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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**  17th Meeting: Brussels, BE, 7–17 January 2020 | Document: JVET-Q\_Notes\_d8 |

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| *Title:* | **Meeting Report of the 17th Meeting of the Joint Video Experts Team (JVET), Brussels, BE, 7–17 Jan. 2020** | | |
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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 seventeenth meeting during 7–17 January 2020 at Square – Brussels Convention Center in Brussels, BE. 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 Tuesday 7 January 2020. Meeting sessions were held on all days (including weekend days) until the meeting was closed at approximately XXXX hours on Friday 17 January 2020. On the first day of the meeting, only aspects related to high level syntax were on the agenda. Approximately XXX people attended the JVET meeting, and approximately XXX input documents, 5 CE summary reports, and 16 AHG reports were discussed. The meeting took place in a collocated fashion with a meeting of SG16 – one of the two parent bodies of the JVET. The subject matter of the JVET meeting activities consisted of developing video coding technology with a compression capability that significantly exceeds that of the current HEVC standard, or otherwise gives better support regarding the requirements of future application domains of video coding. As a primary goal, the JVET meeting reviewed the work that was performed in the interim period since the sixteenth JVET meeting in producing a seventh draft of the VVC standard and the seventh version of the associated VVC test model (VTM). Further important goals were reviewing the results of 5 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 11 output documents from the meeting (update):

* JVET-P2001 Versatile Video Coding specification text (Draft 7), also issued as ISO/IEC DIS 23090-3 Versatile Video Coding
* JVET-P2002 Algorithm description for Versatile Video Coding and Test Model 7 (VTM 7)
* JVET-P2005 Methodology and reporting template for coding tool testing
* JVET-P2007 Supplemental enhancement information messages for coded video bitstreams (Draft 2), also issued as ISO/IEC DIS 23002-7
* JVET-P2008 Conformance testing for versatile video coding (Draft 1)
* JVET-P2011, JVET common test conditions and software reference configurations for HDR/WCG video
* JVET-P2021 through JVET-P2025, Description of Core Experiments 1 through 5

For the organization and planning of its future work, the JVET established XX “ad hoc groups” (AHGs) to progress the work on particular subject areas. At this meeting, X Core Experiments (CE) were defined. The next four JVET meetings were planned for 15–24 April 2020 under WG 11 auspices in Alpbach, AT, during 23 June – 01 July 2020 under ITU-T SG16 auspices in Geneva, CH, during 7–16 October 2020 under WG 11 auspices in Rennes, FR, and during 6–15 January 2021 under WG 11 auspices in Capetown, ZA.

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

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

# Administrative topics

## Organization

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

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

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

## Meeting logistics

Information regarding logistics arrangements for the meeting had been provided via the email reflector [jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de) and at <http://wftp3.itu.int/av-arch/jvet-site/2020_01_Q_Brussels/>.

## Primary goals

As a primary goal, the JVET meeting reviewed the work that was performed in the interim period since the sixteenth JVET meeting in producing a seventh draft of the VVC standard and the seventh version of the associated VVC test model (VTM). Further important goals were reviewing the results of 5 Core Experiments (CE), reviewing other technical input on novel aspects of video coding technology, producing the next versions of draft text and VTM, and planning next steps for further investigation of candidate technology towards the formal standard development.

## Documents and document handling considerations

### General

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

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

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

Highlighting of recorded decisions in this report is practised as follows:

* Decisions made by the group that might affect the normative content of a future standard are identified in this report by prefixing the description of the decision with the string “Decision:”.
* Decisions that affect the VTM software but have no normative effect are marked by the string “Decision (SW):”.
* Decisions that fix a “bug” in the VTM description (an error, oversight, or messiness) or in the software are marked by the string “Decision (BF):”.
* Decisions that are merely editorial without effect on the technical content of the draft standard are marked by the string "Decision (Ed.):". Such editorial decisions are merely suggestions to the editor, who has the discretion to determine the final action taken if their judgment differs.

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, 31 December 2019. Any documents uploaded after 1159 hours Paris/Geneva time on Wednesday 1 January 2020 were considered “officially late”, giving a grace period of 12 hours to accommodate those living in different time zones of the world. The deadline does not apply to AHG reports, and other such reports which can only be produced after the availability of other input documents.

As agreed by the fifteenth meeting as permanent rule, contributions related to CE proposals (including draft text) were to be uploaded 1 week ahead of the above mentioned deadline, such that more thorough 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 25 December 2019 were considered “officially late”.

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

All contribution documents with registration numbers higher than JVET-Q0523 were registered after the “officially late” deadline (and therefore were also uploaded late). Likewise, CE proposal documents with registration numbers higher than JVET-Q0096 were registered late. However, some documents in the “late” range might include break-out activity reports that were generated during the meeting, and are therefore better considered as report documents rather than as late contributions. Also, all cross-check reports were uploaded late.

In many cases, contributions were also revised after the initial version was uploaded. The contribution document archive website retains publicly accessible prior versions in such cases. The timing of late document availability for contributions is generally noted in the section discussing each contribution in this report.

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

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

* JVET-Q0XXX (a proposal on …), uploaded XX-XX.
* …

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

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

* JVET-Q0XXX (a document on …), uploaded XX-XX.
* …

All cross-verification reports at this meeting (except for JVET-Q0XXX) were registered late and all were uploaded late. In the interest of brevity, these are not specifically identified here. Initial upload times for each document are recorded in Annex A of this report.

The following (X) contribution registrations were later cancelled, withdrawn, never provided, were cross-checks of a withdrawn contribution, or were registered in error: JVET-Q0XXX, … .

The following cross verification reports had not been uploaded yet by the end of the meeting, but were provided later: JVET-Q0XXX, … .

“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-Q0XXX, … .

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

* JVET-Q0XXX (…)
* …

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-P2000, the Versatile Video Coding specification text (Draft 7) JVET-P2001, the Algorithm description for Versatile Video Coding and Test Model 7 (VTM 7) JVET-P2002, the Methodology and reporting template for coding tool testing JVET-P2005, the Supplemental enhancement information messages for coded video bitstreams (Draft 2) JVET-P2007, the Conformance testing for VVC (Draft 1) JVET-P2008, the JVET common test conditions and software reference configurations for HDR/WCG video JVET-P2011, and the Description of Core Experiments 1 through 5 (JVET-P2021 through JVET-P2025), had been completed and were approved. The software implementation of VTM (versions 7.0 and 7.1) was also approved.

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

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

## Attendance

The list of participants in the JVET meeting can be found in Annex B of this report.

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

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

## Agenda

The agenda for the meeting was as follows:

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

On the first day of the meeting (January 7), only aspects related to high level syntax (including AHG8, AHG9, AHG12, and AHG14 reports) were on the agenda. In the morning of January 8, the meeting was continued with general status review and administrative matters, and then proceeded with reports of ad *hoc* group activities, reports of core experiments, and other matters.

## IPR policy reminder

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

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

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

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

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

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

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

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

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

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

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

The responsible coordinators invited participants to make any necessary verbal reports of previously-unreported IPR in technology that might be considered as prospective candidate for inclusion in future standards, and opened the floor for such reports: No such verbal reports were made.

## Software copyright disclaimer header reminder

It was noted that the VTM software implementation package uses the same software copyright license header as the HEVC reference software, where the latter had been agreed at the 5th meeting of the JCT-VC and approved by both parent bodies at their collocated meetings at that time. This license header language is based on the BSD license with a preceding sentence declaring that other contributor or third party rights, including patent rights, are not granted by the license, as recorded in [N 10791](http://phenix.it-sudparis.eu/mpeg/doc_end_user/current_document.php?id=27881&id_meeting=16) of the 89th meeting of ISO/IEC JTC 1/‌SC 29/‌WG 11. Both ITU and ISO/IEC will be identified in the <OWNER> and <ORGANIZATION> tags in the header. This software is used in the process of designing the VTM software, and for evaluating proposals for technology to be potentially included in the design. This software or parts thereof might be published by ITU-T and ISO/IEC as an example implementation of a future video coding standard and for use as the basis of products to promote adoption of such technology.

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

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

## Communication practices

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

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

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

It was emphasized that reflector subscriptions and email sent to the reflector must use real names when subscribing and sending messages and subscribers must respond to inquiries regarding the nature of their interest in the work. The current number of subscribers was 1221.

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

## Terminology

Some terminology used in this report is explained below:

