142) Non-CE3: Unification of PDPC for diagonal intra prediction modes [L. Zhao, X. Zhao, X. Li, S. Liu (Tencent)]

[JVET-O0766](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7387) Crosscheck of JVET-O0535: Non-CE3: Unification of PDPC for diagonal intra prediction modes [F. Racapé, G. Rath (Interdigital)]

[JVET-O0536](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7143) CE3-related: Redundant bit saving for CE3-2.2 [L. Zhao, X. Zhao, X. Li, S. Liu (Tencent)]

[JVET-O0779](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7400) Crosscheck of JVET-O0536: CE3-related: Redundant bit saving for CE3-2.2 [L. Pham Van, G. Van der Auwera, M. Karczewicz (Qualcomm)]

[JVET-O0547](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7159) Non-CE: Modified MIP Matrices for Fast Implementation [K. Naser, L. Kerofsky, F. Le Léannec, T. Poirier (InterDigital)]

[JVET-O0962](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7592) Crosscheck of JVET-O0547 (Non-CE: Modified MIP Matrices for Fast Implementation) [J. Pfaff, M. Schäfer (HHI)]

[JVET-O0571](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7186) Non-CE3: Up-sampling with a fixed order in MIP [H. Liu, L. Zhang, K. Zhang, Z. Deng, J. Xu (Bytedance)]

[JVET-O0843](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7464) Crosscheck of JVET-O0571: Non-CE3: Up-sampling with a fixed order in MIP [J. Chen (Alibaba)]

[JVET-O0598](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7213) CE3-related: Simplification on MIP Look-up Table [T.-C. Ma, X. Xiu, Y.-W. Chen, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-O0693](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7313) Crosscheck of JVET-O0598 (CE3-related: Simplification on MIP Look-up Table) [L. Zhao (Tencent)]

[JVET-O0599](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7214) CE3-related: Simplification on MIP flag context model [T.-C. Ma, X. Xiu, Y.-W. Chen, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-O0815](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7436) Crosscheck of JVET-O0599 (CE3-related: Simplification on MIP flag context model) [J. Heo, L. Li (LGE)]

[JVET-O0606](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7221) Non-CE3: Context Reduction for MPM Signaling [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-O1020](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7657) Crosscheck of JVET-O0606 (Non-CE3: Context Reduction for MPM Signaling) [?? (??)]

[JVET-O0621](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7236) Non-CE3: MIP simplification [Y. Yasugi, T. Ikai (Sharp)] [miss] [late]

[JVET-O0855](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7476) Crosscheck of JVET-O0621 (Non-CE3: MIP simplification) [Z. Deng (Bytedance)]

[JVET-O0632](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7247) Non-CE3: WAIP restriction for square sub-CU blocks partitioned by ISP [A. Kumar, S. Shrestha, B. Lee (Chosun Univ), Y. Lee, J. Park (Humax)]

[JVET-O0640](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7256) CE3-related: On 2x2/2x4/4x2 chroma blocks at the corner of pictures [L. Pham Van, G. Van der Auwera, A. K. Ramasubramonian, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0647](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7263) Non-CE3: On signalling of intra coded blocks [L. Pham Van, G. Van der Auwera, A. K. Ramasubramonian, V. Seregin, H. Huang, M. Karczewicz (Qualcomm)]

[JVET-O0649](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7265) Non-CE3: Simplification of reference sample smoothing in intra prediction [A. K. Ramasubramonian, G. Van der Auwera, M. Karczewicz (Qualcomm)]

[JVET-O0655](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7271) Non-CE3: On chroma DM derivation table for 4:2:2 chroma format [S. Iwamura, S. Nemoto, A. Ichigaya (NHK)]

[JVET-O0687](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7306) Crosscheck of JVET-O0655 (Non-CE3: On chroma DM derivation table for 4:2:2 chroma format) [T. Chujoh (Sharp)]

[JVET-O0671](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7288) Non-CE3: Intra chroma mode coding simplification [B. Ray, G. Van der Auwera, M. Karczewicz (Qualcomm)]

[JVET-O0672](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7290) Non-CE3: MRL intra prediction for chroma DM [C.-C. Kuo, C.-C. Lin, C.-L. Lin (ITRI)]

[JVET-O0673](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7291) Harmonized MIP/CCLM boundary downsampling [T. Biatek, G. Van Der Auwera, M. Karczewicz (Qualcomm)]

[JVET-O1036](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7673) Crosscheck of JVET-O0673 (Harmonized MIP/CCLM boundary downsampling) [Christophe Chevance (InterDigital)]

[JVET-O0674](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7292) Non-CE3: Multiple reference set for CCLM [P.-H. Lin, J.-Y. Deng (Foxconn)] [late]

[JVET-O0760](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7381) Crosscheck of JVET-O0674 (Non-CE3: Multiple reference set for CCLM) [H.-J. Jhu (Kwai Inc.)]

[JVET-O0748](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7369) Non-CE3: On signalling for intra coding mode in the MPM list [L. Pham Van, G. Van der Auwera, A. K. Ramasubramonian, M. Karczewicz (Qualcomm)] [late]

[JVET-O1038](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7675) Crosscheck of JVET-O0748 (Non-CE3: On signalling for intra coding mode in the MPM list) [L. Zhao (Tencent)]

[JVET-O0755](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7376) Non-CE3: On signalling of MIP parameters [A. K. Ramasubramonian, G. Van der Auwera, T. Hsieh, T. Biatek, L. Pham Van, M. Karczewicz (Qualcomm)] [late]

[JVET-O0793](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7414) CE3-related: MIP with simplified mode index coding [Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)] [late]

[JVET-O0848](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7469) Non CE3: Modification of MIP interpolation [B.-J. Fuh, C.-H. Yau, C.-C. Lin, C.-C. Kuo, C.-L. Lin (ITRI)] [late]

[JVET-O1043](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7680) Crosscheck of JVET-O0848 (Non CE3: Modification of MIP interpolation) [[T.-H. Li](mailto:thli@fginnov.com), J.-Y. Deng (Foxconn)]

[JVET-O0925](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7550) Non-CE3: Simplifications of MIP [J. Pfaff, P. Merkle, P. Helle, H. Schwarz, D. Marpe, T. Wiegand (HHI), A. K. Ramasubramonian, T. Biatek, G. Van der Auwera, L. Pham Van, M. Karczewicz (Qualcomm), J. Choi, J. Heo, J. Lim, M. Salehifar, S. Kim (LGE), K. Kondo, M. Ikeda, T. Suzuki (Sony), Z. Zhang, K. Andersson, R. Sjöberg, J. Ström, P. Wennersten (Ericsson)] [late]

## CE4 related – Inter prediction (105)

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

[JVET-O0123](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6727) Non-CE4: Alignment of BDOF refinement process with PROF [J. Li, C. Lim (Panasonic)]

[JVET-O0733](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7354) Crosscheck of JVET-O0123: Non-CE9: Alignment of BDOF refinement process with PROF [[W. Chen (InterDigital)](mailto:Wei.Chen@InterDigital.com)]

[JVET-O0125](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6729) Non-CE4: Alignment of DMVR padding process with specification [J. Li, C.S. Lim (Panasonic)]

[JVET-O0714](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7334) Crosscheck of JVET-O0125: Non-CE9: Alignment of DMVR padding process with specification [X. Xiu (Kwai Inc.)]

[JVET-O0126](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6730) Non-CE4: Align coding of BPWA index with normal truncated rice binarization process [J. Li, C.S. Lim (Panasonic)]

[JVET-O0794](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7415) Crosscheck of JVET-O0126 (Non-CE4: Align coding of BPWA index with normal truncated Rice binarization process) [S.-T. Hsiang (MediaTek)]

[JVET-O0128](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6732) Non-CE4: simplification of triangle mode MV context storage [J. Li, C.S. Lim (Panasonic)]

[JVET-O0724](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7344) Crosscheck of JVET-O0128 (Non-CE4: Simplification of triangle mode MV context storage) [R.-L. Liao (Alibaba)]

[JVET-O0163](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6767) Non-CE4: Simplification on SbTMVP [H. Chen, H. Yang (Huawei)]

[JVET-O0926](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7551) Crosscheck of JVET-O0163 (Non-CE4: Simplification on SbTMVP) [Y.-C. Lin (MediaTek)]

[JVET-O0164](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6768) Non-CE4: Simplification on AMVP list construction [H. Chen, H. Yang (Huawei)]

[JVET-O0742](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7363) Crosscheck of JVET-O0164 (Non-CE4: Simplification on AMVP list construction) [J. Li (Bytedance)]

[JVET-O0801](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7422) Crosscheck of JVET-O0164 (Non-CE4: Simplification on AMVP list construction) [J. Li (Bytedance)]

[JVET-O0167](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6771) Non-CE4: On SbTMVP motion data derivation [J. Zhao, S. Kim (LGE)]

[JVET-O0867](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7488) Crosscheck of JVET-O0167 (Non-CE4: On SbTMVP base motion data derivation) [N. Zhang (Bytedance)]

[JVET-O0190](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6794) Non-CE4: LIC model parameters using forward mapped luma samples in LMCS [J. Shingala, A. Natesan (Ittiam)]

[JVET-O0804](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7425) Crosscheck of JVET-O0190 (Non-CE4: LIC model parameters using forward mapped luma samples in LMCS) [C.-M. Tsai (MediaTek)]

[JVET-O0217](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6822) Non-CE4: Simplification of motion vector storing process for triangle merge mode [Y. Ahn, D. Sim (Digital Insights)]

[JVET-O0220](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6825) Non-CE4: On maximum number of subblock merge candidates [R. Yu, D. Liu (Ericsson)]

[JVET-O0221](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6826) Non-CE4: On merge data syntax [[R. Yu](mailto:ruoyang.yu@ericsson.com), D. Liu (Ericsson)]

[JVET-O0222](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6827) Non-CE4: Modification of triangle merge mode enabling criterion [D. Liu, R. Yu (Ericsson)]

[JVET-O1041](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7678) Crosscheck of JVET-O0222 (Non-CE4: Modification of triangle merge mode enabling criterion) [F. Chen (Hikvision)]

[JVET-O0249](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6854) Non-CE4: Merge Modes Signalling [H. Huang, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0728](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7348) Crosscheck of JVET-O0249 (Non-CE4: Merge Modes Signaling) [R.-L. Liao (Alibaba)]

[JVET-O0951](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7580) Crosscheck of JVET-O0249 Merge Modes Signaling [J. Ye, X. Li]

[JVET-O0252](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6857) CE4-related: Alignment and simplification of PROF and BDOF [H. Huang, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0688](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7307) Crosscheck of JVET-O0252: CE4-related: Alignment and simplification of PROF and BDOF [X. Xiu (Kwai Inc.)]

[JVET-O0253](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6858) Non-CE4: Simplification of HMVP in AMVP mode [H. Huang, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-O0949](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7577) Cross-check of JVET-O253 (Non-CE4: Simplification of HMVP in AMVP mode) [F. Galpin (InterDigital)]

[JVET-O0254](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6859) Non-CE4: Size constrain for inherited affine motion prediction [H. Huang, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-O0990](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7626) Crosscheck of JVET-O0254 (Non-CE4: Size constrain for inherited affine motion prediction) [J. Li (Panasonic)]

[JVET-O0257](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6862) CE4-related: Simplified local illumination compensation [N. Zhang, H. Liu, L. Zhang, K. Zhang, Y. Wang (Bytedance)]

[JVET-O0712](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7332) Crosscheck of JVET-O0257 (CE4-related: Simplified local illumination compensation) [N. Park (LGE)]

[JVET-O0263](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6868) Non-CE4: Cleanups on syntax design for sub-block coding tools [K. Zhang, L. Zhang, H. Liu, N. Zhang, Z. Deng, Y. Wang (Bytedance)]

[JVET-O0265](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6870) Non-CE4: Simplified motion field storage for TPM [N. Zhang, H. Liu, L. Zhang, K. Zhang, Y. Wang (Bytedance)]

[JVET-O0676](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7294) Crosscheck of JVET-O0265: Non-CE4: Simplified motion field storage for TPM [J. Zhao (LGE)]

[JVET-O0278](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6883) CE4-related: On signalling of merge flags [Y.-L. Hsiao, C.-C. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0828](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7449) Crosscheck of JVET-O0278 (CE4-related: On signalling of merge flags) [H. Chen (Huawei)]

[JVET-O0279](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6884) CE4-related: Simplification of motion vector storing process for triangle prediction mode [Y.-L. Hsiao, C.-C. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0835](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7456) Crosscheck of JVET-O0279 (CE4-related: Simplification of motion vector storing process for triangle prediction mode) [H. Lee, S.-C. Lim, J. Lee, J. Kang (ETRI)]

[JVET-O0280](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6885) CE4-related: SIMD implementation for weighted sample prediction process of triangle prediction mode [Y.-L. Hsiao, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0859](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7480) Crosscheck of JVET-O0280 (CE4-related: SIMD implementation for weighted sample prediction process of triangle prediction mode) [T. Hashimoto (Sharp)]

[JVET-O0281](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6886) CE4-related: Alignment of displacement bitdepths for BDOF and PROF [C.-Y. Lai, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0900](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7522) Crosscheck of JVET-O0281 (CE4-related: Alignment of displacement bitdepths for BDOF and PROF) [H. Huang (Qualcomm)]

[JVET-O0283](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6888) CE4-related: Simplification for SbTMVP [Y.-C. Lin, C.-C. Chen, C.-W. Hsu, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0284](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6889) CE4-related: Interaction between symmetric MVD and mvd\_l1\_zero\_flag [M.-S. Chiang, C.-W. Hsu, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0285](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6890) CE4-related: On merging candidate list construction [Y.-C. Lin, C.-C. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0879](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7501) Crosscheck of JVET-O0285 (CE4-related: On merging candidate list construction) [H. Gao (Huawei)]

[JVET-O0286](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6891) CE4-related: Extension of phase-variant affine subblock motion compensation in CE4-2.5 [T.-D. Chuang, C.-Y. Lai, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0820](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7441) Crosscheck of JVET-O0286 (CE4-related: Extension of phase-variant affine subblock motion compensation in CE4-2.5) [T.-S Chang (Alibaba)]

[JVET-O0305](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6910) Non-CE4: Undefined condition of merge mode syntax [K. Abe, T. Toma, J. Li, V. Drugeon (Panasonic)]

[JVET-O0309](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6914) Non-CE4: Merge mode signalling overhead reduction [G. Ko, D. Kim, J. Jung, J. Son, J. Kwak (WILUS)]

[JVET-O0829](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7450) Crosscheck of JVET-O0309 (Non-CE4: Merge mode signalling overhead reduction) [H. Chen (Huawei)]

[JVET-O0313](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6918) CE4-related: On Conditions for enabling PROF [Y.-C. Yang, P.-H. Lin (Foxconn)]

[JVET-O0734](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7355) Crosscheck of JVET-O0313: CE4-related: On Conditions for enabling PROF [[W. Chen (InterDigital)](mailto:Wei.Chen@InterDigital.com)]

[JVET-O0314](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6919) Non-CE4: Modification of MV storage in triangle merge mode [P.-H. Lin (Foxconn)]

[JVET-O0759](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7380) Crosscheck of JVET-O0314 (Non-CE4: Modification of MV storage in triangle merge mode) [H.-J. Jhu (Kwai Inc.)]

[JVET-O0328](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6933) Non-CE4: On Sub-block Merge Candidates List [H. Lee, S.-C. Lim, J. Lee, J. Kang, H. Y. Kim (ETRI)]

[JVET-O0329](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6934) Non-CE4: Simplification of motion vector storage process for triangle merge mode [H. Lee, S.-C. Lim, J. Lee, J. Kang, H. Y. Kim (ETRI)]

[JVET-O0881](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7503) Crosscheck of JVET-O0329 (Non-CE4: Simplification of motion vector storage process for triangle merge mode) [[R. Yu](mailto:ruoyang.yu@ericsson.com), D. Liu (Ericsson)]

[JVET-O0790](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7411) Crosscheck of JVET-O0328 (Non-CE4: On sub-block merge candidates list) [Y.-L. Hsiao (MediaTek)]

[JVET-O0330](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6935) Non-CE4: Syntax element ‘regular\_merge\_flag’ signalling [H. Lee, S.-C. Lim, J. Lee, J. Kang, H. Y. Kim (ETRI)]

[JVET-O0770](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7391) Crosscheck of JVET-O0330 (Non-CE4: Syntax element ‘regular\_merge\_flag’ signaling) [Y.-W. Chen (Kwai Inc.)]