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

* **ACT**: Adaptive colour transform.
* **AFF**: Affine.
* **AI**: All-intra.
* **AIF**: Adaptive interpolation filtering.
* **ALF**: Adaptive loop filter.
* **AMP**: Asymmetric motion partitioning – a motion prediction partitioning for which the sub-regions of a region are not equal in size (in HEVC, being N/2x2N and 3N/2x2N or 2NxN/2 and 2Nx3N/2 with 2N equal to 16 or 32 for the luma component).
* **AMVP**: Adaptive motion vector prediction.
* **AMT or MTS**: Adaptive multi-core transform, or multiple transform selection.
* **AMVR**: (Locally) adaptive motion vector resolution.
* **APS**: Adaptation parameter set.
* **ARC**: Adaptive resolution conversion (synonymous with DRC, and a form of RPR).
* **ARSS**: Adaptive reference sample smoothing.
* **ATMVP** or “subblock-based temporal merging candidates”: Alternative temporal motion vector prediction.
* **AU**: Access unit.
* **AUD**: Access unit delimiter.
* **AVC**: Advanced video coding – the video coding standard formally published as ITU-T Recommendation H.264 and ISO/IEC 14496-10.
* **BA**: Block adaptive.
* **BC**: See CPR or IBC.
* **BCW**: Biprediction with CU based weighting
* **BD**: Bjøntegaard-delta – a method for measuring percentage bit rate savings at equal PSNR or decibels of PSNR benefit at equal bit rate (e.g., as described in document VCEG-M33 of April 2001).
* **BDOF**: Bi-directional optical flow (formerly known as **BIO**).
* **BDPCM**: Block-wise DPCM.
* **BL**: Base layer.
* **BMS**: Benchmark set (no longer used), a former preliminary compilation of coding tools on top of VTM, which provide somewhat better compression performance, but are not deemed mature for standardzation.
* **BoG**: Break-out group.
* **BR**: Bit rate.
* **BV**: Block vector (used for intra BC prediction).
* **CABAC**: Context-adaptive binary arithmetic coding.
* **CBF**: Coded block flag(s).
* **CC**: May refer to context-coded, common (test) conditions, or cross-component.
* **CCLM**: Cross-component linear model.
* **CCP**: Cross-component prediction.
* **CE**: Core Experiment – a coordinated experiment conducted toward assessment of coding technology.
* **CG**: Coefficient group.
* **CGS**: Colour gamut scalability (historically, coarse-grained scalability).
* **CIIP**: Combined inter/intra prediction.
* **CL-RAS**: Cross-layer random-access skip.
* **CPMV**: Control-point motion vector.
* **CPMVP**: Control-point motion vector prediction (used in affine motion model).
* **CPR**: Current-picture referencing, also known as IBC – a technique by which sample values are predicted from other samples in the same picture by means of a displacement vector called a block vector, in a manner conceptually similar to motion-compensated prediction.
* **CST**: Chroma separate tree.
* **CTC**: Common test conditions.
* **CVS**: Coded video sequence.
* **DCT**: Discrete cosine transform (sometimes used loosely to refer to other transforms with conceptually similar characteristics).
* **DCTIF**: DCT-derived interpolation filter.
* **DF**: Deblocking filter.
* **DMVR**: Decoder-side motion vector refinement.
* **DPS**: Decoding parameter sets.
* **DRC**: Dynamic resolution conversion (synonymous with ARC, and a form of RPR).
* **DT**: Decoding time.
* **ECS**: Entropy coding synchronization (typically synonymous with WPP).
* **EMT**: Explicit multiple-core transform.
* **EOTF**: Electro-optical transfer function – a function that converts a representation value to a quantity of output light (e.g., light emitted by a display.
* **EPB**: Emulation prevention byte (as in the emulation\_prevention\_byte syntax element).
* **ECV**: Extended Colour Volume (up to WCG).
* **EL**: Enhancement layer.
* **ET**: Encoding time.
* **FRUC**: Frame rate up conversion (pattern matched motion vector derivation).
* **GRA**: Gradual random access
* **HDR**: High dynamic range.
* **HEVC**: High Efficiency Video Coding – the video coding standard developed and extended by the JCT-VC, formalized by ITU-T as Rec. ITU-T H.265 and by ISO/IEC as ISO/IEC 23008-2.
* **HLS**: High-level syntax.
* **HM**: HEVC Test Model – a video coding design containing selected coding tools that constitutes our draft standard design – now also used especially in reference to the (non-normative) encoder algorithms (see WD and TM).
* **HMVP**: History based motion vector prediction.
* **HRD**: Hypothetical reference decoder.
* **HyGT**: Hyper-cube Givens transform (a type of NSST).
* **IBC** (also **Intra BC**): Intra block copy, also known as CPR – a technique by which sample values are predicted from other samples in the same picture by means of a displacement vector called a block vector, in a manner conceptually similar to motion-compensated prediction.
* **IBDI**: Internal bit-depth increase – a technique by which lower bit-depth (8 bits per sample) source video is encoded using higher bit-depth signal processing, ordinarily including higher bit-depth reference picture storage (ordinarily 12 bits per sample).
* **IBF**: Intra boundary filtering.
* **ILP**: Inter-layer prediction (in scalable coding).
* **IPCM**: Intra pulse-code modulation (similar in spirit to IPCM in AVC and HEVC).
* **ISP**: Intra subblock partitioning
* **JCCR**: Joint coding of chroma residuals
* **JEM**: Joint exploration model – the software codebase for future video coding exploration.
* **JM**: Joint model – the primary software codebase that has been developed for the AVC standard.
* **JSVM**: Joint scalable video model – another software codebase that has been developed for the AVC standard, which includes support for scalable video coding extensions.
* **KLT**: Karhunen-Loève transform.
* **LB** or **LDB**: Low-delay B – the variant of the LD conditions that uses B pictures.
* **LD**: Low delay – one of two sets of coding conditions designed to enable interactive real-time communication, with less emphasis on ease of random access (contrast with RA). Typically refers to LB, although also applies to LP.
* **LFNST**: Low-frequency non-separable transform
* **LIC**: Local illumination compensation.
* **LM**: Linear model.
* **LMCS**: Luma mapping with chroma scaling (formerly sometimes called “in-loop reshaping”)
* **LP** or **LDP**: Low-delay P – the variant of the LD conditions that uses P frames.
* **LUT**: Look-up table.
* **LTRP**: Long-term reference pictures.
* **MC**: Motion compensation.
* **MCP**: Motion compensated prediction.
* **MDNSST**: Mode dependent non-separable secondary transform.
* **MIP**: Matrix-based intra prediction
* **MMLM**: Multi-model (cross component) linear mode.
* **MMVD**: Merge with MVD.
* **MPEG**: Moving picture experts group (WG 11, the parent body working group in ISO/IEC JTC 1/‌SC 29, one of the two parent bodies of the JVET).
* **MPM**: Most probable mode (in intra prediction).
* **MRL**: Multiple reference line intra prediction.
* **MV**: Motion vector.
* **MVD**: Motion vector difference.
* **NAL**: Network abstraction layer (as in AVC and HEVC).
* **NSQT**: Non-square quadtree.
* **NSST**: Non-separable secondary transform.
* **NUH**: NAL unit header.
* **NUT**: NAL unit type (as in AVC and HEVC).
* **OBMC**: Overlapped block motion compensation (e.g., as in H.263 Annex F).
* **OETF**: Opto-electronic transfer function – a function that converts to input light (e.g., light input to a camera) to a representation value.
* **OLS**: Output layer set.
* **OOTF**: Optical-to-optical transfer function – a function that converts input light (e.g. l,ight input to a camera) to output light (e.g., light emitted by a display).
* **operation point**: A temporal subset of an OLS.
* **PDPC**: Position dependent (intra) prediction combination.
* **PERP**: Padded equirectangular projection (a 360° projection format).
* **PHEC**: Padded hybrid equiangular cubemap (a 360° projection format).
* **PMMVD**: Pattern-matched motion vector derivation.
* **POC**: Picture order count.
* **PoR**: Plan of record.
* **PROF**: Prediction refinement with optical flow
* **PPS**: Picture parameter set (as in AVC and HEVC).
* **PTL**: Profile/tier/level combination.
* **QM**: Quantization matrix (as in AVC and HEVC).
* **QP**: Quantization parameter (as in AVC and HEVC, sometimes confused with quantization step size).
* **QT**: Quadtree.
* **BT**: Binary tree.
* **TT**: Ternary tree.
* **RA**: Random access – a set of coding conditions designed to enable relatively-frequent random access points in the coded video data, with less emphasis on minimization of delay (contrast with LD).
* **RADL**: Random-access decodable leading.
* **RASL**: Random-access skipped leading.
* **R-D**: Rate-distortion.
* **RDO**: Rate-distortion optimization.
* **RDOQ**: Rate-distortion optimized quantization.
* **RDPCM**: Residual DPCM
* **ROT**: Rotation operation for low-frequency transform coefficients.
* **RPLM**: Reference picture list modification.
* **RPR**: Reference picture resampling (e.g., as in H.263 Annex P), a special case of which is also known as ARC or DRC.
* **RPS**: Reference picture set.
* **RQT**: Residual quadtree.
* **RRU**: Reduced-resolution update (e.g. as in H.263 Annex Q).
* **RVM**: Rate variation measure.
* **SAO**: Sample-adaptive offset.
* **SBT**: Subblock transform.
* **SbTMVP**: Subblock based temporal motion vector prediction.
* **SCIPU**: Smallest chroma intra prediction unit.
* **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.
* **SIF**: Switchable (motion) interpolation filter.
* **SIMD**: Single instruction, multiple data.
* **SMVD**: Symmetric MVD.
* **SPS**: Sequence parameter set (as in AVC and HEVC).
* **STMVP**: Spatial-temporal motion vector prediction.
* **STSA**: Step-wise temporal sublayer access.
* **TBA/TBD/TBP**: To be announced/determined/presented.
* **TGM**: Text and graphics with motion – a category of content that primarily contains rendered text and graphics with motion, mixed with a relatively small amount of camera-captured content.
* **TPM**: Triangular partitioning mode
* **UCBDS**: Unrestricted center-biased diamond search.
* **UWP**: Unequal weight prediction.
* **VCEG**: Visual coding experts group (ITU-T Q.6/16, the relevant rapporteur group in ITU-T WP3/16, which is one of the two parent bodies of the JVET).
* **VPS**: Video parameter set – a parameter set that describes the overall characteristics of a coded video sequence – conceptually sitting above the SPS in the syntax hierarchy.
* **VTM**: VVC Test Model.
* **VVC**: Versatile Video Coding, the standardization project developed by JVET.
* **WAIP**: Wide-angle intra prediction
* **WCG**: Wide colour gamut.
* **WG**: Working group, a group of technical experts (usually used to refer to WG 11, a.k.a. MPEG).
* **WPP**: Wavefront parallel processing (usually synonymous with ECS).
* Block and unit names in HEVC:
  + **CTB**: Coding tree block (luma or chroma) – unless the format is monochrome, there are three CTBs per CTU.
  + **CTU**: Coding tree unit (containing both luma and chroma, synonymous with LCU), with a size of 16x16, 32x32, or 64x64 for the luma component.
  + **CB**: Coding block (luma or chroma), a luma or chroma block in a CU.
  + **CU**: Coding unit (containing both luma and chroma), the level at which the prediction mode, such as intra versus inter, is determined in HEVC, with a size of 2Nx2N for 2N equal to 8, 16, 32, or 64 for luma.
  + **PB**: Prediction block (luma or chroma), a luma or chroma block of a PU, the level at which the prediction information is conveyed or the level at which the prediction process is performed in HEVC.
  + **PU**: Prediction unit (containing both luma and chroma), the level of the prediction control syntax within a CU, with eight shape possibilities in HEVC:
    - **2Nx2N**: Having the full width and height of the CU.
    - **2NxN (or Nx2N)**: Having two areas that each have the full width and half the height of the CU (or having two areas that each have half the width and the full height of the CU).
    - **NxN**: Having four areas that each have half the width and half the height of the CU, with N equal to 4, 8, 16, or 32 for intra-predicted luma and N equal to 8, 16, or 32 for inter-predicted luma – a case only used when 2N×2N is the minimum CU size.
    - **N/2x2N** paired with **3N/2x2N** or **2NxN/2** paired with **2Nx3N/2**: Having two areas that are different in size – cases referred to as AMP, with 2N equal to 16 or 32 for the luma component.
  + **TB**: Transform block (luma or chroma), a luma or chroma block of a TU, with a size of 4x4, 8x8, 16x16, or 32x32.
  + **TU**: Transform unit (containing both luma and chroma), the level of the residual transform (or transform skip or palette coding) segmentation within a CU (which, when using inter prediction in HEVC, may sometimes span across multiple PU regions).
* Block and unit names in VVC:
  + **CTB**: Coding tree block (luma or chroma) – there are three CTBs per CTU in a P or B slice or in an I slice that uses a single tree, and one CTB per luma CTU and two CTBs per chroma CTU in an I slice that uses separate trees.
  + **CTU**: Coding tree unit (synonymous with LCU, containing both luma and chroma in a P or B slice or in an I slice that uses a single tree, containing only luma or only chroma in an I slice that uses separate trees), with a size of 16x16, 32x32, 64x64, or 128x128 for the luma component.
  + **CB**: Coding block, a luma or chroma block in a CU.
  + **CU**: Coding unit (containing both luma and chroma in P/B slice, containing only luma or chroma in I slice), a leaf node of a QTBT. It’s the level at which the prediction process and residual transform are performed in JEM. A CU can be square or rectangle shape.
  + **PB**: Prediction block, a luma or chroma block of a PU.
  + **PU**: Prediction unit, has the same size as a CU in the VVC context.
  + **TB**: Transform block, a luma or chroma block of a TU.
  + **TU**: Transform unit, has the same size as a CU in the VVC context.

## Opening remarks

Remarks during the opening session of the meeting 0900 Tuesday 7 January (chaired by GJS) were as follows.

* The first day was dedicated to high-level syntax (incl. AHGs 8, 9, 12)
* 0900 start time on the first two days; 0800 generally thereafter
* Balloting and approval timeline: "H.VVC" | ISO/IEC 23090-3 for VVC and H.SEI | ISO/IEC 23002-7
  + DIS as output of the previous meeting (N18873 and N18877), with ballot period between the January and April meetings
    - Post-meeting editing
  + FDIS and Consent in July
* The meeting logistics, agenda, working practices, policies, and document allocation were reviewed.
  + The meeting host is XXXX
  + Having text and software 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 and the meeting report were reviewed.
  + See the AHG3 report for the software integration status
  + The relationship between the VVC and SEI texts was noted
    - VUI is in the SEI text, mostly for providing colour interpretation
      * It was noted that VUI is within the SPS, whereas SEI is in the SEI payload syntax structure, although this is not so relevant to the SEI text itself, and is more tied with the bitstream (less likely to be altered or removed).
      * VUI has a clear scope, is more tied to the sequence level
      * Should VUI be in the VVC spec instead of the SEI spec?
      * VUI could contain other info, such as constraint indicators (info that does not affect the decoding process)
      * SEI has a length parameter that enables discarding; VUI does not. SPS extension data follows the VUI. It was remarked that having a size indicator for VUI may be desirable.
    - field\_seq\_flag was put into the SPS to improve
* There was somewhat less of a problem of late non-cross-check documents and no “placeholders” – (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 and associated SEI draft texts and VTM.
* Due to the high number of input contributions, parallelization and breakout work were planned to be used at the meeting.
* Viewing & equipment setup was discussed – having a visual comparison of VVC vs. HEVC was encouraged
* Principles of standards development were discussed.
  + It was noted that now is the time for the filing of formal IPR declarations for those who have patent rights that would be necessary for implementation of VVC or the associated SEI standard.

## Scheduling of discussions

Scheduling: Generally meeting time was scheduled during 0800–2100+ hours, with coffee and lunch breaks as convenient. Ongoing scheduling refinements were announced on the group email reflector as needed. Some particular scheduling notes are shown below, although not necessarily 100% accurate or complete:

* Tue. 7 Jan., 1st day
  + 0900–1000 Opening remarks, review of practices, agenda, IPR reminder
  + 1010-1215 Reports of AHGs 8, 9, 12
  + 1400-1800 room 201, 1900-2230 Bozar bldg BoG Q0625 (J. Boyce)
    - High-level tool control (section 6.19.2)
    - RPR and reference wrap-around (section 6.19.1.2)
    - Parameter sets cleanup (section 6.19.4)
  + 1400-1800, 1845-2245, room 100 (GJS)
    - Subpicture general issues (section 6.20.1.1)
    - Subpicture layout signalling (section 6.20.1.2)
    - Subpicture ID signalling (section 6.20.1.3)
* Wed. 8 Jan., 2nd day (Rooms available: 100 (200) until 2300, The Arc (140) until 2200, Bozar 1 (70), Bozar 2 (70))
  + 0900 Status review (GJS & JRO)
  + 0940–1300, 1430–XX Remaining AHG reports, room 100 (GJS & JRO)
  + Track A (room The Arc - GJS)
    - 1640 CE4: Inter prediction with geometric partitioning (7) (section 5.4) (Track A)
    - 1920-2200 Subpicture ID signalling (section 6.20.1.3)
    - 2200-2240 Slices and tiles (section 6.20.2)
  + Track B (room 100 - JRO) 1645-2250
    - CE1: Deblocking filtering (5) (section 5.1) (Track B)
    - CE5: Cross-component adaptive loop filtering (7) (section 5.5) (Track B)
    - CE2: Palette mode coding (5) (section 5.2) (Track B)
    - CE3: Lossless coding (12) (section 5.3) (Track B)
  + 1930- BoG on CE4-related: Inter prediction with geometric partitioning (31) (section 6.4) (room Bozar 1 H. Yang)
* Thu. 9 Jan., 3rd day (Rooms available: 100 (200), The Arc (140), Hall 300 (65), 311+312 (75), 314+316 (75), Bozar 1 (70), Bozar 2 (20))
  + Track A (GJS)
    - 0800-1330 Slices and tiles (section 6.20.2)
    - 1500 Picture header, slice header, and AUD (section 6.19.6)
  + 0800- BoG on CE4-related: Inter prediction with geometric partitioning (31) (section 6.4) (room Hall 300, H. Yang)
  + Track B (room 100 - JRO)
    - 0800-1015 CE3: Lossless coding
    - 1100-1300 CE3 related
    - 1430-1500 CE1 revisit and further planning
    - 1500-1600 CE3 related
    - 1630-1800 Lossless and near lossless coding (6.16) and Entropy coding (6.13)
    - 1800-1900 Residual coding (6.12)
    - 1900-2150 Transforms and transform signaling (6.11)
  + 1900-2100 Informal viewing CE1 deblocking
* Fri. 10 Jan., 4th day
  + 0800-1100 and ??? BoG CE5 related (room 100, A. Segall, C.-Y. Chen)
  + 0800-1100 BoG Q0625 (see BoG topics above, Room The Arc, J. Boyce)
  + Track A (GJS)
    - 1115-1330 Picture header, slice header, and AUD (section 6.19.6)
    - 1500 Mixed NAL unit types 6.19.7
    - 1800 Constant SH parameters 6.19.5
    - 2010 Misc. general HLS 6.19.3
    - scalability HLS 6.21.1
  + 1100-2200 Track B (room 100 - JRO)
    - 1100-1215 Revisits on CEs, CE1 concluded.
    - 1215-1315 and 1430-1630 Transforms and transform signaling (6.11)
    - 1700-1815 CE1 related (6.1)
    - 1815-2100 Loop filtering (6.8)
    - 2100-2200 New version CE2 report & CE2 related (palette) (6.2)
  + 1900-2100 Informal viewing CE5 CCALF
  + 0900-1100 JCT-VC opening plenary (outside of JVET) room 300
* Sat. 11 Jan., 5th day
  + Track A (GJS)
    - 2010 Misc. general HLS 6.19.3
    - 1010 Scalability HLS 6.21.1
    - 1115 Review of CE4 BoG
    - 1500 Scalability HLS 6.21.1
  + 1115 BoG Q0625 (see BoG topics above, Room 300, J. Boyce)
  + 0800-2200 Track B (room 100 - JRO)
    - 0800-1035 CE2 related (palette) (6.2) -> encoder only TBP with sec. 8
    - 1100-1315 and 1445-1615 Intra prediction and mode coding (6.7)
    - 1645-1800 CE5 viewing results and decision from CE5
    - 1800-1915 Reference picture resampling (6.9) -> remaining stuff is HLS related
    - 1915-2200 Quantization control (6.10) -> not finished yet
    - Partitioning (6.14)
    - Chroma formats and chroma related coding tools (6.15)
    - Screen content coding tools (6.17)
  + 1900-XXXX BoG CE5 related (room 300, A. Segall, C.-Y. Chen)
* Sun. 12 Jan., 6th day
  + 0800-1215 JVET plenary
  + 1330 Track A
    - 1330 6.19.9 Virtual boundary signalling (5)
    - 1430 Q0775 Combined PH and SH
    - 1500 6.19.12 VUI and SEI (13)
  + Track B 1330-1800 in room 100:
    - 1330-1550 Partitioning (6.14)
    - 1615-1810 Chroma formats and chroma related coding tools (6.15)
  + 1800-XXXX BoG on CE5 related (6.5) in Bozar (A. Segall)
  + 1800-XXXX BoG on Inter prediction and MV coding (6.6) in room 100 (H. Yang)

1800-2115 BoG on HLS Q0625 (see BoG topics above, Room 300, J. Boyce)

* Mon. 13 Jan., 7th day
  + 0900-1230 WG 11 plenary (hosting parent body)
  + Track A(Room The Arc)
    - 1400
    - Review of BoG Q0625 status
    - 6.19.11 Hypothetical reference decoder (HRD) (10 w/ summary of 7)
    - [Coffee break]
    - 2100
    - 6.19.8 Reference picture list signalling (2)
    - 6.9 Reference picture resampling (13; 3 resolved in Track B)
  + 1300-2030 Track B:
    - 1315-1350 Review of BoG JVET-Q0780 CE5 related
    - 1350-1820Remaining docs: Chroma formats and chroma related coding tools (6.15)
    - 1820-1950Remaining docs: Quantization control (6.10)
    - 1950-2030 Remaining docs: JVET-Q0438, JVET-Q0242, JVET-Q0500
  + 1700-1800 VCEG plenary (parent body)
  + 1800-2100 HLS BoG
    - revisits
    - 6.20.1.4 Subpicture based bitstream merging topic summarized in Q0694
  + 2030-XXXX BoG on Inter prediction and MV coding (6.6) in room 100 (H. Yang)
* Tue. 14 Jan., 8th day
  + 0900-1000 Joint meeting on Requirements (Room 100)
  + 1000 Track A (Room The Arc)
    - 6.9 Reference picture resampling (13; 3 resolved in Track B)
    - 6.19.12 VUI and SEI (13; 7 TBP, 2 revisit)
    - 6.19.11 Hypothetical reference decoder (HRD) (10 w/ summary of 7)
    - 6.20.3 Control of loop filtering across subpicture/tile/slice boundaries (4)
    - 6.19.10 Gradual decoding refresh (2)
    - 6.20.4 Tile/WPP entry point offset signalling (2)
    - HLS revisits
  + XXXX-XXXX HLS BoG
    - revisits
    - 6.20.1.4 Subpicture based bitstream merging topic summarized in Q0694
* Wed. 15 Jan., 9th day
  + 0900-1100 WG 11 plenary (hosting parent body)
  + 1115-1215 Joint meeting on verification tests (Room 214&216)
  + Afternoon TBP track B: Remaining docs 6.8 and 6.11, Screen content (6.17), Complexity analysis (7), encoder optimization (8), Inter prediction (BoG JVET-Q0794), revisits

## Contribution topic overview

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

* AHG reports (18) (section 3) (Plenary)
* Project development (section 4) (Plenary)
  + Text and software development (2)
  + Test conditions (0)
  + Performance assessment (3)
  + Coding studies and tools on specific use cases (3)
  + Test Material (0)
  + Conformance (1)
  + Implementation studies (11)
  + Profile/level specification (4)
* Core Experiments (section 5) with subtopics
  + CE1: Deblocking filtering (5) (section 5.1) (Track B)
  + CE2: Palette mode coding (5) (section 5.2) (Track B)
  + CE3: Lossless coding (12) (section 5.3) (Track B)
  + CE4: Inter prediction with geometric partitioning (7) (section 5.4) (Track A)
  + CE5: Cross-component adaptive loop filtering (7) (section 5.5) (Track B)
* Non-CE technology proposals (section 6) with subtopics
  + CE1 related – Deblocking filtering (4) (section 6.1) (Track B)
  + CE2 related – Palette mode coding (13) (section 6.2) (Track B)
  + CE3 related – Lossless coding (26) (section 6.3) (Track B)
  + CE4 related – Inter prediction with geometric partitioning (31) (section 6.4) (Track A)
  + CE5 related – Cross-component adaptive loop filtering (24) (section 6.5) (Track B)
  + Inter prediction and MV coding (29) (section 6.6) (Track B)
  + Intra prediction and mode coding (20) (section 6.7) (Track B)
  + Loop filtering (8) (section 6.8) (Track B)
  + Reference picture resampling (4) (section 6.9) (Track A&B)
  + Quantization control (13) (section 6.10) (Track B)
  + Transforms and transform signalling (24) (section 6.11) (Track B)
  + Residual coding (11) (section 6.12) (Track B)
  + Entropy coding (3) (section 6.13) (Track B)
  + Partitioning (5) (section 6.14) (Track B)
  + Chroma formats and chroma related coding tools (22) (section 6.15) (Track B)
  + Lossless and near lossless coding (1) (section 6.16) (Track B)
  + Screen content coding tools (2) (section 6.17) (Track B)
  + 360 degree video (0) (section 6.18) (Track X)
  + AHG9: General high-level syntax (133) (section 6.19) (Track A)
  + AHG12: High-level parallelism and coded picture regions (53) (section 6.20) (Track A)
  + AHG8: Layered coding and resolution adaptation (19) (section 6.21) (Track A)
* Complexity analysis (3) (section 7) (Track B)
* Encoder optimization (2) (section 8) (Track B)
* Metrics and evaluation criteria (0) (section 9) (Track B)
* Withdrawn (13) (section 10) (Track none)
* Joint meetings, plenary discussions, BoG reports, Summary of actions (section 11)
* Project planning (section 12)
* Establishment of AHGs (section 13)
* Output documents (section 14)
* Future meeting plans and concluding remarks (section 15)

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

Track A (241) was generally chaired by GJS and Track B (246) by JRO.

# AHG reports (16)

These reports were discussed Tuesday 7 January 2020 during 1010-1215 (chaired by GJS) and Wednesday 8 January during 0940–1300 and 1430–XX (chaired by GJS and JRO), except as otherwise noted.

[JVET-Q0001](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9361) JVET AHG report: Project management (AHG1) [J.-R. Ohm, G. J. Sullivan]

This AHG report was discussed Wednesday 8 January 2020 at 0940 (chaired by GJS & JRO).

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

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

Output documents from the preceding meeting had been made available at the "Phenix" site (<http://phenix.it-sudparis.eu/jvet/>) or the ITU-based JVET site ([http://wftp3.itu.int/av-arch/jvet-site/2019\_10\_ P\_Geneva/](http://wftp3.itu.int/av-arch/jvet-site/2019_10_%20P_Geneva/)), particularly including the following:

* The meeting report (JVET-P2000) [Posted 2020-01-06]
* Versatile Video Coding (Draft 7) (JVET-P2001) [Posted 2019-10-12, last update 2019-11-13]
* Algorithm description for Versatile Video Coding and Test Model 7 (VTM 7) (JVET-P2002) [Posted 2019-11-10]
* Methodology and reporting template for coding tool testing (JVET-P2005) [Posted 2019-11-28]
* Supplemental enhancement information messages for coded video bitstreams (Draft 2) (JVET-P2007) [Posted 2019-10-31, last update 2019-11-15]
* Conformance testing for Versatile Video Coding (Draft 1) (JVET-P2008) [Posted 2019-11-28]
* JVET common test conditions and software reference configurations for HDR/WCG video (JVET-P2011) [Posted 2019-10-23]
* Description of CE 1..5 (JVET-P2021..25) [all first posted 2019-10-11/12, 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-P2021 [last updated 2019-12-28]
    - JVET-P2022 [last updated 2019-11-21]
    - JVET-P2023 [last updated 2019-12-18]

The sixteen *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 500 input contributions to the current meeting, not counting the AHG and CE summary reports and cross-checks, had been registered for consideration at the meeting. Almost half of these documents were submitted on aspects of high-level syntax, whereas submissions on low-level coding tools (including CEs) has significantly decreased.

A preliminary basis for the document subject allocation and meeting notes for the 17th meeting had been made publicly available on the ITU-hosted ftp site.

[JVET-Q0002](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9362) JVET AHG report: Draft text and test model algorithm description editing (AHG2) [B. Bross, J. Chen, J. Boyce, S. Kim, S. Liu, Y.-K. Wang, Y. Ye]

This AHG report was discussed Wednesday 8 January 2020 at 1000 (chaired by GJS & JRO).

This document reports the work of the JVET ad hoc group on draft text and test model algorithm description editing (AHG2) between the 16th meeting in Geneva, CH (1–11 October 2019) and the 17th meeting in Brussels, BE (7–17 January 2020).

At the 16th 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 seventh draft of Versatile Video Coding (VVC D7) and the VVC Test Model 7 (VTM7) encoding.

The normative decoding process for Versatile Video Coding is specified in the VVC draft 7 text specification document. The VVC Test Model 7 (VTM 7) Algorithm and Encoder Description document provides an algorithm description as well as an encoder-side description of the VVC Test Model 7, which serves as a tutorial for the algorithm and encoding model implemented in the VTM7.x software.

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

Fourteen versions of JVET-P2001 were published by the Editing AHG between the 16th meeting in Geneva, CH, (1–11 October 2019) and the 17th meeting in Brussels, BE, (7–17 January 2020).

An input document JVET-Q0041 had been prepared to provide integrations of a number of bug fixes reported in the bug tracking system as well as some other editorial changes made by the authors, based on the latest JVET output draft VVC text in JVET-P2001-vE.

The following reported issues had been reported and it seemed that fixing these issues was not straight-forward or that there are multiple ways to fix these. Input contributions that have been identified to be related to these issues are listed as well.

Please note that the following list represents what the editors had been aware of at the time of writing this report and was claimed to be complete.

#519 Mismatch with VTM on CU chroma QP offset enabling

JVET-Q0484 AHG9: HLS control of chroma QP offset

JVET-Q0576 AHG15: History of local chroma QP offsets

#659 CuQpOffset Reset

JVET-Q0126 Initializations and propagation of Chroma QP Offset

JVET-Q0267 AHG16: On Propagation of Chroma CU QP Offsets

JVET-Q0476 On chroma QP offsets for zero-CBF leading chroma coding blocks

JVET-Q0570 AHG15: Reset chroma QP offsets when starting a CTU

#786 JVET-P1001: Encoder / decoder deblocker mismatches for chroma QP

JVET-Q0474 AHG15: Defining QP at TU level

#783 RPR - Interpolation filters for chroma affine blocks.