[JVET-O0361](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6966) Non-CE4: Remove the redundancy among the flag coding for merge modes [F. Chen, L. Wang (Hikvision)]

[JVET-O1008](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7644) Crosscheck of JVET-O0361 (Non-CE4: Remove the redundancy among the flag coding for merge modes) [J. Choi (LGE)]

[JVET-O0362](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6967) Non-CE4: Modified enabling condition for triangle mode [F. Chen, L. Wang (Hikvision)]

[JVET-O0725](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7345) Crosscheck of JVET-O0362 (Non-CE4: Modified Enabling Condition for Triangle Mode) [R.-L. Liao (Alibaba)]

[JVET-O0366](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6971) Non-CE4: Simplifications on BCW index derivation process [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-O0685](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7304) Crosscheck of JVET-O0366 (Non-CE4: Simplifications on BCW index derivation process) [T. Chujoh (Sharp)]

[JVET-O0367](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6972) Non-CE4: The proposed BCW index derivation for pairwise candidate [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-O0991](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7627) Crosscheck of JVET-O0367 (Non-CE4: The proposed BCW index derivation for pairwise candidate) [J. Li (Panasonic)]

[JVET-O0378](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6983) Non-CE4: Simplification of MV context storage for triangle mode [F. Chen, L. Wang (Hikvision)]

[JVET-O0880](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7502) Crosscheck of JVET-O0378 (Non-CE4: Simplification of MV context storage for triangle mode) [[D. Liu](mailto:du.liu@ericsson.com), R. Yu (Ericsson)]

[JVET-O0379](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6984) Non-CE4: Modified mode decision process for triangle mode [F. Chen, L. Wang (Hikvision)]

[JVET-O0726](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7346) Crosscheck of JVET-O0379 (Non-CE4: Modified Mode Decision Process for Triangle Mode) [R.-L. Liao (Alibaba)]

[JVET-O0384](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6989) CE4-related: CIIP Simplification [J. Y. Lee (Sejong Univ.), W. Lim, G. Bang, H. Y. Kim (ETRI)] [miss] [late]

[JVET-O1022](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7659) Crosscheck of JVET-O0384 (CE4-related: CIIP Simplification) [K. Choi (Samsung)]

[JVET-O0388](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6993) Non-CE4: On the context of triangle merge index [F. Chen, L. Wang (Hikvision)]

[JVET-O0727](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7347) Crosscheck of JVET-O0388 (Non-CE4: On the Context of Triangle Merge Index) [R.-L. Liao (Alibaba)]

[JVET-O0411](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7016) Non-CE4: Simplification of bi-prediction MV generation for triangle partition mode storage [K. Reuzé, C.-C. Chen, W.-J. Chien, H. Huang, M. Karczewicz (Qualcomm)]

[JVET-O0414](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7019) Non-CE4: Symmetric-MVD control considering the reference picture type [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-O0730](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7351) Crosscheck of JVET-O0414: Non-CE4 : Symmetric-MVD control considering the reference picture type [[Y. He (InterDigital)](mailto:yuwen.he@interdigital.com)]

[JVET-O0415](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7020) Non-CE4: Fix of POC distance condition for MMVD [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-O0868](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7489) Crosscheck of JVET-O0415 (Non-CE4: Fix of POC distance condition for MMVD) [N. Zhang (Bytedance)]

[JVET-O0418](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7023) CE4-related: Simplification of motion vector storage operation for triangle merge mode [X. W. Meng (PKU), X. Zheng (DJI), S. S. Wang, S. W. Ma (PKU)]

[JVET-O0995](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7631) Crosscheck of JVET-O0418 (CE4-related: Simplification of motion vector storage operation for triangle merge mode) [J. Li (Panasonic)]

[JVET-O0420](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7025) CE4-related: Reduce scaling operation number for MMVD [S. H. Wang (PKU), X. Zheng (DJI), S. S. Wang, S. W. Ma (PKU)]

[JVET-O0761](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7382) Crosscheck of JVET-O0420 (CE4-related: Reduce scaling operation number for MMVD) [H.-J. Jhu (Kwai Inc.)]

[JVET-O0421](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7026) Non-CE4: On CIIP Merge mode with no residual [G. Laroche, C. Gisquet, J. Taquet, P. Onno (Canon)]

[JVET-O0422](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7027) Non-CE4: On mode flags signalling for Merge [G. Laroche, C. Gisquet, J. Taquet, P. Onno (Canon)]

[JVET-O0423](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7028) Non-CE4: On SbTMVP derivation using HMVP [C. Gisquet, G. Laroche, P. Onno, J. Taquet (Canon)]

[JVET-O0887](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7509) Crosscheck of JVET-O0423 (Non-CE4: On SbTMVP derivation using HMVP) [F. Henry (Orange), G. Clare (bcom)]

[JVET-O0424](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7029) Non-CE4: On TMVP reference frame selection using HMVP [C. Gisquet, G. Laroche, P. Onno, J. Taquet (Canon)]

[JVET-O0869](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7490) Crosscheck of JVET-O441

0424 (Non-CE4: On TMVP reference frame selection using HMVP) [N. Zhang (Bytedance)]

[JVET-O0431](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7036) Non-CE4: On Merge data signaling [H. Chen, X. Chen, H. Yang (Huawei)]

[JVET-O1025](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7662) Crosscheck of JVET-O0431 (Non-CE4: On Merge data signalling) [Z.-Y. Lin (MediaTek)]

[JVET-O0434](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7039) Non-CE4: Simplification of TMVP [H. Chen, H. Yang (Huawei)]

[JVET-O0947](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7574) Crosscheck of JVET-O0434 (Non-CE4: Simplification of TMVP) [G. Ko, D. Kim, J. Jung, J. Son, J. Kwak (WILUS)]

[JVET-O0438](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7043) Non-CE4: Cleanup for affine AMVR enabling flag in SPS level [G. Ko, D. Kim, J. Jung, J. Son, J. Kwak (WILUS)]

[JVET-O0439](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7044) Non-CE4: Modification of the temporal merging candidate for the regular merge mode [G. Lee, G. Kim, S. Cha, D. Nam, J. Han (Sejong University)]

[JVET-O0834](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7455) Crosscheck of JVET-O0439 (Non-CE4: Modification of the temporal merging candidate for the regular merge mode) [S.-C. Lim, H. Lee, J. Kang, J. Lee (ETRI)]

[JVET-O0440](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7045) Non-CE4: A modified method to derive the temporal merge candidate for long-term reference picture [G. Lee, G. Kim, S. Cha, D. Nam, J. Han (Sejong University)]

[JVET-O0441](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7046) Non-CE4: Short-tap interpolation for bi-prediction [[X. W. Meng (PKU)](mailto:xwmeng@pku.edu.cn), [X. Zheng (DHI)](mailto:xiaozhen.zheng), S. S. Wang, S. W. Ma (PKU)]

[JVET-O0870](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7491) Crosscheck of JVET-O0441 (Non-CE4: Short-tap interpolation filter for bi-prediction) [N. Zhang (Bytedance)]

[JVET-O0456](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7062) Non-CE4: Grouping the syntax elements of motion vector differences [Y.-J. Chang, Y. Zhang, C.-C. Chen, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-O0802](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7423) Crosscheck of JVET-O0456: Non-CE4: Grouping the syntax elements of motion vector differences [Y. He (InterDigital)]

[JVET-O0457](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7064) CE4-related: LIC flag inherited per component [P. Bordes, F. Urban, F. Le Léannec, F. Galpin, T. Poirier (InterDigital)]

[JVET-O0686](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7305) Crosscheck of JVET-O0457 (CE4-related: LIC flag inherited per component) [T. Chujoh (Sharp)]

[JVET-O0468](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7075) Non-CE4: simplified SMVD mode coding [F. Le Léannec, Y. Chen, T. Poirier (InterDigital)]

[JVET-O0470](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7077) CE4-related: encoder simplification of local illumination compensation [F. Urban, P. Bordes, F. Le Léannec, F. Galpin, T. Poirier (InterDigital)]

[JVET-O1065](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7702) Crosscheck of JVET-O0470 on encoder simplification of local illumination compensation [V. Seregin (Qualcomm)]

[JVET-O1066](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7703) Crosscheck of JVET-O0466 (Non-CE6: interaction between MTS and LFNST) [H. E. Egilmez (Qualcomm)]

[JVET-O0489](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7096) Non-CE4: Geometrical partitioning for inter blocks [S. Esenlik, H. Gao, A. Filippov, V. Rufitskiy, A. M. Kotra, B. Wang, E. Alshina (Huawei), M. Bläser, J. Sauer (RWTH Aachen)]

[JVET-O1010](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7646) Crosscheck of JVET-O0489 (Non-CE4: Geometrical partitioning for inter blocks) [A. Wieckowski (HHI)]

[JVET-O0500](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7107) Non-CE4: Affine and sub-block modes coding clean-up [F. Galpin, F. Le Léannec, A. Robert, T. Poirier (InterDigital)]

[JVET-O0903](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7525) Crosscheck of JVET-O0500 (non-CE4: affine and sub-block modes coding clean-up) [H. Huang (Qualcomm)]

[JVET-O0501](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7108) Non-CE4: Temporal merge modes simplification [F. Galpin, F. Le Léannec, A. Robert, T. Poirier (InterDigital)]

[JVET-O0904](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7526) Crosscheck of JVET-O0501 (non-CE4: temporal merge modes simplification) [H. Huang (Qualcomm)]

[JVET-O0513](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7120) Non-CE4: Adaptive blending filtering for TPM [S. Esenlik, H. Gao, B. Wang, A. Kotra, Z. Zhao, E. Alshina (Huawei), M. Bläser, J. Sauer (RWTH Aachen)]

[JVET-O0921](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7545) Crosscheck of JVET-O0513: Non-CE4: Adaptive blending filtering for TPM [X. Xiu (Kwai Inc.)]

[JVET-O0516](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7123) Non-CE4: BCW for pairwise candidate [A. Robert, F. Le Léannec, T. Poirier, F. Galpin (InterDigital)]

[JVET-O1023](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7660) Crosscheck of JVET-O0516 (Non-CE4: BCW for pairwise candidate) [N. Park (LGE)]

[JVET-O0522](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7129) Non-CE4: CIIP using triangular partitions [S. Blasi, G. Kulupana, A. Seixas Dias (BBC)]

[JVET-O1029](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7666) Crosscheck of JVET-O0522 (Non-CE4: CIIP using triangular partitions) [I. Zupancic (HHI)]

[JVET-O0530](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7137) Non-CE4: Adaptive subblock size for affine motion compensation [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

[JVET-O0531](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7138) Non-CE4: On LIC for Affine [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

[JVET-O0713](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7333) Crosscheck of JVET-O0531: Non-CE4: On LIC for Affine [X. Xiu (Kwai Inc.)]

[JVET-O0534](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7141) Non-CE4: Redundancy removal for merge mode signaling [J. Ye, X. Li, S. Liu (Tencent)]

[JVET-O0552](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7165) Non-CE4: Extension of triangle partition mode to P-slices [K. Reuzé, C.-C Chen, W.-J. Chien, H. Huang, M. Karczewicz (Qualcomm)]

[JVET-O1028](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7665) Crosscheck of JVET-O0552 (Non-CE4: Extension of triangle partition mode to P-slices) [I. Zupancic (HHI)]

[JVET-O0553](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7167) Non-CE4: On prediction refinement with optical flow [X. Li, G. Li, X. Xu, S. Liu (Tencent)]

[JVET-O0736](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7357) Crosscheck of JVET-O0553: Non-CE4: On prediction refinement with optical flow [W. Chen (InterDigital)]

[JVET-O0560](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7174) Merge Mode Syntax [L. Wang, K. Panusopone (Nokia)]

[JVET-O0567](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7182) Non-CE4: Cleanups on MVD ranges [Z. Deng, H. Liu, L. Zhang, K. Zhang, Y. Wang (Bytedance)]

[JVET-O0572](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7187) Non-CE4: On availability of default reference pictures used in SMVD [H. Liu, L. Zhang, K. Zhang, Z. Deng, N. Zhang, Y. Wang (Bytedance)]

[JVET-O0579](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7194) Non-CE4: SMVD processing when mvd\_l1\_zero\_flag is set equal to 1 [H. Jang, N. Park, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-O0864](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7485) Crosscheck of JVET-O0579: "Non-CE4: SMVD processing when mvd\_l1\_zero\_flag is set equal to 1" [F. Le Léannec (Interdigital)]

[JVET-O0580](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7195) CE4-related: Additional tests for prediction refinement with optical flow for affine mode (CE4-2.1) with 4x8 sub-block size [Y. He, W. Chen (InterDigital), W. Zeng, E. Cai (Ubilinx)]

[JVET-O0930](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7555) Crosscheck of JVET-O0580 (CE4-related: Additional tests for prediction refinement with optical flow for affine mode (CE4-2.1) with 4x8 sub-block size) [G. Li (Tencent)]

[JVET-O0583](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7198) CE4-related: Prediction refinement with optical flow for chroma components for affine mode [Y. He, W. Chen (InterDigital)]

[JVET-O0812](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7433) Crosscheck of JVET-O0583 (CE4-related: Prediction refinement with optical flow for chroma components for affine mode) [[T.-H. Li](mailto:thli@fginnov.com), J.-Y. Deng (Foxconn)]

[JVET-O0585](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7200) Non-CE4: Merge syntax for removing redundant syntax signaling or fall back merge mode [H. Jang, N. Park, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-O0973](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7605) Crosscheck of JVET-O0585 (Non-CE4: Merge syntax for removing redundant syntax signaling or fall back merge mode) [M.-S. Chiang (MediaTek)]

[JVET-O0586](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7201) Non-CE4: Redundancy removal in merge modes signaling [Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, S. Ye, X. Wang (Kwai Inc.)]

[JVET-O0697](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7317) Crosscheck of JVET-O0586 (Non-CE4: Redundancy removal in merge modes signaling) [Y.-H. Chao (Qualcomm)]

[JVET-O0587](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7202) Non-CE4: Simplification of MVP list construction [Y.-W. Chen, X. Xiu, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-O0931](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7556) Crosscheck of JVET-O0587 (Non-CE4: Simplification of MVP list construction) [G. Li (Tencent)]

[JVET-O0588](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7203) CE4-related: On SbTMVP motion shift derivation [Y.-W. Chen, X. Xiu, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-O0780](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7401) Crosscheck of JVET-O0588: CE4-related: On SbTMVP motion shift derivation [Y.-C. Sun (Alibaba)]

[JVET-O0589](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7204) Non-CE4: Simplification of HMVP in merge list construction [Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-O0698](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7318) Crosscheck of JVET-O0589 (Non-CE4: Simplification of HMVP in merge list construction) [Y.-H. Chao (Qualcomm)]

[JVET-O0592](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7207) CE4-related: Motion estimation improvements [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-O0932](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7557) Crosscheck of JVET-O0592 (CE4-related: Motion estimation improvements) [G. Li (Tencent)]

[JVET-O0593](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7208) CE4-related: Harmonization of BDOF and PROF [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-O0735](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7356) Crosscheck of JVET-O0593: CE4-related: Harmonization of BDOF and PROF [[W. Chen (InterDigital)](mailto:Wei.Chen@InterDigital.com)]

[JVET-O0594](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7209) CE4-related: Prediction sample padding unification for BDOF and PROF [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-O0905](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7527) Crosscheck of JVET-O0594 (CE4-related: Prediction sample padding unification for BDOF and PROF) [H. Huang (Qualcomm)]

[JVET-O0595](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7210) CE4-related: Modified adaptive motion vector resolution (AMVR) for affine mode [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-O0933](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7558) Crosscheck of JVET-O0595 (CE4-related: Modified adaptive motion vector resolution (AMVR) for affine mode) [G. Li (Tencent)]

[JVET-O0601](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7216) CE4-related: On motion vector population under triangle prediction mode [X. Wang, Y.-W. Chen, X. Xiu, T.-C. Ma (Kwai Inc.)]

[JVET-O1034](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7671) Crosscheck of JVET-O0601: CE4-related: On motion vector population under triangle prediction mode [H. Wang (Qualcomm)]

[JVET-O0604](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7219) CE4-related: Simplification on block location validation in SbTMVP [Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-O0785](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7406) Crosscheck of JVET-O0604: CE4-related: Simplification on block location validation in SbTMVP [Y.-C. Sun (Alibaba)]

[JVET-O0605](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7220) CE4-related: On exclusively applying LIC and PROF [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-O0830](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7451) Crosscheck of JVET-O0605 (CE4-related: On exclusively applying LIC and PROF) [H. Chen (Huawei)]

[JVET-O0607](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7222) CE4-related: On handling the interaction of the mvd\_l1\_zero\_flag and sym\_mvd\_flag [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-O0624](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7239) CE4-related: Unified padding for BDOF and PROF [K. Zhang, L. Zhang, H. Liu, J. Xu, Y. Wang (Bytedance)]

[JVET-O0814](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7435) Crosscheck of JVET-O0624 (CE4-related: Unified padding for BDOF and PROF) [[T.-H. Li](mailto:thli@fginnov.com), J.-Y. Deng (Foxconn)]

[JVET-O0629](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7244) Non-CE4: Simplification of motion field for triangle partition [R.-L. Liao, Y. Ye, J. Chen (Alibaba)]

[JVET-O0792](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7413) Crosscheck of JVET-O0629 (Non-CE4: Simplification of motion field for triangle partition) [Y.-L. Hsiao (MediaTek)]

[JVET-O0630](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7245) Non-CE4: DMVR on merge mode [R.-L. Liao, J. Chen, Y. Ye, J. Luo (Alibaba)]

[JVET-O0906](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7528) Crosscheck of JVET-O0630 (Non-CE4: DMVR on merge mode) [H. Huang (Qualcomm)]

[JVET-O0631](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7246) Non-CE4: DMVR on SMVD and AMVP mode [R.-L. Liao, Y. Ye, J. Chen, J. Luo (Alibaba)]

[JVET-O0907](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7529) Crosscheck of JVET-O0631 (Non-CE4: DMVR on SMVD and AMVP mode) [H. Huang (Qualcomm)]

[JVET-O0633](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7248) Non-CE4: On MMVD candidate flag coding [X. Chen, H. Yang (Huawei)]

[JVET-O0927](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7552) Crosscheck of JVET-O0633 (Non-CE4: On MMVD candidate flag coding) [T. Hashimoto, T. Ikai (Sharp)]

[JVET-O0639](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7255) Non-CE4: Context reduction for merge mode [J. Ye, X. Li, C. Auyeung, S. Liu (Tencent)]

[JVET-O0911](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7533) Crosscheck of JVET-O0639: Non-CE4: Context reduction for merge mode [W. Zhu (Bytedance)]

[JVET-O0652](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7268) CE4-related: Line buffer size reduction method for switchable interpolation filter [T. Solovyev, S. Ikonin, E. Alshina (Huawei)] [late]

[JVET-O0653](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7269) Non-CE4: Motion field storage simplification for triangular prediction mode [T. Solovyev, S. Ikonin, E. Alshina (Huawei)]

[JVET-O1053](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7690) Crosscheck of JVET-O0653 (Non-CE4: Motion field storage simplification for triangular prediction mode) [M. Bläser, J. Sauer (RWTH Aachen University)]

[JVET-O0660](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7277) Simplification of MV storage for blending block in triangle mode [K. Panusopone, L. Wang (Nokia)] [late]

[JVET-O0664](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7281) CE4-related: Simplifications on PROF [H. Chen, H. Yang (Huawei)]