JVET-Q0517 On RPR down-sampling filters for affine mode

JVET-Q0518 Mismatch between text specification and reference software on RPR chroma down-sampling for affine mode

#678 JVET-P1026 - DST-7/DCT-8 TUs with coefficients outside 16x16 region

JVET-Q0057 Coefficient group based restriction on MTS signaling

JVET-Q0055 On MTS index signalling

JVET-Q0136 Alignment of MTS index signalling condition with MTS zero-out

JVET-Q0196 MTS redundancy removal

JVET-Q0295 On residual coding for MTS

JVET-Q0430 AHG16: Syntax based MTS zero out

JVET-Q0448 MTS dependent coefficient subblock scanning for zero-out

JVET-Q0529 On LFNST index and MTS index signaling

#727 Wrong filter coefficient value specified for CCLM

#776 Mismatch on getting the down-sampled neighbouring top luma samples in CCLM for 4:2:2

JVET-Q0275 Suggested bugfixes for CCLM filtering in the VVC specification draft

*JVET-P2002 VVC Test Model 7 (VTM 7) Algorithm and Encoder Description*

One version of JVET-P2002 were published by the Editing AHG between the 16th meeting in Geneva, CH, (1–11 October 2019) and the 17th meeting in Brussels, BE, (7–17 January 2020).

JVET-P2002 has been established based on JVET-O2002. It provides the algorithm description for majority of coding tools in VVC. In this editing period, the following changes were included:

* Incorporated JVET-O0683: adaptive color transform
* Incorporated JVET-O1038: ALF boundary padding
* Incorporated JVET-P0505: Fixing non-linear ALF clipping values for 8-bit video
* Incorporated JVET-P0254: Fix number of LMCS segments to 32 regardless of bit depth
* Incorporated JVET-P0371: Signalling of corrective values for chroma residual scaling
* Remove bricks
* Add subpicture
* Incorporated JVET-P0325: Change the checking order of the first two spatial merge candidates
* Incorporated JVET-P0057: 1/32-pel precision of PROF motion refinement
* Incorporated JVET-P1023: Reference picture conditions in DMVR and BDOF

The AHG recommended to:

* Approve the edited JVET-P2001 and JVET-P2002 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 (helpful work by Allegro and Broadcom was mentioned),
* Continue to improve the editorial consistency of VVC WD and Test Model documents,
* Ensure that, when considering the addition of new feature to VVC, properly drafted text for addition to the VVC Test Model and/or the VVC Working Draft is made available in a timely manner.
* Use the the editorial input and fixes for VVC draft 7 in JVET-Q0041 as the basis for integration of adoptions of the 17th JVET meeting. This was reviewed and agreed.

[JVET-Q0003](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9363) JVET AHG report: Test model software development (AHG3) [F. Bossen, X. Li, K. Sühring]

This AHG report was discussed Wednesday 8 January 2020 at 1020 (chaired by GJS & JRO).

This report summarizes the activities of the AhG3 on Test model software development that had taken place between the 16th and 17th 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 6.2 was tagged on Oct. 19, 2019. Changes related to VTM 6.1 were listed in the AHG report.

The version number was increased to VTM 6.3 on Oct. 15, but the tag was only created on Jan. 7. This version removed the previous meeting cycle’s excess macros.

After one release candidates, VTM 7.0 was tagged on Nov. 13, 2019. Changes related to VTM 6.3 were listed in the AHG report.

VTM 7.1 was tagged on Dec 6, 2019. The tag was made on request by AHG13 for testing ACT, which had not been included in VTM 7.0. Changes in this version were listed in the AHG report.

Particularly noted aspects of this version were:

* Fix to low-delay P configuration
* Refinement of LMCS offset in configuration in intra and low-delay B configurations

VTM 7.2 was expected to be tagged during the 17th JVET meeting. Changes so far for that version were listed in the AHG report.

The following tables show **VTM 7.0** performance over **HM 16.20**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra** |  |  |
|  |  |  | **Over HM 16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -28.27% | -33.55% | -33.95% | 1635% | 173% |
| Class A2 | -27.97% | -20.66% | -12.93% | 2664% | 182% |
| Class B | -21.27% | -20.04% | -27.35% | 2916% | 184% |
| Class C | -22.00% | -19.82% | -23.88% | 4102% | 184% |
| Class E | -25.40% | -21.93% | -26.55% | 2364% | 166% |
| **Overall** | -24.40% | -22.66% | -25.14% | 2717% | 179% |
| Class D | -17.82% | -13.97% | -15.50% | 4532% | 187% |
| Class F | -38.93% | -39.38% | -41.87% | 4825% | 180% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **Random access** |  |  |
|  |  |  | **Over HM 16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -37.33% | -40.26% | -45.92% | 830% | 173% |
| Class A2 | -41.50% | -39.26% | -33.53% | 937% | 192% |
| Class B | -33.99% | -43.21% | -44.37% | 884% | 169% |
| Class C | -28.60% | -34.73% | -36.68% | 1153% | 195% |
| Class E |  |  |  |  |  |
| **Overall** | -34.73% | -39.57% | -40.46% | 948% | 181% |
| Class D | -26.30% | -30.81% | -31.55% | 1224% | 230% |
| Class F | -40.43% | -46.25% | -47.51% | 647% | 158% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **Low delay B** |  |  |
|  |  |  | **Over HM 16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -29.83% | -32.71% | -33.55% | 770% | 167% |
| Class C | -27.54% | -27.83% | -28.88% | 915% | 190% |
| Class E | -31.24% | -38.55% | -40.10% | 404% | 157% |
| **Overall** | -29.42% | -32.54% | -33.63% | 694% | 172% |
| Class D | -24.44% | -22.74% | -24.33% | 970% | 246% |
| Class F | -41.43% | -44.49% | -46.18% | 519% | 155% |

The following tables show **VTM 7.0** performance compared to **VTM 6.2**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra** |  |  |
|  |  |  | **Over VTM 6.2** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -0.18% | -0.14% | -0.44% | 107% | 100% |
| Class A2 | -0.13% | 0.12% | 0.16% | 107% | 99% |
| Class B | -0.20% | -0.20% | -0.05% | 102% | 103% |
| Class C | -0.24% | -0.07% | 0.11% | 102% | 99% |
| Class E | -0.28% | -0.76% | -1.20% | 101% | 102% |
| **Overall** | -0.21% | -0.20% | -0.23% | 104% | 101% |
| Class D | -0.08% | 0.57% | 0.31% | 98% | 99% |
| Class F | 0.08% | 0.14% | -0.01% | 112% | 103% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **Random access** |  |  |
|  |  |  | **Over VTM 6.2** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.01% | -3.12% | -2.57% | 96% | 100% |
| Class A2 | 0.27% | -1.35% | -1.64% | 97% | 104% |
| Class B | 0.01% | -2.64% | -2.08% | 95% | 101% |
| Class C | 0.11% | -2.87% | -2.69% | 103% | 116% |
| Class E |  |  |  |  |  |
| **Overall** | 0.09% | -2.54% | -2.25% | 98% | 105% |
| Class D | 0.24% | -1.73% | -1.82% | 96% | 131% |
| Class F | 0.51% | -1.58% | -1.23% | 102% | 112% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **Low delay B** |  |  |
|  |  |  | **Over VTM 6.2** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -3.58% | -2.98% | -2.95% | 92% | 111% |
| Class C | -5.64% | -5.62% | -4.57% | 89% | 118% |
| Class E | -7.37% | -10.25% | -9.60% | 93% | 128% |
| **Overall** | -5.21% | -5.68% | -5.15% | 91% | 117% |
| Class D | -3.60% | -4.00% | -3.81% | 94% | 140% |
| Class F | -4.83% | -3.58% | -3.92% | 99% | 126% |

The following tables show **VTM 7.1** performance compared to **VTM 7.0**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra** |  |  |
|  |  |  | **Over VTM 7.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.14% | -1.78% | -1.48% | 98% | 100% |
| Class A2 | 0.17% | -2.09% | -2.05% | 98% | 96% |
| Class B | 0.11% | -1.64% | -1.65% | 99% | 101% |
| Class C | 0.13% | -1.37% | -1.35% | 99% | 97% |
| Class E | 0.10% | -1.49% | -1.20% | 98% | 97% |
| **Overall** | 0.13% | -1.65% | -1.55% | 99% | 98% |
| Class D | 0.04% | -1.38% | -1.29% | 98% | 94% |
| Class F | 0.14% | -0.82% | -0.81% | 100% | 100% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **Random access** |  |  |
|  |  |  | **Over VTM 7.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.03% | 0.03% | 0.03% | 101% | 101% |
| Class A2 | 0.03% | 0.03% | 0.03% | 100% | 101% |
| Class B | 0.07% | 0.07% | 0.07% | 101% | 96% |
| Class C | 0.15% | 0.14% | 0.14% | 102% | 99% |
| Class E |  |  |  |  |  |
| **Overall** | 0.07% | 0.07% | 0.07% | 101% | 99% |
| Class D | 0.40% | 0.40% | 0.41% | 101% | 100% |
| Class F | 0.16% | 0.20% | 0.22% | 101% | 104% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **Low delay B** |  |  |
|  |  |  | **Over VTM 7.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | 0.10% | -0.99% | -0.56% | 102% | 100% |
| Class C | 0.25% | -0.86% | -0.64% | 104% | 99% |
| Class E | 0.72% | -0.45% | -0.54% | 99% | 98% |
| **Overall** | 0.31% | -0.81% | -0.58% | 102% | 99% |
| Class D | 0.51% | -0.28% | -0.86% | 101% | 97% |
| Class F | 0.59% | -0.17% | 0.57% | 101% | 97% |

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

Several issues were encountered during software development:

* + An issue was identified regarding text and software integration of JVET-N0278 “On VVC HLS relevant to MPEG requirements on immersive media delivery and access”, and the proponents’ expectations of what needed to be integrated. Draft 5 version 1 integrated the exact text of JVET-N0278, which defines an input filter in the decoder that removes all layers except the target layer (LIdTarget). Software was provided implementing this filter into VTM. Later, in Draft 5 version 4 “fixes for JVET-N0278” were integrated that refer to layers in multiple locations of the specification, including definitions, reference picture list construction, and constraints on different NAL unit types. These changes are likely borrowed from layered HEVC, but not required in the case where a decoder would see only one specific value of nuh\_layer\_id. Proponents modified these editorially added constraints later on in the Gothenburg meeting. They expected the original constraints to be implemented in software. Also, for the implementation of scalable coding, proponents expected that the software would already contain some infrastructure for multi-layer coding, which did not exist. This issue still caused problems because proponents of JVET-O1159 “Scalability for VVC – Text for approach 1” did not feel responsible for implementing multi-layer infrastructure into the software. The implementation was seen as “volunteer work”, and the software coordinator requests regarding software quality and documentation were initially dismissed.

Substantial work on the multi-layer software functionality was done by V. Seregin and Y. He. The software for JVET-O1159, other than aspects replaced later by a different proposal, was said to have been completed. Integration of scalability adoptions from the last meeting was still pending.

It was commented that having config files for some use cases is needed so that the software can be tested effectively and regressions can be identified in a timely manner.

V. Seregin said that DPB management aspects were pending integration.

* + A side discussion was opened on the licensing terms for the software manual. The manual uses the same header as other JVET documents, including a list of authors (which are rather editors as for the standard document). One individual claimed that he could not add to that document because of that authors list. It was also asked, if the document should be BSD licensed as the software. There is no explicit license statement in the document, although it resides in a folder of the software, which contains a BSD style license statement. No such problems were brought up in previous meeting cycles. It also seems to be no problem to contribute to the standard document, which also has a list of authors/editors. These issues need to be clarified.

In the JVET review, it was agreed that the header should identify the named people as editors rather than authors. As a group-prepared output, copyright on the output document is understood to belong to ITU-T/ISO/IEC. People responsible for contributing to the software are understood to also be responsible for contributing to the relevant aspects of the manual as well. New parameters (or modified behaviour of existing parameters) need to be described in the manual.

There are some gaps in the manual that need to be filled – e.g., for ALF. (V. Seregin volunteered to help for ALF.)

Revisit for identifying additional aspects needing help and arranging volunteers.

* + After merging MR 1048 that addresses issue #561 on RPR clipping and padding, the runtime of the VTM 7.0 decoder was noticeably increased. The issue turned out to be related to MAX\_SCALING\_RATIO being set to 8, leading to excessive padding of reference pictures. Setting MAX\_SCALING\_RATIO to 2 (which is the maximum RPR downsampling ratio) alleviates the problem. Two related tickets were opened on this issue. It was further suggested to modify the motion compensation implementation to operate on smaller blocks to avoid large padded areas.
  + The coordinators wished to clarify that their comments on merge requests have been made to ensure high quality and usability of the software. They have commonly requested fixes to coding style (as defined in software guidelines) and documentation for newly added configuration parameters. They also commonly ask for clarification if the don’t understand something, and if they sense that something is missing or could be improved, if the impact of a change on coding efficiency is unclear, or if they are unable to determine whether submitted software matches meeting agreements. They reported that they don’t intend to prevent the inclusion of meeting agreements into the software.

At the beginning of the 17th meeting, JVET-O1143 subpicture aspects were partially implemented:

For the following implementations, issues reportedly remained:

* + JVET-O0145/JVET-O0215: The number of entry points is derived instead of being signalled. For this the number of bricks needs to be known in the slice header. The software needs to be restructured to allow derivation of the slice/tile/brick related variables within the slice header parsing process. An initial version of the code has been merged, but disabled.
  + JVET-O0042: The syntax was included with JVET-O0041, but no configuration options exist for frame repetitions. Also, the decoder does not repeat frames.