[JVET-O0732](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7353) Crosscheck of JVET-O0664: CE4-related: Simplifications on PROF [[Y. He (InterDigital)](mailto:yuwen.he@interdigital.com)]

[JVET-O0666](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7283) Non-CE4: Fix for missing MV in 4xN and Nx4 triangle partition mode [K. Reuzé, C.-C Chen, W.-J. Chien, H. Huang, M. Karczewicz (Qualcomm)]

[JVET-O1059](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7696) Crosscheck of JVET-O0666 (Non-CE4: Fix for missing MV in 4xN and Nx4 triangle partition mode) [F. Henry (Orange), G. Clare (bcom)]

[JVET-O0789](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7410) CE4-related: On the context variables and syntax elements of merge index [C.-Y. Lai (MediaTek)] [miss] [late]

[JVET-O0795](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7416) CE4-related: On the context variables and syntax elements of merge index [?? (Mediatek)] [miss] [late]

[JVET-O0849](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7470) Crosscheck of JVET-O0795 (CE4-related: On the context variables and syntax elements of merge index) [R.-L. Liao (Alibaba)]

[JVET-O1016](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7653) Non-CE4: simplified triangle signaling [A. Robert, F. Le Léannec, T. Poirier, F. Galpin (InterDigital)] [late] [miss]

## CE5 related – Loop filtering (38)

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

For Track B review (no BoG)

[JVET-O0047](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6651) Non-CE5: Alternative signalling for ALF clipping parameters [A. M. Kotra, V. Stepin, S. Esenlik, S. Ikonin, B. Wang, H. Gao, E. Alshina (Huawei)]

[JVET-O0997](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7633) Crosscheck of JVET-O0047 on alternative signalling for ALF clipping parameters [P. Onno (Canon)]

[JVET-O0058](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6662) Non-CE5: Simplification on ALF clipping parameter coding [S.-C. Lim, J. Kang, H. Lee, J. Lee, H. Y. Kim (ETRI)]

[JVET-O0999](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7635) Crosscheck of JVET-O0058 on Simplification on ALF clipping parameter coding [J. Taquet (Canon)]

[JVET-O0064](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6668) Non-CE5: Modification of clipping value signalling for adaptive loop filter [N. Hu, H. E. Egilmez, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0839](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7460) Crosscheck of JVET-O0064: Non-CE5: Modification of clipping value signalling for adaptive loop filter [L. Zhang (Bytedance)]

[JVET-O0067](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6671) Non-CE5: Modified coding method for ALF clipping parameters [L. Zhang, K. Zhang, H. Liu, J. Xu, Y. Wang (Bytedance)]

[JVET-O0892](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7514) Crosscheck of JVET-O0067 (Non-CE5: Modified coding method for ALF clipping parameters) [N. Hu (Qualcomm)]

[JVET-O0158](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6762) Non-CE5: Deblocking based on DMVR refined motion [K. Andersson, J. Enhorn]

[JVET-O0159](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6763) Non-CE5: Deblocking tC table defined for 10-bit video [K. Andersson, J. Enhorn]

[JVET-O0188](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6792) Non-CE5: Non-linear ALF simplification [S. Ikonin, V. Stepin, E. Alshina (Huawei)]

[JVET-O1027](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7664) Crosscheck of JVET-O0188 (Non-CE5: Non-linear ALF simplifications) [I. Zupancic (HHI)]

[JVET-O0216](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6821) Non-CE5: Modification of ALF coefficient signalling [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)]

[JVET-O0786](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7407) Crosscheck of JVET-O0216 (Non-CE5: Modification of ALF coefficient signalling) [C.-Y. Lai (MediaTek)]

[JVET-O0247](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6852) AHG17: Multiple ALF APS for chroma [V. Seregin, N. Hu, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-O0287](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6892) CE5-related: Simplification of subblock deblocking [C.-M. Tsai, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek), A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)]

[JVET-O0288](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6893) CE5-related: On the syntax constraints of ALF APS [O. Chubach, C.-Y. Chen, T.-D. Chuang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0831](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7452) Crosscheck of JVET-O0288 (CE5-related: On the syntax constraints of ALF APS) [S.-C. Lim, J. Kang, H. Lee, J. Lee (ETRI)]

[JVET-O0289](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6894) CE5-related: Redundancy removal in ALF coefficient coding [O. Chubach, C.-Y. Chen, T.-D. Chuang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O1019](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7656) Crosscheck of JVET-O0289 (CE5-related: Redundancy removal in ALF coefficient coding) [A. M. Kotra (Huawei)]

[JVET-O0290](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6895) CE5-related: Modified syntax design of ALF clipping parameters signalling [O. Chubach, C.-Y. Chen, T.-D. Chuang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0832](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7453) Crosscheck of JVET-O0290 (CE5-related: Modified syntax design of ALF clipping parameters signalling) [S.-C. Lim, J. Kang, H. Lee, J. Lee (ETRI)]

[JVET-O0374](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6979) CE5-related: Context reduction for ALF enable flag syntax element [L. Xu, X. Cao, F. Chen, L. Wang (Hikvision)]

[JVET-O1057](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7694) Cross-check of JVET-O0374 (CE5-related: Context Reduction for Syntax Element ALF Enable Flag) [Y. Chen, F. Le Léannec (InterDigital)]

[JVET-O0386](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6991) Non-CE5: A simplification of clipping thresholds for Non-Linear ALF [K. Unno, K. Kawamura, S. Naito (KDDI)]

[JVET-O0998](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7634) Crosscheck of JVET-O0386 on a simplification of clipping thresholds for Non-Linear ALF [P. Onno (Canon)]

[JVET-O0413](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7018) Non-CE5: Chroma deblocking filter adjustments for 4:4:4 and 4:2:2 [M. Ikeda, T. Suzuki (Sony)]

[JVET-O0751](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7372) Crosscheck of JVET-O0413 (Chroma deblocking filter adjustments for 4:4:4 and 4:2:2) [T. Chujoh (Sharp)]

[JVET-O0425](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7030) Non-CE5: Supplementary results on alternative filter sets for Adaptive Loop Filter (JVET-O0090) [J. Taquet, P. Onno, C. Gisquet, G. Laroche (Canon)]

[JVET-O0985](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7621) Crosscheck of JVET-O0425 (Non-CE5: Supplementary results on alternative filter sets for Adaptive Loop Filter) [K. Unno (KDDI)]

[JVET-O0430](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7035) Non-CE5: Modification of clipping value signalling for ALF [X. W. Meng (PKU), X. Zheng (DJI), S. S. Wang, S. W. Ma (PKU)]

[JVET-O0896](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7518) Crosscheck of JVET-O0430 (Non-CE5: Modification of clipping value signalling for ALF) [N. Hu (Qualcomm)]

[JVET-O0437](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7042) Non-CE5: Unification of non-linear ALF luma/chroma clipping parameters [X. W. Meng (PKU), X. Zheng (DJI), S. S. Wang, S. W. Ma (PKU)]

[JVET-O0897](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7519) Crosscheck of JVET-O0437 (Non-CE5: Unification of non-linear ALF luma/chroma clipping parameters) [N. Hu (Qualcomm)]

[JVET-O0499](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7106) Non-CE5: Parameter alignment for pipelined ALF [A. Wieckowski, K. Sühring, R. Skupin, B. Bross, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

[JVET-O0894](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7516) Crosscheck of JVET-O0499 (Non-CE5: Parameter alignment for pipelined ALF) [N. Hu (Qualcomm)]

[JVET-O0532](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7139) Non-CE5: Simplification on clipping value calculation for adaptive loop filter [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0983](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7619) Crosscheck of JVET-O0532 (Non-CE5: Simplification on clipping value calculation for adaptive loop filter) [K. Unno (KDDI)]

[JVET-O0566](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7181) Non-CE5: Consistent Deblocking for Chroma Components [J. Xu, J. Wang, L. Zhang, W. Zhu, Y. Wang (Bytedance)]

[JVET-O0846](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7467) Crosscheck of JVET-O0566 (Non-CE5: Consistent Deblocking for Chroma Components) [M. Ikeda (Sony)]

[JVET-O0578](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7193) Non-CE5: Long-tap deblocking filter on vertical tile boundary [H. Jang, S. Lee, N. Park, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-O0950](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7579) Crosscheck of JVET-O0578 Non-CE5: Long-tap deblocking filter on vertical tile boundary [J. Ye, X. Li (Tencent)]

[JVET-O0582](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7197) Non-CE5: Deblock filtering process for BDPCM block [H. Jang, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-O0807](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7428) Crosscheck of JVET-O0582 (Non-CE5: Deblock filtering process for BDPCM block) [C.-M. Tsai (MediaTek)]

[JVET-O0625](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7240) Non-CE5: Unified padding method for samples at variant boundaries in ALF [H. Liu, L. Zhang, K. Zhang, Z. Deng, N. Zhang, J. Xu (Bytedance)]

[JVET-O0865](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7486) Crosscheck of JVET-O0625: "Non-CE5: Unified padding method for samples at variant boundaries in ALF" [F. Le Léannec (Interdigital)]

[JVET-O0636](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7252) Cross-Component Adaptive Loop Filter for chroma [K. Misra, F. Bossen, A. Segall (Sharp Labs of America)]

[JVET-O0637](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7253) Non-CE5: On chroma line selection for gradient computation in deblocking [K. Misra, P. Cowan, A. Segall (Sharp Labs of America)]

[JVET-O0638](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7254) Non-CE5: On derivation of QP predictors for DUAL\_TREE\_CHROMA in deblocking [K. Misra, A. Segall (Sharp Labs of America)]

[JVET-O0648](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7264) Non-CE5: On Exp-Golomb Coding of ALF Filter Coefficients and Clip Values [H. E. Egilmez, N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0142](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6746) AHG12: On turning off ALF filtering at brick and slice boundaries [Y.-K. Wang, J. Chen, Hendry (Futurewei)]

Also included in the agenda item 6.17.6.

[JVET-O0494](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7101) AHG12: On filtering of independently coded region [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

Also included in the agenda item 6.17.6.

[JVET-O0654](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7270) AHG12/Non-CE5: Unification of boundary handling for adaptive loop filter [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

Also included in the agenda item 6.17.6.

[JVET-O0939](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7564) Crosscheck of JVET-O0654 (AHG12/Non-CE5: Unification of boundary handling for adaptive loop filter) [S. Paluri (LGE)]

[JVET-O0662](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7279) Non-CE5: Modified ALF filtering for Slice, Brick and Virtual boundaries [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)]

Also included in the agenda item 6.17.6.

[JVET-O0656](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7273) Non-CE5: Boundary strength derivation for transform skipped block [S. Iwamura, S. Nemoto, A. Ichigaya (NHK)]

[JVET-O0847](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7468) Crosscheck of JVET-O0656 (Non-CE5: Boundary strength derivation for transform skipped block) [[K. Kondo](mailto:Kenji.Kondo@sony.com), M. Ikeda (Sony)]

[JVET-O0665](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7282) Non-CE5: Syntax redundancy removal in adaptive loop filter [X. W. Meng (PKU), X. Zheng (DJI), S. S. Wang, S. W. Ma (PKU)]

[JVET-O0923](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7548) Crosscheck of JVET-O0665 (Non-CE5: Syntax redundancy removal in adaptive loop filter) [S. Ye (Hikvision)]

[JVET-O0669](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7286) Non-CE5: A Simplification of ALF Coefficient Signalling [H. E. Egilmez, N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0803](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7424) Non-CE5: Unified design for longer tap deblocking line buffer reduction [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)] [late]

[JVET-O0809](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7430) Crosscheck of JVET-O0803 (Non-CE5: Unified design for longer tap deblocking line buffer reduction) [C.-M. Tsai (MediaTek)]

[JVET-O0300](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6905) AHG17: Clean-up of ALF Syntax Parameters [S. Paluri, J. Lim, S. Kim (LGE)]

[JVET-O0301](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6906) AHG17: Simplification of ALF Clipping Coefficients in the APS [S. Paluri, J. Lim, S. Kim (LGE)]

[JVET-O0302](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6907) AHG17: Simplification of ALF Coefficients in the APS [S. Paluri, J. Lim, S. Kim (LGE)]

## CE6 related – Transforms and transform signalling (50)

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

[JVET-O0195](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6800) Non-CE6: Simplification on LFNST [Y. Zhao, H. Yang (Huawei)]

[JVET-O0953](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7583) Crosscheck of JVET-O0195 (Non-CE6: Simplification on LFNST) [M. Koo (LGE)]

[JVET-O0209](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6814) Non-CE6: LFNST simplification based on the methods proposed in CE6-2.1a [M. Koo, J. Nam, J. Lim, M. Salehifar, S. Kim (LGE)]

[JVET-O0977](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7612) Crosscheck of JVET-O0209 (Non-CE6: LFNST simplification based on the methods proposed in CE6-2.1a) [Y. Kidani, S. Naito (KDDI)]

[JVET-O0213](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6818) Non-CE6: Block size restriction of LFNST [M. Koo, J. Nam, J. Lim, M. Salehifar, S. Kim (LGE)]

[JVET-O0884](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7506) Crosscheck of JVET-O0213 (Non-CE6: Block size restriction of LFNST) [Z. Zhang (Ericsson)]

[JVET-O0214](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6819) Non-CE6: Harmonization of implicit MTS and LFNST [T. Ikai (Sharp)]

[JVET-O0219](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6824) Non-CE6: On LFNST transform set selection for a CCLM coded block [Z. Zhang, R. Sjöberg, R. Yu (Ericsson)]

[JVET-O0954](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7584) Crosscheck of JVET-O0219 (Non-CE6: On LFNST transform set selection for a CCLM coded block) [M. Koo (LGE)]

[JVET-O0264](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6869) CE6-related: On DCT-8 in VVC [K. Zhang, L. Zhang, Z. Deng, H. Liu, N. Zhang (Bytedance)]

[JVET-O0916](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7538) Crosscheck of JVET-O0264: CE6-related: On DCT-8 in VVC [C. Hollmann (Ericsson)]

[JVET-O0876](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7497) Crosscheck of JVET-O0266 (Non-CE6: Simplifications on LFNST) [T. Tsukuba (Sony)]

[JVET-O0266](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6871) Non-CE6: Simplifications on LFNST [K. Zhang, L. Zhang, Z. Deng, H. Liu, N. Zhang (Bytedance)]

[JVET-O0291](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6896) CE6-related: Constraint and simplification for LFNST signalling [M.-S. Chiang, C.-W. Hsu, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0292](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6897) CE6-related: Simplifications for LFNST [M.-S. Chiang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0293](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6898) CE6-related: Latency reduction for LFNST signalling [M.-S. Chiang, C.-W. Hsu, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O1002](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7638) Crosscheck of JVET-O0293 (CE6-related: Latency reduction for LFNST signalling) [B.-J. Fuh, C.-H. Yau, C.-C. Lin, C.-L. Lin (ITRI)]

[JVET-O0294](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6899) CE6-related: Context modelling for signalling MTS index [O. Chubach, M.-S. Chiang, C.-Y. Chen, T.-D. Chuang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0917](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7539) Crosscheck of JVET-O0294: CE6-related: Context modelling for signalling MTS index [C.-H. Hung (Qualcomm)]

[JVET-O0349](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6954) CE6-related: Simplified LFNST [J. Lainema (Nokia)]

[JVET-O0350](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6955) CE6-related: LFNST with one mode [J. Lainema (Nokia)]

[JVET-O0352](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6957) Non-CE6: TU/TB-level LFNST index coding [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

[JVET-O0743](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7364) Crosscheck of JVET-O0352 (Non-CE6: TU/TB-level LFNST index coding) [K. Zhang (Bytedance)]

[JVET-O0354](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6959) Non-CE6: Context modeling for MTS index coding [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

[JVET-O0711](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7331) Crosscheck of JVET-O0354 (Non-CE6: Context modeling for MTS index coding) [J. Nam (LGE)]

[JVET-O0357](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6962) Non-CE6: Maximum TU size for chroma format 4:2:2 and 4:4:4 [L. Li, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-O0368](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6973) Non-CE6: An MTS-based Restriction for LFNST beyond Transform Skip [H. E. Egilmez, A. K. Ramasubramonian, A. Said, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0863](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7484) Crosscheck of JVET-O0368: "Non-CE6: An MTS-based Restriction for LFNST beyond Transform Skip" [F. Le Léannec (Interdigital)]

[JVET-O0370](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6975) CE6-related: Applying LFNST Only for Top-Left Subblocks [H. E. Egilmez, A. Nalci, A. Said, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0372](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6977) Non-CE6: A Simplification for MTS Index Signaling [A. Nalci, H. E. Egilmez, A. Said, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O1062](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7699) Cross-check of JVET-O0372 (Non-CE6: A Simplification for MTS Index Signaling) [A. Tamse (Samsung)]

[JVET-O0373](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6978) Non-CE6: An Improved Context Modeling for LFNST [A. Nalci, H. E. Egilmez, A. Said, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O1063](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7700) Cross-check of JVET-O0373 (Non-CE6: An Improved Context Modeling for LFNST) [A. Tamse (Samsung)]

[JVET-O0380](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6985) Non-CE6: Simplification on MTS index coding [X. Cao, F. Chen, L. Wang (Hikvision)]

[JVET-O1058](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7695) Cross-check of JVET-O0380 (Non-CE6: Simplification on MTS index coding) [Y. Chen, F. Le Léannec (InterDigital)]

[JVET-O0381](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6986) Non-CE6: Simplification on SBT coding [X. Cao, F. Chen, L. Wang (Hikvision)]

[JVET-O0752](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7373) Crosscheck of JVET-O0381 (Non-CE6: Simplification on SBT coding) [Y. Zhao (Huawei)]

[JVET-O0382](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6987) Non-CE6: Unification between implicit MTS and ISP [X. Cao, F. Chen, L. Wang (Hikvision)]

[JVET-O0972](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7604) Crosscheck of JVET-O0382 (Non-CE6: Unification between implicit MTS and ISP) [M.-S. Chiang (MediaTek)]

[JVET-O0387](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6992) Non-CE6: MTS Index Signaling Simplification [A. Tamse, M. W. Park, K. Choi (Samsung)]

[JVET-O0852](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7473) Crosscheck of JVET-O0387 (Non-CE6: MTS Index Signaling Simplification) [Z. Deng (Bytedance)]

[JVET-O0402](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7007) Non-CE6: Simplification of context modeling on MTS index [J. Nam, M. Koo, J. Lim, S. Kim (LGE)]

[JVET-O0877](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7498) Crosscheck of JVET-O0402 (Non-CE6: Simplification of context modeling on MTS index) [T. Tsukuba (Sony)]

[JVET-O0410](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7015) CE6-related: Signalling of Low Frequency Non-Separable Transform [Y. Kidani, K. Unno, K. Kawamura, S. Naito (KDDI)]

[JVET-O0955](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7585) Crosscheck of JVET-O0410 (CE6-related: Signalling of Low Frequency Non-Separable Transform) [M. Koo (LGE)]

[JVET-O0444](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7049) Non-CE6: On LFNST index coding [C. Hollmann, D. Saffar, P. Wennersten, J. Ström (Ericsson)]

[JVET-O0873](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7494) Crosscheck of JVET-O0444 (Non-CE6: On LFNST index coding) [J. Lainema (Nokia)]

[JVET-O0446](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7051) Non-CE6: Reduced MTS [C. Hollmann, D. Saffar, P. Wennersten, J. Ström (Ericsson)]

[JVET-O0808](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7429) Crosscheck of JVET-O0446 (Non-CE6: Reduced MTS) [[C.-H. Hung](mailto:chaohsiu@qti.qualcomm.com) (Qualcomm)]

[JVET-O0465](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7072) Non-CE6: simplified SBT mode coding [F. Le Léannec, Y. Chen, T. Poirier (InterDigital)]

[JVET-O0853](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7474) Crosscheck of JVET-O0465 (Non-CE6: Simplified SBT mode coding) [Z. Deng (Bytedance)]

[JVET-O0466](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7073) Non-CE6: interaction between MTS and LFNST [F. Le Léannec, F. Urban, K. Naser, T. Poirier (InterDigital)]

[JVET-O0915](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7537) Crosscheck of JVET-O0466: Non-CE6: interaction between MTS and LFNST [C. Hollmann (Ericsson)]

[JVET-O0472](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7079) Non-CE6: Simplified LFNST signalling [J. Jung, D. Kim, G. Ko, J. Son, J. Kwak (WILUS)]

[JVET-O0474](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7081) Non-CE6: Mismatch between text specification and reference software on MTS for IBC-coded block [J. Jung, D. Kim, G Ko, J. Son, J. Kwak (WILUS)]

[JVET-O1012](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7648) Crosscheck of JVET-O0474 (Non-CE6: Mismatch between text specification and reference software on MTS for IBC-coded block) [J. Kim (SK Telecom), K. Ko, A. Baek, S. Lee, S. Son (PIXTREE)]

[JVET-O0475](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7082) Non-CE6: Context Simplification for Subblock Transform (SBT) [J. Park, B. Jeon (SKKU)]

[JVET-O0764](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7385) Crosscheck of JVET-O0475: Non-CE6: Context Simplification for Subblock Transform (SBT) [L. Pham Van, G. Van der Auwera, M. Karczewicz (Qualcomm)]

[JVET-O0476](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7083) Non-CE6: Syntax change for LFNST [D. Park, Y.-U. Yoon, J.-G. Kim (KAU), J. Lee, J. Kang (ETRI)]

[JVET-O0518](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7125) Non-CE6: LFNST selection with no intra-mode dependency [G. Kulupana, A. Seixas Dias, S. Blasi (BBC)]

[JVET-O0521](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7128) Non-CE6: Removing LFNST when MTS larger than zero [G. Kulupana, S. Blasi, A. Seixas Dias (BBC)]

[JVET-O0528](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7135) Non-CE6: Simplified Transform Selection For ISP [K. Naser, F. Le Léannec, T. Poirier, P. de Lagrange (InterDigital)]

[JVET-O0965](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7595) Crosscheck of JVET-O0528 (Non-CE6: Simplified Transform Selection For ISP) [S. De-Luxán-Hernández (HHI)]

[JVET-O0529](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7136) Non-CE6 Interaction between Implicit MTS and LFNST and MIP [K. Naser, F. Le Léannec, T. Poirier (InterDigital)]

[JVET-O0538](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7145) Non-CE6: An SPS Control of ISP and SBT Transform Selection [[K. Naser](mailto:karam.naser@interdigital.com), F. Le Léannec, M. Kerdranvat (InterDigital)]

[JVET-O1067](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7704) Crosscheck of JVET-O0538 (Non-CE6: An SPS Control of ISP and SBT Transform Selection) [[H. E. Egilmez (Qualcomm)](mailto:hegilmez@qti.qualcomm.com)]

[JVET-O0539](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7146) CE6-related: Unified LFNST using block size independent kernel [X. Zhao, X. Li, S. Liu (Tencent)]

[JVET-O0899](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7521) Crosscheck of JVET-O0539 (CE6-related: Unified LFNST using block size independent kernel) [M. Siekmann (HHI)]

[JVET-O0934](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7559) Crosscheck of JVET-O0539: CE6-related: Unified LFNST using block size independent kernel [C. Hollmann (Ericsson)]

[JVET-O0540](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7147) Non-CE6: Harmonization of LFNST, MIP and implicit MTS [X. Zhao, X. Li, S. Liu (Tencent)]

[JVET-O0541](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7148) Non-CE6: Modified high-level syntax control on implicit transform [S. Liu, X. Zhao, X. Li (Tencent)]

[JVET-O0544](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7154) Non-CE6: Modified LFNST Transform Matrices for Fast Implementation [K. Naser, L. Kerofsky, F. Le Léannec, T. Poirier (InterDigital)]

[JVET-O0956](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7586) Crosscheck of JVET-O0544 (Non-CE6: Modified LFNST Transform Matrices for Fast Implementation) [M. Koo (LGE)]

[JVET-O0545](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7156) Non-CE6: Configurable maximum transform size in VVC [X. Zhao, X. Li, S. Liu (Tencent)]

[JVET-O0941](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7568) Crosscheck of JVET-O0545 (Non-CE6: Configurable maximum transform size in VVC) [T.-C. Ma (Kwai Inc.)]

[JVET-O0546](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7157) Non-CE3/6: Transform selection for MRL [L. Zhao, X. Zhao, X. Li, S. Liu (Tencent)]

[JVET-O0680](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7299) Crosscheck of JVET-O0546 (Non-CE3/6: Transform selection for MRL) [J. Jung, D. Kim, G. Ko, J. Son, J. Kwak (WILUS)]

[JVET-O0569](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7184) Non-CE6: LFNST Signaling at the TU Level [A. Nalci, H. E. Egilmez, A. Said, M. Coban, V. Seregin, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-O0576](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7191) Non-CE6: Reduced contexts and context coded bins for MTS index coding [Z. Deng, L. Zhang, H. Liu, K. Zhang, Y. Wang (Bytedance)]

[JVET-O0837](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7458) Crosscheck of JVET-O0576 (Non-CE6: Reduced contexts and context coded bins for MTS index coding) [A. Tamse (Samsung)]

[JVET-O0620](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7235) Non-CE6: Simplification with new LFNST transform basis [T. Zhou, T. Hashimoto, T. Ikai (Sharp)] [miss] [late]

[JVET-O0719](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7339) Crosscheck of JVET-O0620 (Non-CE6: Simplification with new LFNST transform basis) [L. Xu, F. Chen, L. Wang (Hikvision)]

[JVET-O0642](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7258) Non-CE6: Reducing secondary transform kernel for specific residual block size [S. Shrestha, A. Kumar, B. Lee (Chosun Univ.), Y. Lee, J. Park (Humax)]

[JVET-O0699](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7319) Non-CE6: Modified DCT8/DST7 Transform Matrices for Faster Implementation [K. Naser, L. Kerofsky, F. Le Léannec, T. Poirier (InterDigital)] [late]

[JVET-O0986](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7622) Crosscheck of JVET-O0699: Non-CE6: Modified DCT8/DST7 Transform Matrices for Faster Implementation [X. Zhao (Tencent)]

[JVET-O0963](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7593) Non-CE6: LFNST Signaling at the TU Level with Last Position Constraints [A. Nalci, H. E. Egilmez, A. Said, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)] [late] [miss]

## CE7 related – Quantization and coefficient coding (25)

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

[JVET-O0068](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6672) AHG16/Non-CE7: A study of bin to bit ratio for VTM5.0 [M. Zhou (Broadcom)]

[JVET-O0193](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6798) CE7-related: Remove transform depth in cbf coding [Y. Zhao, H. Yang (Huawei)]

[JVET-O0773](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7394) Crosscheck of JVET-O0193 (CE7-related: Remove transform depth in cbf coding) [Y.-W. Chen (Kwai Inc.)]

[JVET-O0223](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6828) Non-CE7: Quantization matrices with single identifier and prediction from larger ones [P. de Lagrange, F. Le Léannec, E. François, K. Naser (InterDigital)]

[JVET-O0924](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7549) Crosscheck of JVET-O0223 (Non-CE7: Quantization matrices with single identifier and prediction from larger ones) [J. Le Tanou (MediaKind)]

[JVET-O0231](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6836) Non-CE7: Modified chroma coded block flag signalling [S. Esenlik, Y. Zhao, A. M. Kotra, H. Gao, B. Wang, E. Alshina (Huawei)]

[JVET-O0872](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7493) Crosscheck of JVET-O0231 (Non-CE7: Modified chroma coded block flag signalling) [J. Lainema (Nokia)]

[JVET-O0295](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6900) CE7-related: Modified subblock coding passes for coding TS residual [S.-T. Hsiang, S.-M. Lei (MediaTek)]

[JVET-O0937](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7562) Crosscheck of JVET-O0295 (CE7-related: Modified subblock coding passes for coding TS residual) [M. Salehifar (LGE)]

[JVET-O0375](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6980) Non-CE7: A Simplified CBF Coding for Luma and Chroma [A. Nalci, H. E. Egilmez, A. Said, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O1070](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7707) Crosscheck of JVET-O0375 (Non-CE7: A Simplified CBF Coding for Luma and Chroma) [H.-J. Jhu (Kwai Inc.)]

[JVET-O0383](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6988) Non-CE7: Harmonization of scaling matrix and LFNST [T. Hashimoto, E. Sasaki, T. Chujoh, T. Ikai (Sharp)]

[JVET-O0791](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7412) Crosscheck of JVET-O0383 (Non-CE7: Harmonization of scaling matrix and LFNST) [Y.-L. Hsiao (MediaTek)]

[JVET-O0400](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7005) CE7-related: Context-coded bin restriction [J. Choi, S. Yoo, J. Heo, J. Choi, J. Lim, S. Kim (LGE)]

[JVET-O0909](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7531) Crosscheck of JVET-O0400: CE7-related: Context-coded bin restriction [W. Zhu (Bytedance)]

[JVET-O0406](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7011) Non-CE7: Unification of syntaxes after CCB count exceeds the maximum number between transform residual and transform skip residual [Y. Kato, K. Abe, T.Toma (Panasonic)]

[JVET-O0788](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7409) Crosscheck of JVET-O0406 (Non-CE7: Unification of syntaxes after CCB count exceeds the maximum number between transform residual and transform skip residual) [C.-Y. Lai (MediaTek)]

[JVET-O0409](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7014) Non-CE7: Unification of CCB count method between transform residual and transform skip residual [Y. Kato, K. Abe, T. Toma (Panasonic)]

[JVET-O1054](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7691) Crosscheck of JVET-O0409 (Non-CE7: Unification of CCB count method between transform residual and transform skip residual) [J. Choi, J. Lim (LGE)]

[JVET-O0527](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7134) Non-CE7: Use INTER quantization matrices for IBC [P. de Lagrange, Y. Chen (InterDigital)]

[JVET-O0543](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7151) CE7-related: Alternative configuration for joint chroma residual coding [C. Helmrich, H. Schwarz, T. Nguyen, C. Rudat, D. Marpe, T. Wiegand (Fraunhofer HHI)]

[JVET-O0874](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7495) Crosscheck of JVET-O0543 (CE7-related: Alternative configuration for joint chroma residual coding) [J. Lainema (Nokia)]

[JVET-O0556](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7170) CE7-related: Alternative method to RDPCM with TS level mapping [M. Karczewicz, Y. Han, Y.-H. Chao, M. Coban (Qualcomm)]

[JVET-O0774](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7395) Crosscheck of JVET-O0556 (CE7-related: Alternative method to RDPCM with TS level mapping) [Y.-W. Chen (Kwai Inc.)]

[JVET-O0557](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7171) Non-CE7: Context modeling unification in significant flag of coefficient group [Y.-H. Chao, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-O0777](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7398) Crosscheck of JVET-O0557 (Non-CE7: Context modeling unification in significant flag of coefficient group) [Y.-W. Chen (Kwai Inc.)]

[JVET-O0558](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7172) CE7-related: Reduction of Gtx passes in transform skip residual coding [M. Karczewicz, Y.-H. Chao, H. Wang, M. Coban (Qualcomm)]

[JVET-O0775](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7396) Crosscheck of JVET-O0558 (CE7-related: Reduction of Gtx passes in transform skip residual coding) [Y.-W. Chen (Kwai Inc.)]

[JVET-O0559](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7173) CE7-related: QP dependent binarization in TS residual coding [M. Karczewicz, Y.-H. Chao, M. Coban (Qualcomm)]

[JVET-O0776](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7397) Crosscheck of JVET-O0559 (CE7-related: QP dependent binarization in TS residual coding) [Y.-W. Chen (Kwai Inc.)]

[JVET-O0575](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7190) CE7-related: Reduction for Context Coded Bins in Transform Skip Mode [W. Zhu, L. Zhang, J. Xu, K. Zhang, H. Liu (Bytedance)]

[JVET-O0596](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7211) CE7-related: On chroma CBF signaling of subblock transform mode [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-O0753](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7374) Crosscheck of JVET-O0596 (CE7-related: On chroma CBF signaling of subblock transform mode) [Y. Zhao (Huawei)]

[JVET-O0613](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7228) CE7-related: Unification of Rice parameter tables in residual coding [C. Auyeung, X. Li, S. Liu (Tencent)]

[JVET-O0758](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7379) Crosscheck of JVET-O0613 (CE7-related: Unification of Rice parameter tables in residual coding) [H.-J. Jhu (Kwai Inc.)]

[JVET-O0617](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7232) CE7-related: Context reduction of transform coefficient significance flag [C. Auyeung, X. Zhao, X. Li, S. Liu (Tencent)]

[JVET-O0936](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7561) Crosscheck of JVET-O0617 (CE7-related: Context reduction of transform coefficient significance flag) [H. Schwarz (Fraunhofer HHI)]

[JVET-O0619](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7234) Non-CE7: Simplification of transform skip residual coding [M. G. Sarwer, Y. Ye (Alibaba)]

[JVET-O0878](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7499) Crosscheck of JVET-O0619 (Non-CE7: Simplification of transform skip residual coding) [T. Tsukuba (Sony)]

[JVET-O0623](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7238) CE7-related: Interleaved coefficient coding for transform-skip mode [M. Karczewicz, H. Wang, M. Coban, Y.-H. Chao (Qualcomm)]

[JVET-O0690](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7310) Crosscheck of JVET-O0623: Interleaved coefficient coding for transform-skip mode [T. Nguyen (HHI)]

[JVET-O0670](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7287) CE7-related: Alternative joint coding of chroma residuals [B. Ray, G. Van der Auwera, M. Karczewicz (Qualcomm)]

[JVET-O0875](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7496) Crosscheck of JVET-O0670 (CE7-related: Alternative joint coding of chroma residuals) [J. Lainema (Nokia)]

[JVET-O0928](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7553) CE7-related: Context reduction for entropy coding sig\_coeff\_flag [S.-T. Hsiang, S.-M. Lei (MediaTek)] [late] [miss]

[JVET-O0935](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7560) CE7-related: Alternative configuration of CE7-2.2 joint chroma residual coding [C. Helmrich, H. Schwarz, T. Nguyen, C. Rudat, D. Marpe, T. Wiegand (Fraunhofer HHI, B. Ray, G. Van der Auwera, A. K. Ramasubramonian, M. Coban, M. Karczewicz (Qualcomm)] [late]

## CE8 related – Screen content coding tools (46)

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

[JVET-O0127](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6731) CE8-related: IBC modifications [J. Li, C.S. Lim (Panasonic)]

[JVET-O0738](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7359) Crosscheck of JVET-O0127 (CE8-related: IBC modifications) [J. Xu (Bytedance)]

[JVET-O0162](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6766) Non-CE8: On IBC motion vector list construction [H. Chen, H. Yang (Huawei)]

[JVET-O0165](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6769) CE8-related: SPS flag for BDPCM [F. Henry (Orange)]

[JVET-O0166](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6770) CE8-related: BDPCM for chroma [F. Henry (Orange), G. Clare (bcom)]

[JVET-O0696](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7316) Crosscheck of JVET-O0166 (CE8-related: BDPCM for chroma) [Y.-H. Chao (Qualcomm)]

[JVET-O0200](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6805) CE8-related: RDPCM intra mode mapping, maximum RDPCM block size [M. Coban, Y. Han, M. Karczewicz (Qualcomm)]

[JVET-O0205](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6810) CE8-related: Improvements on BDPCM [S. Yoo, J. Choi, J. Nam, J. Heo, J. Lim, S. Kim (LGE)]

[JVET-O0705](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7325) Crosscheck of JVET-O0205: CE8-related: Improvements on BDPCM [X. Zhao (Tencent)]

[JVET-O0969](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7601) Crosscheck of method 2 in JVET-O0205 (CE8-related: Improvements on BDPCM) [M.-S. Chiang (MediaTek)]