The following proposals have pending merge requests:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | Notes from the previous meeting |  |
| General | unavailable reference pictures and max\_dec\_pic\_buffering\_minus1 | clarification | JVET-P0184 | !1201 | See notes for HLS BoG report JVET-P0968 | S. Deshpande |
| Intra prediction | Cleanup of reference sample padding for intra prediction | optional editorial improvement | JVET-P0626 | !1096 | just editorial cleanup, it should be up to the editors to decide |  |

Regarding the merge request for JVET-P0626, it was reported that the text change had a problem, as it refers to a list entry that has not been set to value. The editor was asked to correct this. There appeared to be no need for the corresponding software change.

The following proposals had not been implemented:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **HLS** |  |  |  |  | Notes from the previous meeting |  |
| Profile |  | Functionality | Profiles, tiers and levels | JVET-P0894 | Decision: Adopt, but with a maxDpbPicBuf of 8 rather than 7 (see notes for P0133). | J. Boyce |
| Parameter sets | VUI | Conformance | Constraining the maximum number of bits for a CU or CTU | JVET-P0188 | Decision: It was agreed to establish a picture-level constraint the same as in HEVC (using MinCR as a function of timing). | T. Suzuki |
| RPL | Constraints | expression of existing intent |  | JVET-P0978 | See notes for HLS BoG report JVET-P0968 | M. Pettersson |
| Scalability | ilrp\_idc and DirectDependentLayerIdx | expression of existing intent |  | JVET-P0221, JVET-P0589 | See notes for HLS BoG report JVET-P0968 | B. Choi |
| APS | ALF APS constraints | cleanup unnecessary constraints | Remove some ALF APS constraints | JVET-P0122 | See notes for HLS BoG report JVET-P0968 | Y.-K. Wang, X. Ma, R. Chernyak |
| SEI | self\_contained\_cvs\_flag | cleanup |  | JVET-P0359 | See notes for HLS BoG report JVET-P0968 | R. Sjöberg |
| SEI | Omnidirectional video | enhanced vs. HEVC based on prior work in JVET | Add a new SEI message on omnidirectional video | JVET-P0597 | See notes for HLS BoG report JVET-P0968 | Y.-H. Lee |
| Subpictures | Boundary treating | BF |  | JVET-P0378, JVET-P0572 | See notes for HLS BoG report JVET-P0968 | K. Zhang |
| Scalability | General decoding process | consequence of agreement on OLS decoding concept |  | JVET-P0115 | See notes for HLS BoG report JVET-P0968 | Y.-K. Wang, X. Ma, R. Chernyak |
| Scalability | PTL | consequence of agreement on OLS decoding concept |  | JVET-P0117 | See notes for HLS BoG report JVET-P0968 | Y.-K. Wang, X. Ma, R. Chernyak |
| Scalability | HRD | consequence of agreement on OLS decoding concept | HRD signalling and process | JVET-P0118 | See notes for HLS BoG report JVET-P0968 | Y.-K. Wang, X. Ma, R. Chernyak |
| Scalability | HRD | consequence of agreement on OLS decoding concept | Scalable nesting SEI message | JVET-P0190 | See notes for HLS BoG report JVET-P0968 | Y.-K. Wang, X. Ma, R. Chernyak |
| NUH | Tid and Lid | expression of existing intent | Constraints and rules on values of TemporalId and nuh\_layer\_id | JVET-P0125 | See notes for HLS BoG report JVET-P0968 | Y.-K. Wang, X. Ma, R. Chernyak |
| SEI | General SEI constraints | consequence of agreement on OLS decoding concept |  | JVET-P0125 | See notes for HLS BoG report JVET-P0968 | Y.-K. Wang, X. Ma, R. Chernyak |
| VPS | Single layer bitstreams | expression of existing intent |  | JVET-P0097, JVET-P0205 | When sps\_video\_parameter\_set\_id is equal to 0, it is a requirement for bitstream conformance that there shall be only a single layer in the bitstream. | M. M. Hannuksela |
| Scalability | Random access | layered coding support simpler than in SHVC | POC for independent layers | JVET-P0116 | See notes for HLS BoG report JVET-P0968 | Y.-K. Wang, X. Ma, R. Chernyak |
| Scalability | Random access | layered coding support simpler than in SHVC | POC for dependent layers | JVET-P0101 | See notes for HLS BoG report JVET-P0968 | M. M. Hannuksela |
| Scalability | Random access | layered coding support simpler than in SHVC | IRAP AU | JVET-P0116 | Each IRAP AU is complete (i.e., there is a picture in each layer present in the CVS) and all pictures in an IRAP AU are IRAP pictures with the same NAL unit type. | Y.-K. Wang, X. Ma, R. Chernyak |
| HRD | Sub-bitstream extraction | existing design intent for extraction process | Keep DPS, VPS, and EOB in extraction | JVET-P0098 | See notes for HLS BoG report JVET-P0968 | M. M. Hannuksela |
| Scalability | EOS | existing design intent esp. for independent layers | Specify EOS NUTs to be layer specific | JVET-P0125 | See notes for HLS BoG report JVET-P0968 | Y.-K. Wang, X. Ma, R. Chernyak |
| Scalability | Output layers and pictures | expression of existing intent | Clarification to the bullet items in setting of PicOutputFlag | JVET-P0097 | See notes for HLS BoG report JVET-P0968 | M. M. Hannuksela |
| Subpictures | Extraction and merging | extraction/merge functionality | Mixed IRAP/non-IRAP VCL NALUs within a picture | JVET-P0124, P0095, P0222 | See notes for HLS BoG report JVET-P0968 | Y.-K. Wang, X. Ma, R. Chernyak |
| Tiles and slices |  | cleanup | Refinement that avoids sending an unnecessary syntax element for the last slice under some circumstance | JVET-P1012 | See notes for HLS BoG report JVET-P0968 | W. Lim |
| Subpictures |  | cleanup | Signalling of subpicture layout | JVET-P0171 | See JVET meeting notes | J. Li |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Software** |  |  |  |  |
| RPL | Bug fix | bugfix of SPS flags and reference picture list structure | JVET-P0235 | The text problem has already been fixed in P0113. Decision (SW): The software bug also needs fixing |

Revisit for scheduling of the integration effort.

*Software manual*

Possible license issues (as reported above) were requested to be clarified.

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.

See notes above regarding this issue.

*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. A second account exists for VCEG members with account information available in the TIES system at:

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

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
* Design and add configuration files to the VTM software for testing of HLS features. See the notes above regarding this issue.

[JVET-Q0004](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9364) JVET AHG report: Test material and visual assessment (AHG4) [V. Baroncini, T. Suzuki, M. Wien, R. Chernyak, A. Norkin]

This AHG report was discussed Wednesday 8 January 2020 at 1215 (chaired by GJS & JRO).

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

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

In the last meeting, a modified directory structure was approved as follows.

* ctc/ Contains the active test set of the common testing conditions
* ahg/ Contains subdirectories with sequences under consideration.
* ce/ Contains subdirectories for data exchange for specific CE
* jvet-cfe/ The sequences used for CfE
* jvet-cfp/ The sequences used for CfP
* old/ Contains the JEM bitstreams directory, used before the CfP
* upload Stays as before

In the CTC directory, following subdirectories have been created:

* ctc/360/
* ctc/hdr/
* ctc/scc/
* ctc/sdr/

No related contributions were submitted

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

It was commented that a late contribution would be provided, offering 8K 60 fps test sequences under a Creative Commons license. It was commented that these could be helpful as verification test source material and for preparation of conformance test bitstreams.

[JVET-Q0005](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9365) JVET AHG report: Conformance testing (AHG5) [J. Boyce, W. Wan, E. Alshina, I. Moccagatta, K. Kawamura, S. McCarthy, K. Sühring]

This AHG report was discussed Wednesday 8 January 2020 at 1225 (chaired by GJS & JRO).

This document summarizes the activity of AHG5: “Conformance testing” between the 16th Meeting in Geneva, CH (1–11 Oct 2019) and the 17th Meeting in Brussels, BE (7–17 Jan 2020).

At the 16th JVET meeting (October 2019) the following preliminary timeline had been agreed on:

* 17th meeting Jan. 2020: Preliminary guidelines for bitstream preparation (e.g., naming conventions), improved list of conformance bitstreams
* 18th meeting Apr. 2020: Final guidelines for bitstream preparation and improved list of conformance bitstreams with identified responsible experts, initial bitstreams provided
* 19th meeting July 2020: Confirmed list of bitstreams to be included in v1, collection of bitstream  
  candidates for CD ballot at next meeting
* 20th meeting Oct. 2020: CD of conformance specification
* 21st meeting Jan. 2021: Final bitstreams provided, DIS ballot in ISO/IEC at 22nd meeting
* April 2021: No action pending DIS ballot
* 23rd meeting July 2021: Final conformance specification

Output document JVET-P2008 “Conformance testing for versatile video coding (Draft 1)” published on November 28th, 2019.

The regular JVET e-mail reflector was used for discussions ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de)).

The AHG chairs sent 2 emails on the JVET e-mail reflector to solicit volunteers to generate the streams listed in tables in the conformance testing draft.

Huawei, InterDigital, Ericsson, Samsung, KKDI, HHI, Dolby, Futurewei, MediaTek, LGE, and Panasonic volunteered to create conformance streams, and provided names of volunteers who will generate the streams. In addition, feedback was provided by email to improve the conformance testing draft.

After the publication of the first draft of [JVET-P2008](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8861), the following companies volunteered to create conformance streams in the follow categories:

* Nokia (J. Lainema) for IP (Intra Prediction) and JCCR (Joint coding of chroma residuals)
* Tencent (Xiaozhong Xu) for IBC (Intra block copy mode)
* Mediatek (Jian-Liang Li) for loop filters on/off at virtual boundaries
* Bytedance (Na) for Subblock-based temporal merging candidates

The status at the start of the 17th JVET meeting was as follow:

* 81 bitstream categories have been identified
* VTM SW support is needed to output the log file specified in section 2.4 of [JVET-P2008](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8861), and described as follows:
  + Per picture in output order: Picture width, picture height, MD5sum for each of Y, U, and V
  + Each output picture log file contains one row for each output picture in the bitstream, in output order.
  + Each row contains the following information, as CSV.
    - PicOrderCntVal
    - pic\_width\_max\_in\_luma\_samples
    - pic\_height\_max\_in\_luma\_samples
    - MD5 checksum for the Y component
    - MD5 checksum for the U component
    - MD5 checksum for the V component
* Volunteers have been identified to generate 51/81 streams (63%)
* Volunteers are needed for the following tools / features:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Categories** | **Tool description** | **Feature name** | **Bitstream features** | **Submitter** |
| All | Tool set 0 | SET0 | Basic set, with all tools with enable flags disabled |  |
| All | Tool set 1 | SET1 | ???? |  | |
| All | Tool set 2 | SET2 | SET1 + ???? |  | |
| All | Tool set 3 | SET3 | SET2 + ???? |  | |
| CTU partition | CTC tool set | SETCTC | All tools enabled in CTC version X |  | |
| Intra coding | Quantized residual DPCM | RDPCM |  |  | |
| Inter coding | Temporal motion vector predictor | TMVP |  |  | |
| In-loop filter | Adaptive loop filter | ALF | Use multiple APSes |  | |
| Transform and quantization | Transform |  | min and max transform |  | |
|  |  |  | min number of entropy coded coeff. |  | |
|  |  |  | max number of coeff. |  | |
| Entropy coding | Entropy coding |  | max bins and bits |  | |
|  |  |  | min bits |  | |
| Inter coding | All merge modes |  | max number of merge candidates |  | |
| Intra coding | Position dependent prediction combination (PDPC) |  | Force clipping. Different PU sizes and shapes. |  | |
| SCC coding | Palette mode |  | For 4:4:4 |  | |
| SCC coding | Adaptive Color Transform | ACT | For 4:4:4 |  | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tool description** | | **Feature name** | **Bitstream features** | **Submitter** |
| Tile rows / columns |  | pictures partitions in tiles, bricks and slices |  | |
|  | Different tile sizes in same picture |
|  | loop filters on/off |
| Reference picture resizing |  |  |  | |
| Ref pic wrap-around |  |  |  | |
| Temporal scalability |  |  |  | |
| 360 Video w/ cube map layout and SEI |  |  |  | |
| 360 Video bitstream created using sub-picture extraction & merging |  |  |  | |
| Wavefronts |  |  |  | |
| Conformance cropping window |  |  |  | |
| NAL unit type |  | Exercise all types, including STSA and random access |  | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Tool description** | **Feature** | **Bitstream features** | **Submitter** |
| **Name** |
| 8b 4:0:0 |  | Main 10 profile |  |
| 8b 4:2:0 |  | Main 10 profile |  |
| 8b 4:2:2 |  | Main 4:4:4 10 profile |  |
| 8b 4:4:4 |  | Main 4:4:4 10 profile |  |
| 10b 4:0:0 |  | Main 10 profile |  |
| 10b 4:2:2 |  | Main 4:4:4 10 profile |  |
| 10b 4:4:4 |  | Main 4:4:4 10 profile |  |

The procedure to exchange the bitstream (ftp cite, bitstream files, etc.) is specified in Sec 2 “Procedure” of [JVET-P2008](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8861). As a reminder, the ftp site at ITU-T is used to exchange bitstreams. The ftp site for downloading bitstreams is

<ftp://ftp3.itu.int/jvet-site/bitstream_exchange/>

The files can also be read via http at:

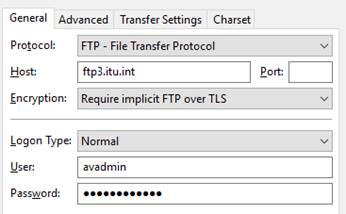
<http://wftp3.itu.int/av-arch/jvet-site/bitstream_exchange/>

The ftp site for uploading bitstream file is as follows.