[JVET-O0206](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6811) CE8-related: Unified condition between BDPCM and transform skip [S. Yoo, J. Nam, J. Choi, J. Lim, S. Kim (LGE)]

[JVET-O0689](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7309) Crosscheck of JVET-O0206: Unified condition between BDPCM and transform skip [T. Nguyen (HHI)]

[JVET-O0248](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6853) CE8-related: Dedicated IBC reference buffer without bitstream restrictions [H. Gao, A.Karabutov, S. Esenlik, S. Ikonin, B. Wang, A. M. Kotra, E. Alshina (Huawei)]

[JVET-O0739](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7360) Crosscheck of JVET-O0248 (CE8-related: Dedicated IBC reference buffer without bitstream restrictions) [J. Xu (Bytedance)]

[JVET-O0258](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6863) Non-CE8: Adaptive single/dual tree with IBC simplification [W. Zhu, J. Xu, L. Zhang (Bytedance)]

[JVET-O0695](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7315) Crosscheck of JVET-O0258 (Non-CE8: Adaptive single/dual tree with IBC simplification) [C.-H. Hung, Y.-H. Chao (Qualcomm)]

[JVET-O0259](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6864) CE8-related: Palette mode with 8 bits entries [W. Zhu, J. Xu, L. Zhang, H.-C. Chuang (Bytedance)]

[JVET-O0889](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7511) Crosscheck of JVET-O0259 (CE8-related: Palette mode with 8 bits entries) [F. Henry (Orange), G. Clare (bcom)]

[JVET-O0282](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6887) CE8-releated: Bug Fix in CE8-2.1 [C.-H. Hung, Y.-H. Chao, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0787](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7408) Crosscheck of JVET-O0282 (CE8-related: Bug fix in CE8-2.1) [C.-Y. Lai (MediaTek)]

[JVET-O0296](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6901) CE8-related: Intra prediction mode for BDPCM [M.-S. Chiang, O. Chubach, C.-W. Hsu, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0913](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7535) Crosscheck of JVET-O0296: CE8-related: Intra prediction mode for BDPCM [W. Zhu (Bytedance)]

[JVET-O0315](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6920) CE8-related: Intra prediction mode alignment for BDPCM [W. Zhu, L. Zhang, J. Xu (Bytedance)]

[JVET-O0970](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7602) Crosscheck of JVET-O0315 (CE8-related: Intra prediction mode alignment for BDPCM) [M.-S. Chiang (MediaTek)]

[JVET-O0325](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6930) CE8-related: Simple BVD coding scheme without adding more context [Y. Sun, F. Chen, L. Wang (Hikvision)]

[JVET-O0709](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7329) Crosscheck of JVET-O0325 (CE8-related: Simple BVD coding scheme without adding more context) [J. Nam (LGE)]

[JVET-O0326](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6931) CE8-related: JVET-O0325 combined with CE8 BVD coding scheme [Y. Sun, F. Chen, L. Wang (Hikvision)]

[JVET-O0710](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7330) Crosscheck of JVET-O0326 (CE8-related: JVET-O0325 combined with CE8 BVD coding scheme) [J. Nam (LGE)]

[JVET-O0327](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6932) CE8-related: Default filling method for IBC mode [S. Ye, Y. Sun, F. Chen, L. Wang (Hikvision)]

[JVET-O0840](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7461) Crosscheck of JVET-O0327: CE8-related: Default filling method for IBC mode [J. Chen (Alibaba)]

[JVET-O0908](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7530) Crosscheck of JVET-O0327: CE8-related: Default filling method for IBC mode [W. Zhu (Bytedance)]

[JVET-O0331](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6936) Non-CE8: On IBC BVP Candidate List Derivation [H. Lee, S.-C. Lim, J. Lee, J. Kang, H. Y. Kim (ETRI)]

[JVET-O0342](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6947) Non-CE8: Unification of intra prediction mode of BDPCM block [J. Lee, J. Kang, H. Lee, S.-C. Lim, H. Y. Kim (ETRI)]

[JVET-O0683](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7302) Crosscheck of JVET-O0342: Non-CE8: Unification of intra prediction mode of BDPCM block [X. Zhao (Tencent)]

[JVET-O0376](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6981) CE8-related: A SPS level flag for BDPCM and JCCR [L. Xu, X. Cao, F. Chen (Hikvision)]

[JVET-O0772](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7393) Crosscheck of JVET-O0376 (CE8-related: A SPS level flag for BDPCM and JCCR) [Y.-W. Chen (Kwai Inc.)]

[JVET-O0405](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7010) Non-CE8: Minimum Allowed QP for Transform Skip Mode [T. Nguyen, B. Bross, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

[JVET-O1068](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7705) Crosscheck of JVET-O0405 (Non-CE8: Minimum Allowed QP for Transform Skip Mode) [M Coban (Qualcomm)]

[JVET-O0442](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7047) [Non-CE8] IBC prediction improvement [A. Singh, A. Konda (Samsung)] [miss] [late]

[JVET-O0443](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7048) [Non-CE8] Flipping of reference blocks for Intra Block Copy (IBC) [A. Singh, A. Konda (Samsung)] [late]

[JVET-O0455](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7061) Non-CE8: On IBC merge mode [Y.-J. Chang, Y. Zhang, C.-C. Chen, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-O0463](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7070) Non-CE8: Intra prediction mode of BDPCM [D. Kim, G. Ko, J. Son, J. Kwak (WILUS), J. Jung (Gaudio Lab)]

[JVET-O0822](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7443) Crosscheck of JVET-O0463 (Non-CE8: Intra prediction mode of BDPCM) [S. Yoo, J. Lim (LGE)]

[JVET-O0480](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7087) Non-CE8: On signaling of IBC block vector predictor list size [X. Xu, X. Li, S. Liu (Tencent)]

[JVET-O0860](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7481) Crosscheck of JVET-O0480: Non-CE8: On signaling of IBC block vector predictor list size [X. Xiu (Kwai Inc.)]

[JVET-O0482](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7089) CE8-related: Modulo operations for IBC block vectors [X. Xu, X. Li, S. Liu (Tencent)]

[JVET-O0542](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7150) Non-CE8: Modified intra mode associated with BPDCM [X. Zhao, X. Li, X. Xu, S. Liu (Tencent)]

[JVET-O1032](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7669) Crosscheck of JVET-O0542 (Non-CE8: Modified intra mode associated with BDPCM) [J. Lee, S.-C. Lim, H. Lee, J. Kang (ETRI)]

[JVET-O0563](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7177) Non-CE8: disabling TPM blending [W. Zhu, L. Zhang, J. Xu, K. Zhang (Bytedance)]

[JVET-O0922](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7547) Crosscheck of JVET-O0563 (Non-CE8: disabling TPM blending) [S. Ye (Hikvision)]

[JVET-O0564](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7178) CE8-related: Signalling of chroma IBC prediction modes [W. Zhu, L. Zhang, J. Xu, K. Zhang (Bytedance)]

[JVET-O0565](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7179) CE8-related: Default chroma IBC mode with vertical/ horizontal copying [W. Zhu, J. Xu, L. Zhang (Bytedance)]

[JVET-O0568](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7183) Non-CE8: An Alternative VPDU Memory Reuse for IBC [J. Xu, L. Zhang, K. Zhang, H. Liu, Y. Wang (Bytedance)]

[JVET-O0993](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7629) Crosscheck of JVET-O0568 (Non-CE8: An Alternative VPDU Memory Reuse for IBC) [J. Li (Panasonic)]

[JVET-O0574](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7189) Non-CE8: Fixes of IBC BV candidate list [L. Zhang, J. Xu, K. Zhang, H. Liu, W. Zhu (Bytedance)]

[JVET-O0597](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7212) CE3/8-related: On signaling of PDPC enabling/disabling flag in SPS [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-O0929](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7554) Crosscheck of JVET-O0597 (CE3/8-related: On signaling of PDPC enabling/disabling flag in SPS) [Y.-H. Chao (Qualcomm)]

[JVET-O0600](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7215) CE8-related: Palette mode excluding small blocks [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-O0821](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7442) Crosscheck of JVET-O0600 (CE8-related: Palette mode excluding small blocks) [T.-S Chang (Alibaba)]

[JVET-O0602](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7217) Non-CE3/Non-CE8: Remove MIP/IBC mode storage from line buffer [H.-J. Jhu, Y.-W. Chen, X. Xiu, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-O0813](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7434) Crosscheck of JVET-O0602 (Non-CE3/Non-CE8: Remove MIP/IBC mode storage from line buffer) [[T.-H. Li](mailto:thli@fginnov.com), J.-Y. Deng (Foxconn)]

[JVET-O0614](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7229) CE8-related: Combination of a simplified IBC mode and the palette mode in CE8-2.5 [Y.-C. Sun, X. Zuo, T.-S. Chang, J. Lou (Alibaba)]

[JVET-O0769](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7390) Crosscheck of JVET-O0614 (CE8-related: Combination of a simplified IBC mode and the palette mode in CE8-2.5) [Y.-W. Chen (Kwai Inc.)]

[JVET-O0626](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7241) Non-CE8: Simplified IBC BV candidate list construction process [L. Zhang, K. Zhang, H. Liu, J. Xu, Z. Deng, N. Zhang (Bytedance)]

[JVET-O0645](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7261) Non-CE4/8: Blending-off Switch for TPM Mode [C.-C. Chen, Y. Zhang, K. Reuze, Y.-J. Chang, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-O0912](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7534) Crosscheck of JVET-O0645: Non-CE4/8: Blending-off Switch for TPM Mode [W. Zhu (Bytedance)]

[JVET-O0646](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7262) Non-CE4/8: Combination of Blending-off Switch (JVET-O0645) and Simplified Motion Storage (JVET-O0411) for TPM Mode [C.-C. Chen, K. Reuze, Y. Zhang, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-O0763](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7384) Crosscheck of JVET-O0646 (Non-CE4/8: Combination of Blending-off Switch (JVET-O0645) and Simplified Motion Storage (JVET-O0411) for TPM Mode) [H. Yang (InterDigital)]

[JVET-O0651](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7267) Non-CE8: Intra prediction mode derivation for DM chroma block with corresponding IBC/PCM luma [L. Pham Van, G. Van der Auwera, A. K. Ramasubramonian, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0694](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7314) Crosscheck of JVET-O0651 (Non-CE8: Intra prediction mode derivation for DM chroma block with corresponding IBC/PCM luma) [L. Zhao (Tencent)]

[JVET-O0661](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7278) Non-CE4/8: Simplification of CIIP on IBC mode [Y. Zhang, C.-C. Chen, Y.-J. Chang, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-O0682](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7301) CE8-related: An Intra-Affine mode for screen content coding [J. Cao, Z.-R. Li, J. Wang, F. Liang (SYSU), Y.-F. Yu, Y. Liu (OPPO)] [late] [miss]

[JVET-O0996](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7632) Crosscheck of JVET-O0682 (CE8-related: An Intra-Affine mode for screen content coding) [?? (??)]

[JVET-O0706](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7326) CE8-related: 4x4 sub-block based dual-tree chroma IBC block-vector derivation [H. Yang, Y. He (InterDigital)] [late]

[JVET-O0740](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7361) Crosscheck of JVET-O0706 (CE8-related: 4x4 sub-block based dual-tree chroma IBC block-vector derivation) [J. Xu (Bytedance)]

[JVET-O0783](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7404) AHG17: Control of transform skip residual coding [L Chen, Y.-W. Huang, S.-M. Lei (MediaTek)] [late]

[JVET-O0914](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7536) CE8-related: Improved color generation method for palette mode [C.-H. Hung, Y.-H. Chao, V. Seregin, M. Karczewicz (Qualcomm)] [late] [miss]

[JVET-O0919](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7541) Non-CE8: Minimum QP for Transform Skip Mode [M. Karczewicz, Y.-H. Chao, H. Wang, M. Coban (Qualcomm)] [late]

[JVET-O1017](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7654) Crosscheck of JVET-O0919: Minimum QP for Transform Skip Mode [T. Nguyen (HHI)]

## CE9 related – Decoder motion vector derivation (26)

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

[JVET-O0207](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6812) Non-CE9: A bug fix of BDOF specification [T. Chujoh, E. Sasaki, T. Ikai (Sharp)]

[JVET-O0208](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6813) Non-CE9: An improvement of early termination for BDOF [T. Chujoh, E. Sasaki, T. Ikai (Sharp)]

[JVET-O0987](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7623) Crosscheck of JVET-O0208: Non-CE9: An improvement of early termination for BDOF [K. Kondo, M. Ikeda (Sony)]

[JVET-O0210](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6815) Non-CE9: BDOF for chroma components [T. Chujoh, E. Sasaki, T. Ikai (Sharp)]

[JVET-O0679](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7298) Crosscheck of JVET-O0210 on BDOF for chroma components [[S. Iwamura (NHK)](mailto:iwamura.s-gc@nhk.or.jp)]

[JVET-O0702](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7322) Crosscheck of JVET-O0210 (Non-CE9: BDOF for chroma components) [N. Park (LGE)]

[JVET-O0211](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6816) Non-CE9: A speed up method of BDOF [T. Chujoh, T. Ikai (Sharp)]

[JVET-O0982](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7618) Crosscheck of JVET-O0211 (Non-CE9: A speed up method of BDOF) [K. Unno (KDDI)]

[JVET-O0250](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6855) DMVR and BDOF on/off control [H. Huang, W.-J. Chien, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-O0684](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7303) Crosscheck of JVET-O0250 (DMVR and BDOF on/off control) [T. Chujoh (Sharp)]

[JVET-O0297](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6902) CE9-related: Simplification for DMVR padding process [Y.-C. Lin, C.-C. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0902](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7524) Crosscheck of JVET-O0297 (CE9-related: Simplification for DMVR padding process) [H. Huang (Qualcomm)]

[JVET-O0304](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6909) Non-CE9: Simplification of BDOF [Y. Kato, T. Toma, K. Abe (Panasonic)]

[JVET-O0861](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7482) Crosscheck of JVET-O0304 (Non-CE9: Simplification of BDOF) [S. Sethuraman (Ittiam)]

[JVET-O0307](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6912) Non-CE9/3: Unification of division processing [K. Abe, Y. Kato, T. Toma (Panasonic)]

[JVET-O0981](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7617) Crosscheck of JVET-O0307 (Non-CE9/3: Unification of division processing) [K. Unno, K. Kawamura (KDDI)]

[JVET-O0385](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6990) Non-CE9: An applying condition considering temporal correlation for DMVR [K. Unno, K. Kawamura, S. Naito (KDDI)]

[JVET-O0659](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7276) Crosscheck of JVET-O0385 on DMVR applying condition [S. Iwamura (NHK)]

[JVET-O0503](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7110) Non-CE9: Modifications to MMVD for CUs eligible for DMVR [S. Sethuraman (Ittiam)]

[JVET-O0810](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7431) Crosscheck of JVET-O0503 (Non-CE9: Modifications to MMVD for CUs eligible for DMVR test3) [E. Sasaki (Sharp)]

[JVET-O0504](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7111) Non-CE9: Header flags to disable DMVR and BDOF at finer granularities [S. Sethuraman (Ittiam)]

[JVET-O0505](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7112) Non-CE9: Simplifying BDOF early termination related cost calculations [S. Sethuraman (Ittiam)]

[JVET-O0984](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7620) Crosscheck of JVET-O0505 (Non-CE9: Simplifying BDOF early termination related cost calculations) [K. Unno (KDDI)]

[JVET-O0506](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7113) Non-CE9: An improvement to extended predicted sample value derivation in BDOF [S. Sethuraman (Ittiam)]

[JVET-O0871](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7492) Crosscheck of JVET-O0506 (Non-CE9: An improvement to extended predicted sample value derivation in BDOF) [C.-C. Chen, W.-J. Chien (Qualcomm)]

[JVET-O0508](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7115) Non-CE9: Refinement of optical flow estimates in BDOF [S. Sethuraman (Ittiam)]

[JVET-O0782](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7403) Crosscheck of JVET-O0508: Non-CE9: Refinement of optical flow estimates in BDOF [X. Xiu (Kwai Inc.)]

[JVET-O0570](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7185) Non-CE9: Unified gradient calculations in BDOF [H. Liu, L. Zhang, K. Zhang, Z. Deng, N. Zhang (Bytedance)]

[JVET-O0731](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7352) Crosscheck of JVET-O0570: Non-CE9: Unified gradient calculations in BDOF [[Y. He (InterDigital)](mailto:yuwen.he@interdigital.com)]

[JVET-O0573](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7188) Non-CE9: Restriction on motion vector refinement in BDOF [H. Liu, L. Zhang, K. Zhang, H.-C. Chuang, J. Xu (Bytedance)]

[JVET-O0819](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7440) Crosscheck of JVET-O0573 (Non-CE9: Restriction on motion vector refinement in BDOF) [T. Ikai (Sharp)]

[JVET-O0577](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7192) Non-CE9: Bi-directional optical flow (BDOF) for chroma components [W. Chen, Y. He (InterDigital)]

[JVET-O0857](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7478) Crosscheck of JVET-O0577 (Non-CE9: Bi-directional optical flow (BDOF) for chroma components) [H. Liu (Bytedance)]

[JVET-O0581](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7196) Non-CE9: Block Boundary Prediction Refinement with Optical Flow for DMVR [W. Chen, Y. He (InterDigital)]

[JVET-O0729](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7350) Crosscheck of JVET-O0581: Non-CE9: Block Boundary Prediction Refinement with Optical Flow for DMVR [[X. Xiu (Kwai Inc.)](mailto:xiaoyuxiu@kwai.com)]

[JVET-O0590](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7205) Non-CE9: Improvement of DMVR [Y.-W. Chen, X. Xiu, X. Wang (Kwai Inc.)]

[JVET-O0799](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7420) Crosscheck of JVET-O0590 on Non-CE9: Improvement of DMVR [X. Li (Tencent)]

[JVET-O0609](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7224) CE9-related: On BDOF precision alignment for high internal bit-depth [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-O0612](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7227) CE9-related: Complexity reduction for BDOF parameters calculation [K. Panusopone (Nokia)]

[JVET-O0615](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7230) Non-CE9: Derivation of extended prediction samples for BDOF gradient calculation [Y. He, W. Chen (InterDigital)]

[JVET-O0994](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7630) Crosscheck of JVET-O0615 (Non-CE9: Derivation of extended prediction samples for BDOF gradient calculation) [J. Li (Panasonic)]

[JVET-O0628](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7243) Non-CE9: SATD based DMVR [J. Chen, R.-L. Liao, Y. Ye, J. Luo (Alibaba)]

[JVET-O0703](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7323) Crosscheck of JVET-O0628: Non-CE9: SATD based DMVR [X. Xiu (Kwai Inc.)]

[JVET-O0634](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7249) Non-CE9: BDOF simplifications [X. Chen, H. Yang (Huawei)]

[JVET-O0940](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7566) Crosscheck of JVET-O0634: Non-CE9: BDOF simplifications [X. Xiu (Kwai Inc.)]

[JVET-O0975](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7608) Crosscheck of JVET-O0634 (Non-CE9: BDOF simplifications) [T. Zhou (Sharp)]

[JVET-O1060](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7697) Cross-check of JVET-O0364 (On general intra sample prediction) [A. K. Ramasubramonian (Qualcomm)]

[JVET-O0644](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7260) Non-CE9: Evaluation of Threshold Value Applied to SAD-based Early Termination in DMVR [C.-C. Chen, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-O0866](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7487) Crosscheck of JVET-O0644 (Non-CE9: Evaluation of Threshold Value Applied to SAD-based Early Termination in DMVR) [S. Sethuraman (Ittiam)]

[JVET-O0681](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7300) CE9-related: Disabled DMVR, BDOF and BCW for CIIP [H. Huang, W.-J. Chien, M. Karczewicz (Qualcomm)] [late]

[JVET-O0952](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7582) Crosscheck of JVET-O0681 (CE9-related: Disabled DMVR, BDOF and BCW for CIIP) [Y.-W. Chen (Kwai Inc.)]

## CE10 related – Neural network based loop filtering (2)

Contributions in this category were discussed Thursday 4 July 2020–XXXX in Track B (chaired by JRO).

[JVET-O0157](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6761) Non-CE10: A CNN based in-loop filter for intra frame [L. Xu, J. Zhu, K. Kazui (Fujitsu)]

A sub-sampled Convolution Neural Network filter is proposed to replace the de-blocking filter (DBF) in VVC. This CNN based in-loop filter is trying to reduce neural network complexity while keeping coding efficiency. It is a light weight CNN and with an effective way to control the CNN filtering strength for processing in different quantization condition. It is only for intra frames. On top of VTM-5.0, simulation results reportedly show 1.44%/2.51%/3.39% BD-rate saving for Y, Cb and Cr components respectively in AI configuration. The decoding time is 1040%. Subjective quality improvement can also be observed.

Presentation deck to be uploaded.

It is commented that the division by QSTEP is not exactly approximating the coding errors that VVC produces, since quantization is performed in the residual transform domain. Might be better to condsider the characteristics of transform basis functions and block structure additionally.

From the example given, the method seems to have some smoothing but also some sharpening effects, depending on local content.

ALF and SAO are still operated.

Only intra is tested – would it work for inter coded pictures?

In terms of performance, it is better (and more complex) than the simplest AI solution from CE10 (CE10-2.8c), but worse (and less complex) than other such as CE10-2.2a.

Further study recommended along with other NN technology.

[JVET-O0348](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6953) CE10-Related: Classifier Based Adaptive Convolutional Neural Network Loop Filter [H. Yin, R. Yang, X. Fang, S. Ma (Intel)] [miss] [late]

TBP – no presenter present, and doc not yet existing when the category was reviewed on 07-04.

## CE11 related – Gradual random access (2)

[JVET-O0976](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7611) CE11-related: Wavefront-based GRA and Related Syntax [L. Wang, M. M. Hannuksela (Nokia)] [late]

This contribution was discussed Thursday 4 July 1800 (chaired by GJS).

This contribution contains the following proposed items:

* It is proposed to indicate a virtual boundary type in PPS. Type 0 would be the same as currently in VVC Draft 5, and types 1 to 3 would be specified for vertical, horizontal, and wavefront-based (i.e., diagonal) virtual boundaries specified with syntax elements in the slice header. Types 1 to 3 are asserted to avoid the need for updating PPSs for turning off loop filtering.
* The contribution proposes a special syntax for a wavefront-based GRA (Gradual Random Access) and proposes related syntax to turn off loop filtering across a wavefront boundary. A GRA picture, in general, consists of three areas; clean, intra coded and dirty. With the wavefront-based GRA, all the reference pixels for the blocks in intra coded area are in clean and/or intra coded area. Hence, no restriction would be imposed on intra prediction for the blocks in the intra coded area.

It was noted that some form of diagonal refresh would be possible without special syntax support. Note that JVET-O0979 considers this.

It is proposed that the block granularity of the diagonal boundary could be smaller than a CTU.

Reviewing the proposed syntax, it seemed clear that some aspects had not been fully thought out yet.

See also the notes for JVET-O0979.

[JVET-O0979](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7614) CE11-related: Wavefront-based GRA Method [L. Wang (Nokia)] [late]

This contribution was discussed Thursday 4 July 1820 (chaired by GJS).

This contribution describes a gradual random access (GRA) method using a GRA block size which could be smaller than a CTU. This could be done without any special support in the syntax or decoding process to some degree, but the contribution proposes having a special treatment for in-loop filtering.

It was commented that this could avoid the need for CIP because “dirty” above-right data is never used. However, if CIP is not used (and nothing else special is done about intra prediction), the refresh could only start when the encoder starts over at the upper-left corner; it cannot jump in at any arbitrary picture.

Syntax was proposed but full spec text and software were not.

Further study of this and JVET-O0976 was encouraged.

[JVET-O1048](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7685) Non-CE11: Non-CIP normative Gradual Random Access [D. Gommelet, J.-M. Thiesse, D. Nicholson (VITEC)] [late] [miss]

## Quantization parameter signalling (8)

[JVET-O0046](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6650) AHG16: Changing cu\_qp\_delta signalling to facilitate VDPU-level processing [B. Heng, M. Zhou, T. Hellman (Broadcom)]

This contribution was discussed 4 July 1900 (GJS).

This contribution claims that the existing syntax definition for cu\_qp\_delta, in which QP delta transmission is delayed until the first transform unit with coded coefficients, inhibits VDPU-level decode processing (64x64 decoder pipeline). It notes that a QP value is necessary for filtering operations, and therefore, for CU sizes larger than 64x64, earlier VDPUs cannot be filtered until cu\_qp\_delta is received. It claims that this is the only syntax element in the entire standard that introduces such a delay.

The contribution recommends changing the delta QP syntax as follows:

* For any CU larger than 64x64, send the cu\_qp\_delta syntax with the first transform unit, regardless of whether that first TU has any non-zero CBF or not.

In this way, QP can be determined when a VDPU is parsed, rather than depending on delta QP information carried in future VDPUs. The experimental results revealed that the proposed delta QP signalling method is equally efficient when compared to the current method implemented in VTM5.0.

It was noted that this would send delta QP in a rare case when it otherwise would not be sent: in a very large intra CU when all CBFs are zero. This has no effect on CTC, since CTC does not use delta QP. An experiment found no practical effect from this.

See also JVET-O0643.

It was commented that this approach seems simpler, at least from a spec text impact perspective, than the one proposed in JVET-O0643.

Decision (bug fix): Adopt.

[JVET-O0838](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7459) Crosscheck of JVET-O0046: AHG16: Changing cu\_qp\_delta signalling to facilitate VDPU-level processing [L. Zhang (Bytedance)]

[JVET-O0643](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7259) Modification on Delta QP for Deblocking [Y. Han, G. Van Der Auwera, M. Coban, M. Karczewicz (Qualcomm)]

This contribution was discussed 4 July at 1910 (GJS).

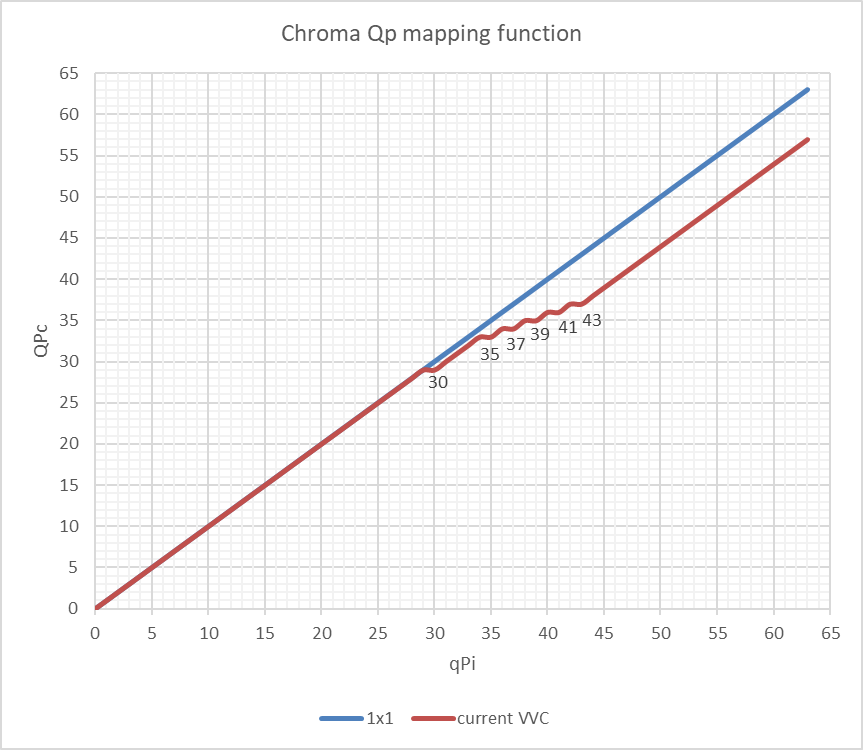
This is similar in concept to JVET-O0046, but has a different proposed approach, which is to not change the signalling, but apply the delta QP only to the VDPUs that follow the first one that has nonzero transform coefficients – i.e., there would be different QP values for different areas within a large CU. Complete spec text was not provided. See the notes for JVET-O0046.

[JVET-O0186](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6790) AHG15: Signalling of chroma Qp mapping table [S. Ikonin, R. Chernyak, E. Alshina (Huawei)]

This contribution was discussed 4 July at 1925 (chaired by GJS).

O0186 O0298, O0433, O0562, and O0650 are all related.

This contribution proposes a signalling mechanism for a chroma Qp mapping table. It is also reported that usage of an adjusted mapping table can provide additional benefits in terms of coding performance and coding gain balancing across luma and chroma components. Informal subjective evaluation results are also reported demonstrating no noticeable difference for moving pictures and slight improvement for static pictures. No color issues or artefacts are reportedly detected.



The proponent indicated that the coding of the deltas was proposed to be ue(v).

Experiment results were shown with a different table, with gain shown relative to the anchor. However, it was commented that subjective effects may be different, and one participant remarked that some sample images in the contribution seemed to have lower visual quality.

It was commented that aside from the fact that the default relationship was never optimized to begin with, the desired default relationship might be different for different colour spaces (e.g. PQ).

The current CTC has an offset intended shift some bits from chroma to luma, but at very low QPs it can result in chroma problems. Adjusting the table rather than the offset could prevent.

The syntax proposed here requires the slope of the table to always be less than or equal to 1.

This proposal does not have separate tables for different chroma components (although it’s not difficult to adapt it to do that).

[JVET-O0298](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6903) AHG15: Chroma Quantization Qpc Parameter Signalling [S. Paluri, J. Zhao, J. Lim, S. Kim (LGE)]

This contribution was discussed 4 July at 2010 (chaired by GJS).

O0186 O0298, O0433, O0562, and O0650 are all related.

This document proposes the inclusion of a user defined chroma quantization (QpC) in the VVC specification text. A flag in the sequence parameter set (SPS) is introduced to indicate if the default table in the specification text is to be used or if the contents of the table should be derived from the information signaled in the SPS. In the current draft of VVC, the QpC values are derived using a fixed table given in the specification text. It is asserted that this design enables functionality to accommodate user defined chroma quantization to benefit different content. Additionally, two options are presented in the proposal. Option 1 asserts that only 1 user defined table is sufficient while Option 2 provides added flexibility to have separate user defined tables for Cb and Cr components.

There were comments about the syntax in the very low QP range (for QP <= 0).

[JVET-O0433](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7038) AHG15: Chroma quantization parameters Qpc table [F. Pu, T. Lu, P. Yin, S. McCarthy, W. Husak, T. Chen (Dolby)]

This contribution was discussed 4 July at 2020 (chaired by GJS).

O0186 O0298, O0433, O0562, and O0650 are all related.

This contribution proposes syntax and semantics for signalling user-defined chroma quantization parameter QpC tables for any signal type. The proposed syntax and semantics support signalling of either one QpC table to be shared by both chroma components or a pair of QpC tables, one for each chroma component. The proposed syntax and semantics can be used for any signal type, including SDR and HDR. This contribution additionally proposes that default chroma quantization parameter QpC tables be defined to provide an option to simplify signalling and reduce the number of bits required to signal QpC tables. Three default QpC tables are proposed to support the following use cases: SDR Y'CbCr, HDR PQ Y'CbCr and HDR HLG Y'CbCr. (The proposed syntax and semantics allow additional default QpC tables, for example default tables for ICTCP, to be specified later if desired.)

The maximum number of bits required to signal QpC table(s) for each option is reportedly as follows:

* two QpC tables (one for each chroma component): 170 bits
* one QpC table (shared by both chroma components): 86 bits
* default QpC table (shared by both components): 2 bits for SDR and 4 bits for HDR

[JVET-O0678](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7297) Crosscheck of JVET-O0433 (AHG15: chroma quantization parameters QpC table) [Louis Kerofsky (InterDigital)]

[JVET-O0562](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7176) AHG15: Flexible luma-to-chroma quantization parameter tables [F. Bossen, A. Segall (Sharp)]

This contribution was discussed 4 July at 2030 (chaired by GJS).

O0186 O0298, O0433, O0562, and O0650 are all related.

The current VVC draft defines a table that maps a luma quantization parameter value to a chroma quantization parameter value. The table is substantially the same as what was used in previous standards, and it is the authors understanding that the table was originally developed to manage the bit-allocation between luma and chroma channels at lower rates. However, compared to these previous standards, the VVC draft now contains additional tools that impact the balance of luma and chroma, such as dual tree support and cross-component linear model prediction (CCLM). Furthermore, it is anticipated that the VVC standard will be used to compress a larger amount of content types – including both standard dynamic range and high dynamic range content – that contain different relationships between the luma and chroma channels. As such, it is asserted that the current and fixed table may not be ideal, and it is proposed to have a programmable table to offer encoder flexibility.

The contribution notes that there is something different about QP for joint chroma coding. Revisit that.

The proposed syntax uses a piece-wise linear scheme (with no slope assumption).

The syntax is proposed to be at the PPS level.

Offsets both prior to and after the mapping table are proposed to be used.

Tests with not rounding the lambda value were reported, showing a more linear behaviour with increasing chroma QP.

It was commented that the chroma QP offset as currently used may not be needed if a general table is supported.

[JVET-O0650](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7266) AHG15: On signalling of chroma QP tables [A. K. Ramasubramonian, G. Van der Auwera, D. Rusanovskyy, M. Karczewicz (Qualcomm)]

This contribution was discussed 4 July at 2100 (chaired by GJS).

O0186 O0298, O0433, O0562, and O0650 are all related.

This document proposes a signalling mechanism for chroma QP tables. It is suggested that the mechanism should be flexible to provide encoders the opportunity to optimize the table for SDR and HDR content. It is argued that the signalling mechanism should have support for signalling the tables separately for Cb and Cr components. The proposed mechanism signals the chroma QP table as a piece-wise linear function.