<ftp://ftp3.itu.int/jvet-site/dropbox/>

(user id: avguest, p w: Avguest201007)

For access to the ftp site, using FileZilla with the following configuration in the Site manager settings (not accessing directly without using the Site manager) is suggested:



The following related contribution was noted: JVET-Q0479 Updates to conformance testing for versatile video coding [I. Moccagatte, J. Boyce (Intel)]

The AHG recommends the following:

* Review related input contributions
* Discuss and refine the list of conformance bitstreams
* Identify contributors for all identified bitstreams
* Develop a plan to implement the VTM software to output the logfile
* Identify a volunteer to submit initial bitstreams, to test the process

A. Fillipov volunteered to implement the log file output into the VTM software.

BoG and revisit were planned for identifying additional volunteered contributions.

[JVET-Q0006](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9366) JVET AHG report: 360° video coding tools, software and test conditions (AHG6) [J. Boyce, Y. He, K. Choi, J.-L. Lin, Y. Ye]

This AHG report was discussed Wednesday 8 January 2020 at 1255 (chaired by GJS & JRO).

The document summarizes activities on 360-degree video content coding between the 16th (1–11 Oct. 2019) and the 17th (7–17 Jan. 2020) JVET meetings.

The 360Lib-10.0 software package was released on Dec. 3, 2019, and included following changes:

* FishEye projection format from JCTVC-AE1005 was integrated;
* Generalized cubemap projection format from JVET-P0597 was integrated;
* Adding encoding configuration files for two new projection formats;
* Updating configuration files for format conversion between different formats;
* Updating the software manual document.

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

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

The released version of 360Lib-10.0 can be found at:

<https://jvet.hhi.fraunhofer.de/svn/svn_360Lib/tags/360Lib-10.0/>

360Lib-10.0 testing results can be found at:

[ftp.ient.rwth-aachen.de/ahg/testresults/360Lib-10.0](ftp://ftp.ient.rwth-aachen.de/ahg/testresults/360Lib-10.0)

360Lib bug tracker

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

360Lib-10.0 results were reported as follows.

The first table below is for the projection formats comparison using VTM-7.0 according to 360-degree video CTC (JVET-L1012). It compares padded hybrid equi-angular cubemap (PHEC) coding and padded equi-rectangular projection (PERP) coding using VTM-7.0.

The second table is for PERP coding comparison between VTM-7.0 and HM-16.16. The third table below is to compare PHEC coding with VTM-7.0 with and CMP coding with HM-16.16.

**VTM-7.0 PHEC vs PERP (PERP as anchor)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **PHEC over PERP (VTM-7.0)** | | | | | |
|  | **End-to-end WS-PSNR** | | | **End-to-end S-PSNR-NN** | | |
|  | Y | U | V | Y | U | V |
| Class S1 | -11.71% | -6.95% | -7.51% | -11.61% | -6.85% | -7.44% |
| Class S2 | -5.34% | -1.70% | -1.80% | -5.31% | -1.62% | -1.73% |
| **Overall** | -9.16% | -4.85% | -5.23% | -9.09% | -4.76% | -5.16% |

**VTM-7.0 PERP vs HM-16.16 PERP (HM-16.16 PERP as anchor)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **VTM-7.0 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 | -25.07% | -40.90% | -43.34% | -25.07% | -40.92% | -43.31% |
| Class S2 | -34.68% | -41.56% | -43.89% | -34.67% | -41.59% | -43.93% |
| **Overall** | -28.91% | -41.17% | -43.56% | -28.91% | -41.19% | -43.56% |

**VTM-7.0 PHEC vs HM-16.16 CMP (HM-16.16 CMP as anchor)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **VTM-7.0 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 | -29.52% | -42.64% | -44.69% | -29.41% | -42.61% | -44.66% |
| Class S2 | -37.39% | -44.13% | -46.27% | -37.38% | -44.13% | -46.29% |
| **Overall** | -32.67% | -43.23% | -45.32% | -32.60% | -43.22% | -45.31% |

There were 10 input documents noted as related to signalling syntax for 360-degree video coding, which are listed below.

* JVET-Q0134 AHG8: Disabling reference wraparound for reference picture resampling [B. Heng, P. Chen, T. Hellman, W. Wan, M. Zhou (Broadcom)]
* JVET-Q0184 AHG9: On signalling of wrap-around motion compensation [C.-Y. Chiu, C.-C. Chen, C.-W. Hsu, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]
* JVET-Q0212 [AHG9/AHG12] On sub-picture wrap around signaling [Y. He, A. Hamza (InterDigital), B. Choi, S. Wenger (Tencent)]
* JVET-Q0238 AHG8/AHG9: On reference picture wraparound [M. M. Hannuksela (Nokia)]
* JVET-Q0287 AHG9: On wrap-around motion compensation [B. Choi, S. Wenger, S. Liu (Tencent)]
* JVET-Q0316 AHG9: On signaling of the wraparound offset [K. Zhang, L. Zhang, Y.-K. Wang, H. Liu, J. Xu, Z. Deng (Bytedance)]
* JVET-Q0335 AhG9: On the wraparound offsets [Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]
* JVET-Q0343 AHG6/AHG9: Signalling guard band type for generalized cubemap projection [Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek)]
* JVET-Q0344 AHG6/AHG9: Signalling wrap-around for subpictures [Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek)]
* JVET-Q0345 AHG6/AHG9: Signalling EAP via the ERP SEI message [Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek)]

The AHG recommended:

* To review input contributions
* 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.

[JVET-Q0007](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9367) JVET AHG report: Coding of HDR/WCG material (AHG7) [A. Segall, E. François, W. Husak, S. Iwamura, D. Rusanovskyy]

This AHG report was discussed Wednesday 8 January 2020 at 1305 (chaired by GJS & JRO).

This document summarizes the activity of AHG7: Coding of HDR/WCG Material between the 16th meeting in Geneva, CH (1–11 October 2019) and the 17th meeting in Brussels, BE (7–17 January 2020).

The AHG used the main JVET reflector, [jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de), with an [AHG7] indication on message headers. Only a couple of messages were sent in this manner. The primary activity of the AhG was related to the mandates of (i) generating CTC anchor for the VTM according to JVET-P2011 and (ii) comparing the performance of the VTM for HDR/WCG content. This work is described in the following subsection.

The AhG generated CTC anchors for the VTM according to JVET-P2011. The performance of the anchors was reported to the reflector on December 3, 2019. A summary of the performance is provided below, and more detailed information may be found in the included XLS data.

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

VTM 7.0 versus VTM 6.0

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | | | | | |
|  | **Over VTM-6.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | 17.89% | -3.92% | -3.61% | 24.85% | 74.26% | -2.16% | 27.76% | 86.34% | 97% | 94% |
| Class H2 |  |  |  |  |  | -0.17% | -0.30% | -0.18% | 101% | 92% |
| **Overall** | 17.89% | -3.92% | -3.61% | 24.85% | 74.26% | -1.44% | 17.56% | 54.88% | 99% | 93% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access** | | | | | | | | | |
|  | **Over VTM-6.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | 34.30% | -4.15% | -4.15% | 44.54% | 132.58% | -2.71% | 48.92% | 150.48% | 96% | 101% |
| Class H2 |  |  |  |  |  | -0.18% | -0.23% | -0.16% | 97% | 95% |
| **Overall** | 34.30% | -4.15% | -4.15% | 44.54% | 132.58% | -1.79% | 31.04% | 95.70% | 97% | 99% |

VTM 7.0 versus HM 16.18

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | | | | | |
|  | **Over HM-16.18** | | | | | | | | | |
|  |  |  | **wPSNR** | |  | **PSNR** |  |  |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -36.72% | -26.75% | -26.32% | -50.47% | -38.22% | -23.66% | -44.82% | -26.06% | - | - |
| Class H2 |  |  |  |  |  | -21.28% | -37.80% | -39.98% | - | - |
| **Overall** | -36.72% | -26.75% | -26.32% | -50.47% | -38.22% | -22.79% | -42.27% | -31.12% | - | - |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access** | | | | | | | | | |
|  | **Over HM-16.18** | | | | | | | | | |
|  |  |  | **wPSNR** | |  | **PSNR** |  |  |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -24.81% | -31.32% | -31.15% | -37.91% | -4.93% | -28.13% | -30.10% | 14.56% | - | - |
| Class H2 |  |  |  |  |  | -28.37% | -46.02% | -49.72% | - | - |
| **Overall** | -24.81% | -31.32% | -31.15% | -37.91% | -4.93% | -28.21% | -35.89% | -8.82% | - | - |

In addition to evaluating the performance of VTM 7.0, the AhG also studied the performance of individual coding tools in the context of HDR content. This was accomplished by conducting a Tool-On/Tool-Off test according to the methodology established in AhG13.

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

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

Class H1 (PQ)

Simulation Results for AI (Class H1)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **AI** |  |  |  |  |
| **Abbreviation** | **DE100** | **PSNR-L** | **BDR-wY** | **BDR-wU** | **BDR-wV** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| **CST** | **18.90%** | **0.84%** | **0.74%** | **17.22%** | **24.68%** | **154%** | **103%** | **151%** | **101%** |
| **DQ** | **-1.65%** | **1.59%** | **1.70%** | **-3.24%** | **-4.41%** | **96%** | **108%** | **96%** | **104%** |
| **CCLM** | **22.33%** | **2.26%** | **2.05%** | **70.63%** | **78.26%** | **101%** | **101%** | **100%** | **100%** |
| **MTS** | **0.92%** | **1.14%** | **1.19%** | **0.91%** | **1.02%** | **87%** | **108%** | **85%** | **100%** |
| **ALF** | **2.85%** | **2.89%** | **2.36%** | **4.79%** | **3.55%** | **97%** | **89%** | **95%** | **91%** |
| **MRLP** | **0.35%** | **0.34%** | **0.31%** | **0.14%** | **0.36%** | **99%** | **101%** | **101%** | **100%** |
| **IBC on** | **-0.20%** | **-0.34%** | **-0.33%** | **-0.06%** | **-0.12%** | **145%** | **102%** | **164%** | **100%** |
| **ISP** | **0.04%** | **0.66%** | **0.74%** | **-0.34%** | **-0.19%** | **90%** | **99%** | **84%** | **98%** |
| **LMCS** | **2.66%** | **1.19%** | **0.71%** | **0.72%** | **3.70%** | **96%** | **98%** | **95%** | **99%** |
| **BDPCM on** | **-0.04%** | **0.00%** | **-0.03%** | **-0.12%** | **-0.06%** | **105%** | **99%** | **105%** | **100%** |
| **MIP** | **0.39%** | **0.70%** | **0.56%** | **0.19%** | **0.19%** | **93%** | **99%** | **88%** | **101%** |
| **LFNST** | **-0.73%** | **1.08%** | **1.04%** | **-1.70%** | **-0.64%** | **98%** | **99%** | **105%** | **101%** |
| **JCCR** | **0.36%** | **0.55%** | **0.57%** | **2.83%** | **-0.22%** | **98%** | **99%** | **97%** | **101%** |
| **SAO** | **0.98%** | **0.07%** | **0.00%** | **1.17%** | **2.47%** | **100%** | **102%** | **98%** | **100%** |

Class H2 (HLG)

Simulation Results for AI (Class H2)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **AI** |  |  |  |  |
| **Abbreviation** | **BDR-Y** | **BDR-U** | **BDR-V** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| **CST** | **0.57%** | **13.68%** | **20.27%** | **165%** | **104%** | **159%** | **103%** |
| **DQ** | **1.85%** | **-1.29%** | **-1.45%** | **100%** | **103%** | **99%** | **105%** |
| **CCLM** | **1.75%** | **40.57%** | **20.50%** | **103%** | **100%** | **101%** | **100%** |
| **MTS** | **1.78%** | **2.89%** | **2.18%** | **87%** | **97%** | **85%** | **98%** |
| **ALF** | **2.83%** | **2.16%** | **3.16%** | **98%** | **88%** | **93%** | **90%** |
| **MRLP** | **0.04%** | **-0.02%** | **-0.10%** | **99%** | **100%** | **100%** | **99%** |
| **IBC on** | **-0.11%** | **0.03%** | **0.05%** | **186%** | **100%** | **165%** | **100%** |
| **ISP** | **0.34%** | **-0.72%** | **-0.36%** | **86%** | **99%** | **84%** | **100%** |
| **LMCS** | **0.06%** | **-0.78%** | **-0.64%** | **95%** | **96%** | **94%** | **97%** |
| **RDPCM on** | **0.00%** | **0.00%** | **-0.08%** | **108%** | **100%** | **109%** | **101%** |
| **MIP** | **0.71%** | **0.93%** | **0.50%** | **90%** | **101%** | **91%** | **102%** |
| **LFNST** | **0.67%** | **-0.11%** | **-0.44%** | **113%** | **101%** | **110%** | **101%** |
| **JCCR** | **0.28%** | **0.43%** | **5.37%** | **100%** | **101%** | **98%** | **101%** |
| **SAO** | **0.05%** | **0.25%** | **0.58%** | **100%** | **97%** | **99%** | **97%** |

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **VTM RA** |  |  |  |  |
| **Abbreviation** | **BDR-wY** | **BDR-wU** | **BDR-wV** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| **CST** | **0.21%** | **8.36%** | **15.19%** | **103%** | **100%** | **102%** | **101%** |
| **DQ** | **1.79%** | **-0.46%** | **-0.80%** | **103%** | **102%** | **104%** | **103%** |
| **CCLM** | **0.77%** | **48.22%** | **25.89%** | **101%** | **101%** | **99%** | **101%** |
| **MTS** | **1.11%** | **1.57%** | **0.94%** | **95%** | **100%** | **95%** | **99%** |
| **ALF** | **3.54%** | **3.36%** | **2.76%** | **97%** | **88%** | **95%** | **93%** |
| **AFF** | **0.70%** | **0.49%** | **0.55%** | **80%** | **97%** | **83%** | **99%** |
| **SbTMVP** | **0.40%** | **0.24%** | **0.20%** | **102%** | **102%** | **101%** | **99%** |
| **AMVR** | **0.73%** | **1.06%** | **1.62%** | **87%** | **102%** | **83%** | **102%** |
| **TPM** | **0.37%** | **0.60%** | **0.62%** | **100%** | **101%** | **98%** | **98%** |
| **BDOF** | **0.61%** | **0.29%** | **0.19%** | **98%** | **98%** | **98%** | **99%** |
| **PROF** | **0.12%** | **0.13%** | **0.05%** | **99%** | **99%** | **98%** | **98%** |
| **CIIP** | **0.18%** | **-0.29%** | **-0.47%** | **99%** | **101%** | **98%** | **101%** |
| **MMVD** | **0.18%** | **0.35%** | **0.50%** | **91%** | **101%** | **91%** | **101%** |
| **BCW** | **0.20%** | **0.23%** | **0.29%** | **94%** | **102%** | **96%** | **102%** |
| **MRLP** | **0.03%** | **-0.03%** | **0.05%** | **100%** | **100%** | **100%** | **100%** |
| **IBC on** | **0.11%** | **-0.03%** | **-0.04%** | **108%** | **100%** | **107%** | **101%** |
| **ISP** | **0.25%** | **0.19%** | **0.09%** | **97%** | **100%** | **95%** | **100%** |
| **DMVR** | **0.87%** | **1.04%** | **0.95%** | **101%** | **97%** | **102%** | **98%** |
| **SBT** | **0.28%** | **-0.14%** | **-0.17%** | **97%** | **100%** | **98%** | **100%** |
| **LMCS** | **0.94%** | **1.33%** | **0.92%** | **99%** | **99%** | **98%** | **100%** |
| **SMVD** | **0.20%** | **0.07%** | **0.19%** | **97%** | **100%** | **96%** | **102%** |
| **RDPCM on** | **0.00%** | **-0.05%** | **-0.05%** | **101%** | **100%** | **101%** | **102%** |
| **MIP** | **0.49%** | **0.58%** | **-0.07%** | **97%** | **100%** | **96%** | **101%** |
| **LFNST** | **0.53%** | **0.06%** | **-0.33%** | **96%** | **100%** | **96%** | **101%** |
| **JCCR** | **0.20%** | **-0.07%** | **7.15%** | **99%** | **100%** | **98%** | **100%** |
| **SAO** | **0.05%** | **0.36%** | **1.96%** | **101%** | **99%** | **101%** | **99%** |

PSNR-Y vs weighted runtime ratio figures were also provided in the report.

There was one contribution related to HDR video coding.

* JVET-Q0523 Redistribution of chroma information for improved HDR color representation [Maryam Azimi (Univ. of Cambridge), Mahsa T. Pourazad (TELUS), Panos Nasiopoulos (UBC)]

While not listed in the AHG report, it is noted that responses to CE5 also evaluated the performance of in-loop filtering on HDR content:

The AHG recommends to review the relevant input contributions.

[JVET-Q0008](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9368) 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]

This AHG report was discussed Tuesday 7 January 2020 at 1010 (chaired by GJS).

The document summarizes activities of AHG on Layered coding and resolution adaptivity between the 16th and the 17th JVET meetings. Two email messages were exchanged on the reflector, covering the DPB size in case of layered coding. While there was no extended discussion, the conclusion reached can be summarized as follows: In VVC version 1, the constraint on DPB size should be specified to be independent of the number of layers, without specifying an explicit limit on the maximum number of layers. Proposal contribution JVET-Q0112 to this meeting is aligned with this suggestion.

A total of 35 relevant documents were received in preparation of the Brussels meeting.

The AHG recommended:

* To review all related contributions
* To continue to study VVC layered coding and resolution adaptivity

[JVET-Q0009](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9369) JVET AHG report: High-level syntax (AHG9) [R. Sjöberg, J. Boyce, B. Choi, S. Deshpande, M. M. Hannuksela, R. Skupin, A. Tourapis, Y.-K. Wang, W. Wan]

This AHG report was discussed Tuesday 7 January 2020 at 1020 (chaired by GJS).

This AHG report summarizes the activities of the AHG on High-level syntax (HLS) between the 16th JVET meeting in Geneva, CH (1–11 October 2019) and the 17th JVET meeting in Brussels, BE (7–17 January 2020).

It is reported that the estimated number of input contributions related to high-level syntax has increased from 137 at the 16th JVET meeting to 188 at this 17th meeting.

It is noted that the first day of the 17th meeting in Brussels was announced on the reflector on November 6 to be devoted to high-level syntax related topics.

An e-mail reflector discussion on HLS planning took place. The discussion was summarized by the AHG as the following lists of suggested actions:

Suggested actions to handle HLS input contributions at this meeting:

* Encourage joint contributions to reduce the number of documents
* Allocate more meeting time for HLS compared to low-level work
* Let software availability impact the presentation times of HLS proposals

Suggested actions for future meetings:

* Require that software is provided with HLS contributions, preferably also require cross-checks
* Prioritize missing HLS adoptions for VTM-8 integration
* Allocate much earlier time slots for the HLS-related implementation work
* Define test conditions for HLS aspects (e.g. scalability, RPR, subpictures) to ensure that the software works as expected

It was commented that we need greater clarity on who is responsible for providing software for contributions that merge proposals from different organizations.

It was also commented that when we have some part of the design that has not yet been adequately implemented in the software, the focus should be on getting that problem fixed rather than making additional refinements of the non-implemented feature.

[JVET-Q0010](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9370) JVET AHG report: Encoding algorithm optimization (AHG10) [A. Duenas, A. Tourapis, S. Ikonin, A. Norkin, R. Sjöberg, J. Le Tanou, J.-M. Thiesse]

This AHG report was discussed Wednesday 8 January 2020 at 1430 (chaired by GJS & JRO).

The document summarizes the activities of the AHG on Encoding algorithm optimizations between the 16th meeting in Geneva, CH (1-11, October 2019) and the 17th meeting in Brussels, BE (7-17, January 2020).

No particular coordinated work was identified in the AHG report, which listed the relevant input contributions as follows:

* JVET-Q0323: Encoder optimization for chroma BDPCM
* JVET-Q0433: Encoder only: On unbalanced luma/chroma gains for dependent quantization
* JVET-Q0447: Encoder estimation of Weighted-Prediction parameters
* JVET-Q0493: Non-CE2: Palette encoder improvements for lossless coding
* JVET-Q0502: Non-CE2: Encoder only approach for CTU row palette predictor initialization
* JVET-Q0503: CE2-related: Encoder improvement for palette mode
* JVET-Q0514: AHG11: Encoder improvements on JCCR with chroma transform skip mode

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

[JVET-Q0011](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9371) JVET AHG report: Screen content coding (AHG11) [S. Liu, J. Boyce, A. Filippov, Y.-C. Sun, J. Xu, H. Yang]

This AHG report was discussed Wednesday 8 January 2020 at 1435 (chaired by GJS & JRO).

This document summarizes the activity of AHG11: Screen Content Coding between the 16th meeting in Geneva, CH (1–11 October 2019) and the 17th Meeting in Brussels, BE (7–17 January 2020).

The AHG used the main JVET reflector, jvet@lists.rwth-aachen.de, with [AHG11] in message headers. There were few email activities through the main reflector but many email exchanges among CE2 participants using jvet-ce@lists.rwth-aachen.de reflector with tool-specific discussions.

In total there were 22 SCC related technical contributions identified in the AHG report, among which there were 4 IBC related technical contributions and 18 Palette related technical contributions identified for this meeting. The contributions were listed in the AHG report.

Transform skip and BDPCM were also mentioned as relevant, but were not listed in this AHG report, as they are covered in AHG14.

The AHG recommended:

* To review all related contributions.
* To continue investigating SCC coding tool performance, complexity and interactions between these and other coding tools.
* To continue evaluating new test materials.

[JVET-Q0012](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9372) JVET AHG report: High-level parallelism and coded picture regions (AHG12) [S. Deshpande, B. Choi, M. M. Hannuksela, R. Sjöberg, R. Skupin, W. Wan, Y.-K. Wang]

This AHG report was discussed Tuesday 7 January 2020 at 1110 (chaired by GJS).

The document summarizes activities of AHG on High-level parallelism and coded picture regions between the 16th and the 17th JVET meetings.

In the JVET email reflector, a kick-off message was sent. There were no other emails on the reflector specifically focusing on AHG12.

Input documents (total 70) related to AHG12 were listed in the AHG report, categorized as follows:

* Slice, tile information signalling (14)
* Sub-pictures/ independent coded regions (39)
* Entry point (2)
* Miscellaneous (11)
* Summaries (4)

[JVET-Q0013](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9373) JVET AHG report: Tool reporting procedure and testing (AHG13) [W.-J. Chien, J. Boyce, W. Chen, Y.-W. Chen, R. Chernyak, K. Choi, R. Hashimoto, Y.-W. Huang, H. Jang, R.-L. Liao, S. Liu]

This AHG report was discussed Wednesday 8 January 2020 at 1505 (chaired by GJS & JRO).

This document summarizes the activity of AHG13: “Tool reporting procedure” between the 16th meeting in Geneva, CH (1–11 Oct 2019) and the 17th Meeting in Brussels, BE (7–17 Jan. 2020). Tool on/off experimental results vs. VTM anchor are provided for the tools specified in JVET-P2005.

The initial version of JVET-P2005 “Methodology and reporting template for tool testing” was provided on November 28th.

All tests described in JVET-P2005 were conducted. VTM tool tests were conducted on VTM-7.0 (or VTM-7.1 for adaptive colour transform) 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.

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Tool Name** | **Acronym** | **Document reference(s)** | **AI** | **RA** | **LD** | **Tester** | **Crosscheck** |
| Chroma separate tree | CST | JVET-N0137, JVET-P0063, JVET-P0406 | X | X | X | Tzu-Der Chuang (peter.chuang@mediatek.com) | Wei-Jung Chien (wchien@qti.qualcomm.com) |
| Dependent quantization\* | DQ | JVET-M0173, JVET-M0251, JVET-M0470, JVET-P0170 | X | X | X | Tzu-Der Chuang (peter.chuang@mediatek.com) | Wei Chen (wei.chen@interdigital.com) |
| Cross-component linear model | CCLM | JVET-O1124 | X | X | X | Roman Chernyak (chernyak.roman@huawei.com) | Shan Liu (shanl; leolzhao@ tencent.com) |
| multiple transform set | MTS | JVET-O0294, JVET-O0474, JVET-O0541, | X | X | X | Kiho Choi (kiho14.choi@samsung.com) | Shan Liu (shanl; xinzzhao@ tencent.com) |
| Adaptive loop filter | ALF | JVET-O0064, JVET-O0090, JVET-O0216, JVET-O0228, JVET-O0247, JVET-O0625, JVET-O0662, JVET-O0669, JVET-P0162, JVET-P0164, JVET-P0505, JVET-P0554, JVET-P0665, JVET-P1038, | X | X | X | Wei-Jung Chien (wchien@qti.qualcomm.com) | Wei Chen (wei.chen@interdigital.com) |
| Affine motion model | AFF | JVET-O0070 |  | X | X | Roman Chernyak (chernyak.roman@huawei.com) | Shan Liu (shanl; guichunli@ tencent.com) |
| subblock-based temporal merging candidates | SbTMVP | JVET-O0163, JVET-O0220, JVET-P0385 |  | X | X | Shan Liu  (shanl; guichunli@ tencent.com) | Wei-Jung Chien (wchien@qti.qualcomm.com) |
| Adaptive motion vector resolution | AMVR | JVET-O0057 |  | X | X | Shan Liu (shanl; guichunli@ tencent.com) | Wei-Jung Chien (wchien@qti.qualcomm.com) |
| Triangular partition mode | TPM | JVET-O0265, JVET-P0530 | X | X | X | Kiho Choi (kiho14.choi@samsung.com) | Shan Liu (shanl; leolzhao@ tencent.com) |
| Bi-directional optical flow | BDOF | JVET-O0055, JVET-O0304, JVET-O0570, JVET-O0594, JVET-P0091, JVET-P0519, JVET-P1023 |  | X |  | Kiho Choi (kiho14.choi@samsung.com) | Tzu-Der Chuang (peter.chuang@mediatek.com) |
| Combined intra/inter prediction | CIIP | JVET-O0108, JVET-O0681 |  | X | X | Kiho Choi (kiho14.choi@samsung.com) | Tzu-Der Chuang (peter.chuang@mediatek.com) |
| Merge with MVD | MMVD | JVET-N0127,  JVET-N0332, JVET-N0448, JVET-N0380, JVET-P1023 |  | X | X | Kiho Choi (kiho14.choi@samsung.com) | Hyeongmun Jang ([hm.jang@lge.com](mailto:hm.jang@lge.com)) |
| Bi-predictive with CU weights | BCW | JVET-O0366, JVET-P0280 |  | X | X | Wei Chen (wei.chen@interdigital.com) | Tzu-Der Chuang (peter.chuang@mediatek.com) |
| Multi-reference line prediction | MRLP | JVET-O0426, JVET-P0418 | X | X | X | Shan Liu (shanl; leolzhao@ tencent.com) | Hyeongmun Jang (hm.jang@lge.com) |
| Intra block copy mode | IBC | JVET-O0078, JVET-O0162, JVET-O0258, JVET-O0455, JVET-O1170, JVET-P0400, JVET-P0457, JVET-P1018 | X | X | X | Shan Liu (shanl; xiaozhongxu@ tencent.com) | Wei-Jung Chien (wchien@qti.qualcomm.com) |
| Intra sub-partitioning | ISP | JVET-O0106, JVET-O0341, JVET-O0502 | X | X | X | Roman Chernyak (chernyak.roman@huawei.com) | Hyeongmun Jang (hm.jang@lge.com) |
| Decoder motion vector refinement | DMVR | JVET-O0297, JVET-O0590, JVET-O0634 |  | X |  | Wei Chen (wei.chen@interdigital.com) | Roman Chernyak  ([chernyak.roman@huawei.com](mailto:chernyak.roman@huawei.com)) |
| Sub-block transform | SBT | JVET-M0140, JVET-P1026 |  | X | X | Roman Chernyak (chernyak.roman@huawei.com) | Shan Liu (shanl; xinzzhao@ tencent.com) |
| Luma mapping with chroma scaling | LMCS | JVET-O0272, JVET-O0428, JVET-O1109, JVET-P0254, JVET-P0371 | X | X | X | Taoran Lu (tlu@dolby.com) | Hyeongmun Jang (hm.jang@lge.com) |
| Symmetric motion vector difference | SMVD | JVET-O0284, JVET-O0414, JVET-O0567, JVET-O0572 |  | X |  | Yi-Wen Chen(yiwenchen@kwai.com) | Hyeongmun Jang (hm.jang@lge.com) |
| Quantized residual DPCM | BDPCM | JVET-O0315, JVET-O1136, JVET-P0059 | X | X | X | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) | Yi-Wen Chen(yiwenchen@kwai.com) |
| Matrix based intra prediction | MIP | JVET-O0925, JVET-P0054, JVET-P0199, JVET-P0803 | X | X | X | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) | Yi-Wen Chen(yiwenchen@kwai.com) |
| Low frequency non-separable transform | LFNST | JVET-O0094, JVET-O0213, JVET-O0219, JVET-O0368, JVET-O0472, JVET-O0529, JVET-P1026, JVET-P0350 | X | X | X | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) | Yi-Wen Chen(yiwenchen@kwai.com) |
| Joint coding of chrominance residuals | JCCR | JVET-N0054 | X | X | X | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) | Yi-Wen Chen(yiwenchen@kwai.com) |
| Sampled-adaptive offset | SAO | HEVC | X | X | X | Tzu-Der Chuang (peter.chuang@mediatek.com) | Wei Chen (wei.chen@interdigital.com) |
| Prediction refinement using optical flow | PROF | JVET-O0070, JVET-P0409, JVET-P0057, JVET-P0154, JVET-P0491, JVET-P0653 |  | X | X | Wei Chen (wei.chen@interdigital.com) | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) |
| Palette coding mode\*\* | PLT | JVET-P0077 | X | X | X | Yung-Hsuan Chao (yunghsua@qti.qualcomm.com) | Yi-Wen Chen(yiwenchen@kwai.com) |
| Adaptive colour transform\*\*\* | ACT | JVET-P0517 | X | X | X | Xiaoyu Xiu (xiaoyuxiu@kwai.com) | Shan Liu (shanl; xinzzhao@ tencent.com) |

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

\*\* Test was conducted with test sequences and test condition defined in JVET-P2022.

\*\*\* Test was conducted Test sequences and test condition are defined in JVET-P0517.

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-6.0/>

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

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

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **AI** |  |  |  |
| **Acronym** | **BDR-Y** | **BDR-U** | **BDR-V** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| CST | 0.35% | 9.34% | 9.26% | 152% | 103% | 154% | 103% |
| DQ | 1.99% | -0.66% | -0.73% | 99% | 101% | 96% | 104% |
| CCLM | 1.61% | 14.73% | 15.86% | 100% | 100% | 100% | 98% |
| MTS | 1.22% | 0.98% | 1.07% | 81% | 98% | 86% | 101% |
| ALF | 2.37% | 2.91% | 3.62% | 98% | 91% | 96% | 92% |
| MRLP | 0.32% | 0.10% | 0.14% | 98% | 101% | 98% | 101% |
| IBC | 0.65% | 0.62% | 0.66% | 54% | 100% | 58% | 99% |
| ISP | 0.52% | 0.29% | 0.26% | 85% | 98% | 85% | 98% |
| LMCS | 1.09% | -1.11% | -0.71% | 99% | 99% | 98% | 98% |
| BDPCM | 0.01% | 0.04% | -0.01% | 94% | 100% | 98% | 105% |
| MIP | 0.61% | 0.16% | 0.17% | 89% | 101% | 86% | 96% |
| LFNST | 1.20% | 0.72% | 1.03% | 111% | 101% | 107% | 98% |
| JCCR | 0.59% | 0.28% | 0.41% | 98% | 100% | 96% | 98% |
| SAO | 0.00% | 0.15% | 0.17% | 100% | 96% | 100% | 97% |

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **RA** |  |  |  |
| **Acronym** | **BDR-Y** | **BDR-U** | **BDR-V** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| CST | 0.10% | 3.78% | 4.53% | 104% | 100% | 102% | 100% |
| DQ | 1.76% | -0.25% | -0.52% | 104% | 98% | 99% | 102% |
| CCLM | 1.02% | 11.85% | 13.71% | 99% | 100% | 99% | 100% |
| MTS | 0.70% | 0.56% | 0.72% | 90% | 100% | 93% | 100% |
| ALF | 4.56% | 4.93% | 4.94% | 98% | 89% | 96% | 90% |
| AFF | 3.01% | 2.04% | 2.00% | 81% | 96% | 82% | 97% |
| SbTMC | 0.46% | 0.32% | 0.36% | 101% | 101% | 101% | 100% |
| AMVR | 1.42% | 2.17% | 2.27% | 84% | 101% | 85% | 102% |
| TPM | 0.38% | 0.64% | 0.68% | 95% | 100% | 98% | 101% |
| BDOF | 0.76% | 0.31% | 0.27% | 98% | 97% | 101% | 94% |
| CIIP | 0.28% | 0.01% | 0.01% | 99% | 100% | 98% | 101% |
| MMVD | 0.51% | 0.47% | 0.51% | 93% | 101% | 93% | 101% |
| BCW | 0.40% | 0.42% | 0.45% | 94% | 100% | 98% | 99% |
| MRLP | 0.16% | 0.07% | 0.10% | 100% | 100% | 100% | 100% |
| IBC | -0.04% | 0.05% | 0.05% | 91% | 100% | 91% | 100% |
| ISP | 0.32% | 0.24% | 0.31% | 95% | 100% | 96% | 100% |
| DMVR | 0.83% | 1.08% | 1.10% | 100% | 97% | 100% | 97% |
| SBT | 0.40% | -0.03% | -0.01% | 95% | 100% | 95% | 100% |
| LMCS | 1.42% | 1.39% | 0.96% | 95% | 98% | 94% | 98% |
| SMVD | 0.25% | 0.25% | 0.26% | 93% | 97% | 97% | 101% |
| BDPCM | -0.01% | -0.04% | -0.05% | 99% | 100% | 103% | 103% |
| MIP | 0.33% | 0.40% | 0.52% | 95% | 100% | 92% | 97% |
| LFNST | 0.88% | 0.02% | 0.49% | 94% | 100% | 91% | 98% |
| JCCR | 0.57% | 0.04% | -0.52% | 98% | 100% | 94% | 97% |
| SAO | 0.08% | 0.20% | 0.33% | 100% | 98% | 100% | 98% |
| PROF | 0.46% | 0.16% | 0.13% | 98% | 99% | 98% | 98% |

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **LDB** |  |  |  |
| **Acronym** | **BDR-Y** | **BDR-U** | **BDR-V** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| CST | 0.00% | 1.34% | 2.21% | 110% | 97% | 100% | 98% |
| DQ | 1.56% | 0.29% | -0.05% | 109% | 99% | 100% | 102% |
| CCLM | 0.01% | 3.39% | 3.69% | 100% | 100% | 100% | 99% |
| MTS | 0.53% | 0.12% | 0.10% | 99% | 100% | 98% | 98% |
| ALF | 4.26% | 5.11% | 4.67% | 96% | 90% | 94% | 90% |
| AFF | 2.96% | 1.90% | 2.29% | 74% | 94% | 75% | 96% |
| SbTMC | 0.78% | 0.86% | 0.78% | 101% | 97% | 101% | 97% |
| AMVR | 0.60% | 0.83% | 0.67% | 86% | 100% | 87% | 101% |
| TPM | 0.92% | 1.29% | 1.25% | 97% | 102% | 97% | 100% |
| CIIP | 0.39% | 0.46% | 0.48% | 99% | 100% | 97% | 97% |
| MMVD | 0.45% | 0.34% | 0.36% | 96% | 100% | 95% | 100% |
| BCW | 0.28% | 0.17% | 0.10% | 100% | 103% | 97% | 99% |
| MRLP | 0.05% | -0.36% | -0.04% | 100% | 100% | 100% | 100% |
| IBC | -0.01% | -0.01% | -0.06% | 85% | 100% | 85% | 100% |
| ISP | 0.07% | -0.05% | 0.13% | 99% | 100% | 99% | 99% |
| SBT | 0.57% | -0.22% | -0.13% | 93% | 99% | 93% | 98% |
| LMCS | 0.97% | -0.59% | -0.86% | 97% | 99% | 94% | 95% |
| BDPCM | 0.03% | 0.28% | 0.01% | 99% | 100% | 102% | 103% |
| MIP | 0.17% | 0.48% | 0.49% | 95% | 103% | 103% | 99% |
| LFNST | 0.42% | 0.09% | -0.07% | 92% | 103% | 108% | 98% |
| JCCR | 0.15% | 1.92% | 2.55% | 99% | 98% | 97% | 99% |
| SAO | 0.09% | 0.36% | 0.93% | 101% | 99% | 100% | 96% |
| PROF | 0.33% | -0.03% | 0.00% | 98% | 98% | 97% | 92% |

Table 7 Simulation results for screen coding tools for ClassF and ClassTGM (VTM anchor)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **AI** |  |  |  |
| **Acronym** | **BDR-Y** | **BDR-U** | **BDR-V** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| IBC Class F | 15.22% | 15.16% | 15.31% | 54% | 101% | 57% | 99% |
| IBC Class TGM | 47.19% | 44.63% | 44.63% | 64% | 103% | 67% | 103% |
| BDPCM ClassF | 0.92% | 0.81% | 0.95% | 98% | 100% | 96% | 93% |
| BDPCM ClassTGM | 1.39% | 1.27% | 1.24% | 101% | 102% |  |  |
|  |  |  |  | **RA** |  |  |  |
| IBC Class F | 12.19% | 12.14% | 12.29% | 85% | 100% | 88% | 100% |
| IBC Class TGM | 22.12% | 21.66% | 22.06% | 88% | 102% | 102% | 105% |
| BDPCM ClassF | 0.68% | 0.66% | 0.70% | 99% | 100% | 94% | 95% |
| BDPCM ClassTGM | 0.70% | 0.75% | 0.78% | 100% | 101% |  |  |
|  |  |  |  | **LD** |  |  |  |
| IBC Class F | 6.04% | 6.85% | 6.63% | 84% | 101% | 86% | 99% |
| IBC Class TGM | 11.33% | 12.03% | 12.34% | 84% | 105% | 95% | 102% |
| BDPCM ClassF | 0.45% | -0.18% | 0.90% | 99% | 101% | 97% | 97% |
| BDPCM ClassTGM | 0.27% | 0.08% | 0.14% | 100% | 100% |  |  |

Table 8 Simulation results of coding tools for color space 4:4:4 (VTM anchor)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **AI** |  |  |  |
| **Acronym** | **BDR-Y** | **BDR-U** | **BDR-V** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| PLT | 11.35% | 14.77% | 15.95% | 98% | 108% | 98% | 107% |
| ACT, RGB | 10.61% | 2.74% | 3.57% | 104% | 100% | 98% | 102% |
|  |  |  |  | **RA** |  |  |  |
| PLT | 7.83% | 10.48% | 11.87% | 99% | 101% | 100% | 102% |
| ACT, RGB | 19.12% | 6.66% | 8.27% | 104% | 100% | 97% | 101% |
|  |  |  |  | **LD** |  |  |  |
| PLT | 3.98% | 7.23% | 8.24% | 96% | 101% | 96% | 99% |
| ACT, RGB