[JVET-O1021](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7658) Crosscheck of JVET-O0186 (AHG15: Signalling of chroma Qp mapping table) [K. Choi (Samsung)]

General consideration of chroma QP mapping

Discussion time Thursday 4 July 2110-2230 (GJS)

Issues:

* Separate mapping tables for Cb and Cr – yes, should support this (also supporting a common table)
* SPS, PPS, or APS – SPS
* Default(s) – no default
* Additional offsets prior to or after the mapping table (currently we have PPS and slice level offsets before the mapping) – PPS and slice level, offsets applied *after* the mapping table (deblocking continues to use only the picture level offset)
* Joint chroma coding handling – use a third table if not using a common table, and support a third offset at PPS and slice level (similar to what we’re doing now at the PPS and slice level)
* Open:
  + Degree of generality needed for the mapping table (slope constraints other than non-negative, and starting point constraints) – it was commented that we seem to have some use for a general non-negative slope, where we want slope of 1 at very low QP, a somewhat higher QP for chroma in some middle range, but then a somewhat lower QP for chroma at very high QP values – we prefer to have a general syntax, O0562 actually supports negative slopes, O0650 supports arbitrary non-negative slopes, so it was suggested to consider that syntax as a candidate for adoption; revisit after offline study.
  + Syntax & semantics details (amount of bits, number of syntax elements, text description)
  + What to do in CTC

[JVET-O0267](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6872) AHG15: Cleanups for scaling matrices [O. Chubach, C.-Y. Lai, C.-Y. Chen, T.-D. Chuang, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0737](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7358) Chroma Delta QP for Separate Tree [Y. Han, G. Van Der Auwera, M. Coban, W.-J. Chien, Y.-H. Chao, A. Nalci, M. Karczewicz (Qualcomm)] [late]

## Entropy coding (6)

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

[JVET-O0308](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6913) CABAC skip mode [K. Abe, T. Toma (Panasonic), D.-Y. Kim (Chips&Media)]

[JVET-O1052](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7689) Crosscheck of JVET-O0308 (CABAC skip mode) [C. Rosewarne (Canon)]

[JVET-O0450](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7056) Separating context coded and bypass coded data [A. Hallapuro, J. Lainema (Nokia)]

[JVET-O0517](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7124) Slice/tile level CABAC zero-word constraints [A. Browne, S. Keating, K. Sharman (Sony)]

[JVET-O0519](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7126) Switching between CABAC context coded bins and EP coded bins [A. Browne, S. Keating, K. Sharman (Sony)]

[JVET-O1069](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7706) Crosscheck of JVET-O0519 (Switching between CABAC context coded bins and EP coded bins) [M. Coban (Qualcomm)]

[JVET-O0520](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7127) GT1 flag coding [A. Browne, S. Keating, K. Sharman (Sony)]

[JVET-O0554](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7168) Removal of infrequently used context models [A. Alshin, J. Boyce, Pavel Frolov, Vasily Aristarkhov (Intel)]

[JVET-O0854](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7475) Crosscheck of JVET-O0554 (Removal of infrequently used context models) [Z. Deng (Bytedance)]

## Chroma sampling and chroma formats (2)

[JVET-O0616](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7231) Non-CE: Various chroma format support in VVC [N. Zhang, L. Zhang, H. Liu, K. Zhang, Y. Wang (Bytedance)]

[JVET-O0622](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7237) AHG2: Draft text to update BT.2100 references and ICTCP HLG coding equations [S. McCarthy, F. Pu, T. Lu, P. Yin, W. Husak, T. Chen (Dolby)]

## Other coding tools (13)

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

[JVET-O0194](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6799) On chroma-CU-related flags and coding information [Y. Zhao, H. Yang (Huawei)]

[JVET-O0824](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7445) Crosscheck of JVET-O0194 (On chroma-CU-related flags and coding information) [X. Cao (Hikvision)]

[JVET-O0389](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6994) On Supporting 64x64 Chroma Transform Unit [W. Cai, J. Zhu, J. Yao, K. Kazui (Fujitsu)]

[JVET-O0704](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7324) Crosscheck of JVET-O0389: On Supporting 64x64 Chroma Transform Unit [X. Zhao (Tencent)]

[JVET-O0398](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7003) Chroma block size restriction in dual tree intra coding [J. Choi, J. Heo, J. Lim, S. Kim (LGE)]

[JVET-O1031](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7668) Crosscheck of JVET-O0398 (Chroma block size restriction in dual tree intra coding) [J. Lee, S.-C. Lim, H. Lee, J. Kang (ETRI)]

[JVET-O0447](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7053) Enabling tools for small blocks in small pictures [P. Bordes, F. Le Léannec, T. Poirier, F. Galpin (InterDigital)]

[JVET-O0460](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7067) On lossless coding for VVC [T. Poirier, F. Le Léannec, F. Galpin (InterDigital)]

[JVET-O0945](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7572) Crosscheck of JVET-O0460 (On lossless coding for VVC) [T.-C. Ma (Kwai Inc.)]

[JVET-O0461](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7068) AHG13: On chroma tool evaluation in Dual Tree [T. Poirier, F. Le Léannec, F. Galpin, E. François (InterDigital)] [miss] [late]

[JVET-O0525](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7132) AHG16: Removal of PCM mode [T. Hellman (Broadcom)]

[JVET-O0526](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7133) AHG16: Setting the minimum CTU size to 32x32 [T. Hellman, M. Zhou (Broadcom)]

[JVET-O0537](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7144) Non-CE: Weighted intra and inter prediction mode [L. Zhao, X. Zhao, X. Li, S. Liu (Tencent)]

[JVET-O0778](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7399) Crosscheck of JVET-O0537 (Non-CE: Weighted intra and inter prediction mode) [Y.-W. Chen (Kwai Inc.)]

[JVET-O0548](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7160) Combined bilateral/SAO loop filter [J. Ström, P. Wennersten, J. Enhorn, D. Liu, K. Andersson, R. Sjöberg (Ericsson)]

[JVET-O1035](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7672) Crosscheck of JVET-O0548: Combined bilateral/SAO loop filter [H. Wang (Qualcomm)]

[JVET-O0549](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7162) AHG10: Encoder-only GOP-based temporal filter [P. Wennersten, R. Sjöberg, J. Enhorn (Ericsson)]

[JVET-O1004](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7640) Crosscheck of JVET-N0549 (AHG10: Encoder-only GOP-based temporal filter) [S. Esenlik (Huawei)]

[JVET-O0584](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7199) Comments on transform quantization bypassed mode [H. Jang, J. Nam, N. Park, J. Choi, S. Kim, J. Lim (LGE)]

[JVET-O0591](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7206) Modifications to support the lossless coding [T.-C. Ma, Y.-W. Chen, X. Xiu, X. Wang (Kwai Inc.)]

[JVET-O1033](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7670) Crosscheck of JVET-O0591: Modifications to support the lossless coding [T. Poirier (InterDigital)]

## 360 degree video (5)

[JVET-O0344](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6949) AHG6-Related: Spherical domain rate control for 360-degree video coding in VVC [N. Yan, L. Li, D. Liu, H. Li, Z. Li, F. Wu (USTC)] [miss] [late]

[JVET-O0419](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7024) AHG6: Wrap-around spatial merge candidate for inter prediction [M. Lee, J. Lee, J. Park, D. Sim, S. Oh (KWU), W. Lim, G. Bang, H. Kim (ETRI)]

[JVET-O0487](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7094) Geometry padding for cube based 360 degree video using uncoded areas [J. Sauer, M. Bläser (RWTH Aachen)]

[JVET-O0488](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7095) Parameterizable cubemap for 360 degree video coding [J. Sauer, M. Bläser (RWTH Aachen)]

[JVET-O0891](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7513) AHG6/AHG17: Cubemap-based projection syntax for 360-degree videos [Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek)] [late]

## AHG17: General high-level syntax (61)

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

### NAL unit header and reference picture indication (6)

[JVET-O0146](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6750) AHG17: On unspecified NAL unit types [Y.-K. Wang (Futurewei)]

[JVET-O0179](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6783) On NAL Unit Header Design [S. Deshpande (Sharp)]

[JVET-O0237](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6842) AHG17: Compact NAL unit header [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

[JVET-O0359](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6964) AHG17: On identification of reference and non-reference picture [T. Suzuki (Sony)]

[JVET-O0181](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6785) Comments on High-Level Syntax of VVC [S. Deshpande (Sharp)]

Only the proposal 2 in the contribution belongs to this agenda item.

[JVET-O1037](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7674) AHG17: On NAL unit header [Y.-K. Wang (Futurewei)] [late]

### Parameter set mechanism and parsing dependency (6)

[JVET-O0113](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6717) AHG17: On parsing dependency between parameter sets [Y.-K. Wang (Futurewei), J. Boyce (Intel)]

[JVET-O0155](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6759) AHG17: Resolving PPS parsing dependency on SPS [Hendry, Y.-K. Wang (Futurewei)]

[JVET-O0236](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6841) AHG17: Making PPS parsing independent of SPS [R. Sjöberg, M. Pettersson, M. Damghanian (Ericsson)]

[JVET-O0490](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7097) AHG17: Independent parsing of parameter sets [K. Sühring, R. Skupin, Y. Sanchez, T. Schierl (HHI)]

[JVET-O0181](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6785) Comments on High-Level Syntax of VVC [S. Deshpande (Sharp)]

Only the proposal 1 (on parameter set activation) and proposal 4 (on DPS referencing by SPS) in the contribution belong to this agenda item.

[JVET-O0268](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6873) AHG17: Signalling SPS base and patch [L. Chen, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

### IOP point definition and signalling (2)

[JVET-O0044](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6648) AHG17: Signalling zero or more Sub-Profiles [S. Wenger, B. D. Choi, S. Liu (Tencent)]

[JVET-O0417](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7022) AHG17: On general constraint information [P. Bordes, M. Kerdranvat (InterDigital)]

### Picture types, random access, and sub-layer switching (5)

[JVET-O0147](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6751) AHG17: Constraints on IRAP pictures and leading pictures [Hendry, Y.-K. Wang (Futurewei)]

[JVET-O0226](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6831) AHG17: On constraint about position of leading pictures and trailing pictures associated to an IRAP [V. Drugeon, K. Abe (Panasonic)]

[JVET-O0149](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6753) AHG17: On external decoding refresh (EDR) [Y.-K. Wang, J. Chen (Futurewei), H. Yu, L. Yu (ZJU)]

[JVET-O0393](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6998) AHG17: On cross-RAP referencing [M. M. Hannuksela (Nokia)]

[JVET-O0235](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6840) AHG17: Ensuring temporal switching with STSA pictures [R. Sjöberg, M. Damghanian, M. Pettersson (Ericsson)]

### Reference picture list signalling (2)

[JVET-O0148](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6752) AHG17: On reference picture list signalling [Y.-K. Wang, Hendry (Futurewei)]

[JVET-O0244](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6849) AHG17: On zero delta POC in reference picture structure [V. Seregin, M. Coban, A. K. Ramasubramonian, M. Karczewicz (Qualcomm)]

### Miscellaneous HLS topics (12)

[JVET-O0151](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6755) AHG17: On no\_output\_of\_prior\_pics\_flag [Y.-K. Wang (Futurewei)]

[JVET-O0154](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6758) AHG17: Miscellaneous AHG17 topics [Y.-K. Wang (Futurewei)]

[JVET-O0176](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6780) On Tiles, Bricks and Slices [S. Deshpande (Sharp)]

Only the proposal 5 (also covered in JVET-O0152) in the contribution belongs to this agenda item.

[JVET-O0178](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6782) On DPB Parameters [S. Deshpande (Sharp)]

[JVET-O0201](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6806) AHG17: On Gradual Random Access (GRA) [M. Coban, A. Ramasubramonian, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0234](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6839) AHG17: Slice header extension [R. Sjöberg, M. Damghanian, M. Pettersson (Ericsson)]

[JVET-O0238](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6843) AHG17: Parameters in SPS or slice headers [M. Pettersson, P. Wennersten, R. Sjöberg, M. Damghanian (Ericsson)]

[JVET-O0241](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6846) AHG17: On Decoding Process Steps [S. Deshpande (Sharp)]

[JVET-O0270](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6875) AHG17: Signalling refreshed regions associated with a GRA picture [L. Chen, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0391](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6996) AHG17: Avoiding dependencies on externally controlled variables in the decoding process [M. M. Hannuksela, K. Kammachi-Sreedhar (Nokia)]

[JVET-O0392](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6997) AHG17: Output of SEI messages [M. M. Hannuksela (Nokia)]

[JVET-O0497](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7104) AHG17: On layer grouping for independent regions and ARC [Y. Sanchez, R. Skupin, K. Sühring, T. Schierl (HHI)]

### APS and ALF parameters signalling (8)

[JVET-O0245](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6850) AHG17: On TemporalId and NuhLayerId in APS [V. Seregin, M. Coban, A. K. Ramasubramonian, N. Hu, M. Karczewicz (Qualcomm)]

[JVET-O0246](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6851) AHG17: Separate luma and chroma ALF APS types [V. Seregin, N. Hu, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-O0299](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6904) AHG17: APS support for default and user defined scaling matrices [S. Paluri, J. Zhao, J. Lim, S. Kim (LGE)]

[JVET-O0893](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7515) Crosscheck of JVET-O0302 (Non-CE5: Simplification of ALF Coefficients in the APS) [N. Hu (Qualcomm)]

[JVET-O0491](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7098) AHG17: High-level syntax cleanup [K. Sühring, R. Skupin, Y. Sanchez, T. Schierl (HHI)]

[JVET-O0561](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7175) AHG17: APS ID Control Mechanism [S. Paluri, J. Lim, S. Kim (LGE)]

### Virtual boundary signaling (3)

[JVET-O0339](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6944) AHG17: On virtual bounary signaling [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-O0340](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6945) AHG17: On modifiaction of virtual boundaries signaling [G. Bang, W. Lim, H.Y. Kim (ETRI)]

[JVET-O0445](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7050) [AHG17] Signaling of uniform virtual boundaries [A. DSouza, C. Pujara, R. Gadde, W. Choi, K. P. Choi (Samsung)]

### HRD (11)

[JVET-O0043](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6647) AHG17: Clarification on role of pic\_struct to HRD and the output picture process [C. Fogg (MovieLabs)]

[JVET-O0152](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6756) AHG17: HRD support for GRA and changing the term GRA to GDR [Y.-K. Wang (Futurewei)]

[JVET-O0153](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6757) AHG17: HRD clean-ups [Y.-K. Wang (Futurewei)]

[JVET-O0177](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6781) On HRD Signalling [S. Deshpande (Sharp)]

[JVET-O0180](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6784) On Buffering Period [S. Deshpande (Sharp)]

[JVET-O0189](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6793) AHG17: Support of decoding unit in HRD [K. Kazui (Fujitsu)]

[JVET-O0227](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6832) AHG17: Parsing dependency of picture timing SEI message on SPS [V. Drugeon (Panasonic)]

[JVET-O0228](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6833) AHG17: Harmonized HRD parameters signaling [V. Drugeon (Panasonic)]

[JVET-O0495](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7102) AHG17: On HRD for Open GOP and DRAP [Y. Sanchez, R. Skupin, K. Sühring, T. Schierl (HHI)]

[JVET-O0496](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7103) AHG17: On HRD for splicing [Y. Sanchez, R. Skupin, K. Sühring, T. Schierl (HHI)

[JVET-O0667](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7284) DPB size analysis of VTM5.0 using RA configuration in current CTC [X. Ma, H. Yang (Huawei)]

### VUI and SEI (6)

[JVET-O0041](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6645) AHG17: On signalling of frame field information [Y.-K. Wang (Futurewei), K. Sühring (HHI), C. Fogg (MovieLabs)]

[JVET-O0042](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6646) AHG17: Replicating pic\_struct into separate elements for future extensibility [C. Fogg (MovieLabs)]

[JVET-O0435](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7040) AHG17: on pic\_struct [S. McCarthy, F. Pu, T. Lu, P. Yin, W. Husak, T. Chen (Dolby)]

[JVET-O0360](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6965) AHG17: On sRGB and sYCC [T. Suzuki (Sony)]

[JVET-O0622](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=7237) AHG2/AHG17: Draft text to update BT.2100 references and ICTCP HLG coding equations [S. McCarthy, F. Pu, T. Lu, P. Yin, W. Husak, T. Chen]

[JVET-O0492](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7099) AHG17: On merging of bitstreams and conformance [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

## AHG12: high-level parallelism and coded picture regions (41)

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

[JVET-O0800](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7421) A summary of HLS proposals on coded picture regions [Y.-K. Wang (Futurewei)] [late]

### Sequence-level independent regions (10)

[JVET-O0138](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6742) AHG12: Treating region boundaries as picture boundaries [Hendry, S. Hong, J. Chen, Y.-K. Wang (Futurewei)]

[JVET-O0141](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6745) AHG12: Sub-picture based motion-constrained independent regions [Y.-K. Wang, Hendry, J. Chen (Futurewei), R. Skupin, Y. Sanchez, K. Suehring (HHI)]

[JVET-O0176](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6780) On Tiles, Bricks and Slices [S. Deshpande (Sharp)]

Only the proposal 6 in the contribution belongs to this agenda item.

[JVET-O0182](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6786) AHG12: On picture and sub-picture signaling [Y. He, A. Hamza (InterDigital)]

[JVET-O0183](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6787) AHG12: On layer-based sub-picture extraction and reposition [Y. He, A. Hamza (InterDigital)]

[JVET-O0334](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6939) AHG8/AHG12: On sub-picture partitioning support with layers [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

[JVET-O0394](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6999) AHG12: On independently coded picture regions [M. M. Hannuksela (Nokia)]

[JVET-O0493](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7100) AHG12: On independent regions and output sub-picture sets [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

[JVET-O0555](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7169) AHG12: Sub-pictures and sub-picture sets with level derivation [J. Boyce, L. Xu (Intel)]

[JVET-O0700](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=7320) AHG12: On sub-picture info SEI message [Y. He, A. Hamza (InterDigital)] [late]

### Mixed NAL unit types within a picture (2)

[JVET-O0140](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6744) AHG12: On mixed NAL unit types within a picture [Y.-K. Wang, Hendry (Futurewei)]

[JVET-O0498](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7105) AHG17: On marking process and unequal NALU types per AU [Y. Sanchez, R. Skupin, K. Sühring, T. Schierl (HHI)]

### Slice, tile, and brick signalling in PPS and slice header (15)

[JVET-O0143](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6747) AHG12: Signalling of addresses for rectangular slices [R. Sjöberg, M. Damghanian, M. Pettersson, J. Ström (Ericsson), Hendry, Y.-K. Wang (Futurewei)]

[JVET-O0156](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6760) AHG12: On brick signaling [W. Lim, G. Bang, H. Y. Kim (ETRI)]

[JVET-O0172](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6776) On rectangular slice address signaling [B.-K. Lee (Xris)]

[JVET-O0173](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6777) On brick information signaling [B.-K. Lee (Xris)]

[JVET-O0176](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6780) On Tiles, Bricks and Slices [S. Deshpande (Sharp)]

Only the proposals 1 to 4 in the contribution belongs to this agenda item.

[JVET-O0181](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6785) Comments on High-Level Syntax of VVC [S. Deshpande (Sharp)]

Only the proposal 3 in the contribution belongs to this agenda item.

[JVET-O0199](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6804) AHG12: On rectangular slices [M. Coban, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0225](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6830) AHG17: On signalling of bottom right brick for rectangular slices [V. Drugeon, T. Nishi (Panasonic)]

[JVET-O0269](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6874) AHG17: Suggested syntax improvement on PPS [L. Chen, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-O0338](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6943) AHG12: On signaling for slice, tile and brick [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-O0403](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7008) AHG17: On brick index signalling [P. Bordes, M. Kerdranvat (InterDigital)]

[JVET-O0452](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7058) AHG12: On tile and brick partition [Y.-J. Chang, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-O0453](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7059) AHG12: On rectangular slice signaling [Y.-J. Chang, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-O0454](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7060) AHG12: On sub-bitstream extraction [Y.-J. Chang, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0610](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7225) AHG17: Association of VCL NAL units to coded pictures [B. Heng, W. Wan (Broadcom)]

### Signalling of brick/WPP entries (4)

[JVET-O0144](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6748) AHG12: On end\_of\_subset\_one\_bit, end\_of\_brick\_one\_bit, and byte alignment in the slice data syntax [Hendry, Y.-K. Wang (Futurewei)]

[JVET-O0145](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6749) AHG12: Miscellaneous AHG12 topics [Y.-K. Wang, Hendry (Futurewei)]

[JVET-O0215](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6820) AHG12: Clean up on wavefront parallel processing signaling [T. Ikai, E. Sasaki, T. Chujoh (Sharp)]

[JVET-O0306](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6911) AHG17: Entry point offsets without start code emulation [K. Abe, T. Toma, V. Drugeon (Panasonic)]

### New tile/brick/WPP partitioning schemes (5)

[JVET-O0198](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6803) AHG12: On brick partitioning [M. Coban, A. Ramasubramonian, Y.-J. Chan, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-O0358](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6963) AHG12: On uniform tile spacing [Y. Fujimoto, M. Ikeda, T. Suzuki (Sony)]

[JVET-O0390](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6995) AHG17: On tile and brick signalling [M. M. Hannuksela (Nokia)]

[JVET-O0511](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7118) AHG12: On tiles and bricks partitioning [N. Ouedraogo, E. Nassor (Canon)]

[JVET-O0462](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7069) AHG12: Separated Luma and Chroma wavefront for dual tree [T. Poirier, F. Le Léannec, F. Galpin (InterDigital)]

### Loop filtering across boundaries of independently coded regions (4)

[JVET-O0142](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6746) AHG12: On turning off ALF filtering at brick and slice boundaries [Y.-K. Wang, J. Chen, Hendry (Futurewei)]

Also included in the agenda item 6.5.

[JVET-O0494](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7101) AHG12: On filtering of independently coded region [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

Also included in the agenda item 6.5.

[JVET-O0654](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7270) AHG12/Non-CE5: Unification of boundary handling for adaptive loop filter [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

Also included in the agenda item 6.5.

[JVET-O0858](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7479) Crosscheck of JVET-O0654 (AHG12/Non-CE5: Unification of boundary handling for adaptive loop filter) [H. Liu (Bytedance)]

[JVET-O0662](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7279) Non-CE5: Modified ALF filtering for Slice, Brick and Virtual boundaries [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)]

Also included in the agenda item 6.5.

## AHG8: layered coding and resolution adaptivity (25)

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

### Reference picture resampling (RPR) (12)

[JVET-O0133](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6737) AHG8: Support for reference picture resampling - handling of picture size signalling, conformance windows, and DPB management [Hendry, S. Hong, Y.-K. Wang, J. Chen (Futurewei), Y.-C Sun, T.-S Chang, J. Lou (Alibaba)]

[JVET-O0134](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6738) AHG8: Support for reference picture resampling - handling of resampling, TMVP, DMVR, and BDOF [Y.-C Sun, T.-S Chang, J. Lou (Alibaba), Hendry, S. Hong, Y.-K. Wang, J. Chen (Futurewei)]

[JVET-O0757](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7378) Crosscheck of JVET-O0134 (AHG8: Support for reference picture resampling - handling of resampling, TMVP, DMVR, and BDOF) [H.-J. Jhu (Kwai Inc.)]

[JVET-O0184](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6788) AHG8: On ARC indicator [Y. He, Y. He, A. Hamza (InterDigital)]

[JVET-O0204](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6809) AHG8: On Adaptive Resolution Change (ARC) High-Level Syntax (HLS) [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

[JVET-O0240](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6845) AHG8: Adaptive Resolution Change (ARC) with downsampling [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

[JVET-O0242](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6847) AHG8: Enabling BDOF and DMVR for reference picture resampling [V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-O0303](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6908) AHG8: Adaptive Resolution Change [P. Chen, T. Hellman, B. Heng, W. Wan, M. Zhou (Broadcom)]

[JVET-O0701](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7321) Crosscheck of JVET-O0303 (AHG8: Adaptive Resolution Change) [Y. He (InterDigital)]

[JVET-O0319](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6924) AHG8: On Adaptive Resolution Change [P. Topiwala, M- Krishnan, W. Dai (FastVDO)]

[JVET-O0332](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6937) AHG8: Signaling and filtering for Reference Picture Resampling (RPR) [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-O0395](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7000) AHG8: On adaptive resolution changing and scalable coding [M. M. Hannuksela, A. Aminlou (Nokia)]

[Also listed in another section]

Only the RPR part in the contribution belongs to this agenda item.

[JVET-O0641](file:///C:\Users\y00441455\Downloads\current_document.php?id=7257) AHG8: AHG 8: JVET Common test conditions for adaptive resolution change (ARC) [M. G. Sarwer, R. -L Liao, J. Chen, J. Luo, Y. Ye (Alibaba)]

[Also listed in another section]

[JVET-O1055](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7692) Crosscheck of JVET-O0641 (AHG 8: JVET Common test conditions for adaptive resolution change (ARC)) [J. Choi, J. Lim (LGE)]

[JVET-O1040](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7677) AHG8: Summary of Resolution Adaptivity related proposals [S. Wenger (Tencent), Y-K. Wang (Futurewei)] [late]

### Scalability (13)

[JVET-O0045](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6649) AHG8: Spatial Scalability using Reference Picture Resampling [S. Wenger, B. D. Choi, S. C. Han, X. Li, S. Liu (Tencent)]

[JVET-O0135](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6739) AHG8: Scalability for VVC – general [Y.-K. Wang, Hendry, J. Chen (Futurewei)]

[JVET-O0136](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6740) AHG8: Scalability for VVC - handling of POC, RPL, and RPM [Y.-K. Wang, Hendry, J. Chen (Futurewei)]

[JVET-O0185](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6789) AHG8/AHG17: On layer dependency signaling [Y. He, A. Hamza (InterDigital)]

[JVET-O0243](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6848) AHG8: On inter-layer reference for scalability support [V. Seregin, M. Coban, A. K. Ramasubramonian, M. Karczewicz (Qualcomm)]

[JVET-O0333](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6938) AHG8: On spatial scalability support with reference picture resampling [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-O0335](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6940) AHG8: E-Sport Use cases of VVC region-wise scalability and its system support [B. Choi, S. Zhao, I. Sodagar, S. Wenger, S. Liu (Tencent)]

[JVET-O0336](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6941) AHG8: Region-wise scalability support with reference picture resampling [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-O0337](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6942) AHG8/AHG17: Layered Random Access point (LRA) [B. Choi, S. Wenger, S. Liu (Tencent)] [miss] [late]

[JVET-O0395](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7000) AHG8: On adaptive resolution changing and scalable coding [M. M. Hannuksela, A. Aminlou (Nokia)]

Only the scalability part in the contribution belongs to this agenda item.

[JVET-O0436](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7041) AHG8/AHG17: indication of shutter angle for variable frame rate application [S. McCarthy, T. Lu, F. Pu, P. Yin, W. Husak, T. Chen (Dolby)]

[JVET-O0471](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7078) AHG8/AHG12: Layer concepts clarifications and improvements for immersive media use cases [E. Thomas, A. Gabriel (TNO)]

[JVET-O0473](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7080) AHG8: On HRD operations for layers [E. Thomas, A. Gabriel (TNO)] [miss] [late]

# Complexity analysis and reduction (X)

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

# Encoder optimization (4)

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

[JVET-O0256](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6861) Non-CE: Fast encoder with adjusted threshold in dependent quantization [M. Wang, J. Li, L. Zhang, K. Zhang, H. Liu (Bytedance), S. Wang, S. Ma (Peking University)]

[JVET-O1018](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7655) Crosscheck of [C. Auyeung, X. Li (Tencent)]

[JVET-O0432](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7037) AHG10: LMCS encoder improvement [F. Pu, S. McCarthy, T. Lu, P. Yin, W. Husak, T. Chen (Dolby)]

[JVET-O0658](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7275) Crosscheck of JVET-O0432 on LMCS encoder improvements [S. Iwamura (NHK)]

[JVET-O0675](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7293) Crosscheck of JVET-O0432: LMCS encoder improvement [J. Zhao (LGE)]

[JVET-O0635](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7251) AHG10-Related: Optimized CTU level bit allocation in inter frames [Y. Li, D. Liu, Z. Chen (USTC), L. Li, Z. Li (UMKC)] [miss] [late]

[JVET-O0888](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7510) AHG10: Adaptive Coding Sub-set for encoder optimization [M. Bhat, D Gommelet, J.-M. Thiesse, D. Nicholson (VITEC)] [late] [miss]

# Metrics and evaluation criteria (1)

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

[JVET-O0310](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6915) On video quality analysis [P. Topiwala, M. Krishnan, W. Dai (FastVDO)]

# Withdrawn (X)

JVET-O0137 (withdrawn), JVET-O0150 (withdrawn), JVET-O0218 (withdrawn), JVET-O0239 (withdrawn), JVET-O0251 (withdrawn), JVET-O0458 (withdrawn), JVET-O0459 (withdrawn), JVET-O0478 (withdrawn), JVET-O0479 (withdrawn), JVET-O0784 (withdrawn) , JVET-O0920 (withdrawn) , JVET-O0948 (withdrawn)

# Plenary meetings, joint meetings, BoG reports, and summary of actions taken

## Plenary meeting XXday X July XXXX-XXXX

Reports of the tracks were presented as follows:

The general status of track A was presented and discussed.

The general status of track B was then presented and discussed, which particularly included the following aspects:

* ..

## Closing Plenary meeting Friday 12 July

… .

## High-level syntax / systems relation meeting Saturday 6 July 0900-XXXX

This session, held on 23 March at 0900, was co-chaired by GJS and Youngkown Lim.

…

## Joint meeting XXday XX March XXXX-

JVET with … .

## BoGs (X)

[JVET-O1039](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7676) BoG report on CE4 inter prediction with merge modifications [C.-C. Chen, H. Yang]

[JVET-O1046](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=7683) BoG report on CE4 related contributions for general inter prediction [H. Yang, C.-C. Chen]

## 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.

Note that various other aspects that were just marked as decisions after some discussion, without any particular proposal behind them, are not listed in the table. [Ed. Really? Shouldn’t everything be listed?]

(add Ben’s table)

# 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 June 2019.

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-M1010.

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.

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.
* All substantial communications about a CE, other than logistics arrangements, exchange of data, minor refinement of the test plans, and preparation of documents shall be conducted on the main JVET reflector. In the case that large amounts of data are to be distributed is recommended to send an announcement to the JVET reflector without attaching the materials, and send the materials to those who have requested it directly, or provide a link to it, or upload the data as an input contribution to the next meeting.

General timeline for CEs

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 merked 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 18 January (GJS); CE plan documents were reviewed Friday 19 January (GJS & JRO).

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:

* VTM5.0 will be released by 2019-04-29 including all adoptions necessary for CTC (likely not yet including APS). VTM5.1 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.
* Timeline of 360lib9.1 (related to finalization of inclusions from last meeting): 2019-04-29.

# 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-N1001 VVC text specification draft 4. * Produce and finalize JVET-N1002 VVC Test Model 5 (VTM 5) 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. 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 5 behaviour relative to HEVC and VTM 4 using the VTM common test conditions and the multi-resolution streaming test conditions described in JVET-N0446. * 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, A. Norkin, 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, P. Hanhart, 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, P. Hanhart, J.-L. Lin (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 15th JVET meeting if feasible. * 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, 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 filters for resampling, 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. * Identify related test conditions for an upcoming core experiment, test sequences, and evaluation techniques (including subjective assessment techniques), including a base configuration to test other ARC modalities against. * Develop a software framework which allows testing various modalities of ARC in the context of the VTM software * Study potential approaches for support of layered coding scalability including spatial, temporal, quality, and view scalability | S. Wenger and A. Segall (co-chairs), M. M. Hannuksela, Hendry, S. McCarthy, Y.-C. Sun, P. Topwala, 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, re-sampling 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 (chair), 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), C. Helmrich, S. Ikonin, A. Norkin, R. Sjöberg (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-N1005, 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), Y.-W. Chen, R. Chernyak, K. Choi, R. Hashimoto, Y.**-**W. Huang, H. Jang, R.-L. Liao, S. Liu, D. Luo (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 as in JVET-N0865. * 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 impact of MTS transforms on quantization matrices and the need for default matrices * Study the interaction between LMCS and quantization step size control * 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 two 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 the proposed picture header designs and alternatives * 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 alternatives 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 |

# 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-N1000 Meeting Report of the 14th JVET Meeting [G. J. Sullivan, J.-R. Ohm] (2019-07-02, near next meeting)

Initial versions of the meeting notes (d0 … d9) were made available on a daily basis during the meeting.

JVET-N1001 Versatile Video Coding (Draft 5) [B. Bross, J. Chen, S. Liu] [WG 11 N 18370] (2019-06-15)

(Initial version planned to be made available by 2019-04-18.)

See the list of elements under section 11.8, as agreed by the Wed. 27 March plenary.

JVET-N1002 Algorithm description for Versatile Video Coding and Test Model 5 (VTM 5) [J. Chen, Y. Ye, S. Kim] [WG 11 N 18371] (2019-06-15)

(Initial version planned to be made available by 2019-04-18.)

See the list of elements under section 11.8, as agreed by the Wed. 27 March plenary.

[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-N1005 Methodology and reporting template for coding tool testing [W.-J. Chien and J. Boyce] (2019-04-12)

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-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)

Decided in closing plenary: Keep class F unchanged in CTC. AHG shall further work on defining better test sets for SC. For the current CE, classes F and TGM to be used for 4:2:0 (unchanged), investigations on testing 4:2:0 vs. 4:4:4 to be done with a set TGM + AOV + TBD . A more reasonable set of sequences needs to be defined by next meeting, otherwise CE8 cannot be continued.

JVET-N1011 JVET common test conditions and evaluation procedures for HDR/WCG video [A. Segall, E. François, W. Husak, S. Iwamura, D. Rusanovskyy] (2019-04-05)

See notes for N0828 regarding action items.

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-N1021](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6635) Description of Core Experiment 1 (CE 1): CABAC initialization [F. Bossen, J. Dong, H. Kirchhoffer]

New – previous CE1 was closed, and aspects on LIC subsumed under CE4

[JVET-N1022](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6637) Description of Core Experiment 2 (CE2): Luma/chroma dependency reduction [J. Chen, E. François, P. Yin]

New – previous CE2 was subsumed under CE4

[JVET-N1023](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6630) Description of Core Experiment 3 (CE3): Intra prediction and mode coding [G. Van der Auwera, L. Li, A. Filippov]

Continue

It is emphasized that CE3-1 shall concentrate on simplifying the implementation of 1xN and and 2xN blocks, and not making the design more complicated for the benefit of compression. If there are elements in a proposal that try to compensate a loss due to simplification by adding other elements, it shall be possible to judge the benefit or disadvantage separately. This remark would equivalently apply to other CEs that target simplification of design.

[JVET-N1024](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6633) Description of Core Experiment 4 (CE4): Inter prediction [H. Yang, C.-C. Chen]

CE4-2.x should also conduct subjective tests, as it is claimed to have subjective benefit.

It is noted that for CE4-2.1, test case a would be preferable, as it is best aligned with the new affine mode design of using 4x4 block sizes for uni and bi pred, and same 6-tap filters.

A detailed complexity analysis of CE4-2 and CE4-3 is mandatory.

CE4-3 only two tests

[JVET-N1025](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6636) Description of Core Experiment 5 (CE5): Loop filtering [C.-Y. Chen, A. Norkin]

Includes ALF, and deblocking

[JVET-N1026](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6628) Description of Core Experiment 6 (CE6): Transforms and transform signalling [X. Zhao, H. E. Egilmez]

Joint chroma coding shall also test HDR

[JVET-N1027](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6626) Description of Core Experiment 7 (CE 7): Quantization and coefficient coding [H. Schwarz, M. Coban, C. Auyeung]

includes the coding part of TS residual which was previously in CE8.

[JVET-N1028](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6629) Description of Core Experiment 8 (CE8): Screen Content Coding Tools [X. Xu, Y.-H. Chao, Y.-C. Sun, J. Xu]

Coordination between CE7 and CE8 is desired for TS coefficient coding evaluation, in particular regarding the planned 4:4:4 tests.

[JVET-N1029](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6627) Description of Core Experiment 9 (CE9): Decoder Motion Vector Derivation [S. Esenlik, X. Xiu]

[JVET-N1030](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6631) Description of Core Experiment 10 (CE10): Neural-network based loop filtering [Y. Li, S. Liu, K. Kawamura]

Previous CE10 was closed, and previous CE13 re-numbered

[JVET-N1031](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6634) Description of Core Experiment 11 (CE11): Gradual random access [K. Kazui, J.-M. Thiesse, Hendry, K. Kawamura]

New - previous CE11 was subsumed under CE5

Previous CE12 (Tile set boundary MC handling) is discontinued as per discussion in HLS topics.

It is emphasized that those CEs which plan subjective testing to study JVET-N0835 which points to some issues of selecting the test conditions for that.

# 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 (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 (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.

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

* Tue. 1 – Wed. 9 October 2019, 16th meeting under ITU-T auspices in Geneva, CH.
* 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.

The agreed document deadline for the 15th JVET meeting was planned to be Tuesday XX September 2019. CE proposal documents are due one week ahead of that date. Plans for scheduling of agenda items within that meeting remained TBA.

XXX was thanked for the excellent hosting of the 15th 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 15th JVET meeting was closed at approximately XXXX hours on Friday 12 July 2019.

# Annex A to JVET report: List of documents

# Annex B to JVET report: List of meeting participants

The participants of the fifteenth meeting of the JVET, according to an attendance sheet circulated during the meeting sessions (approximately XXX people in total), were as follows: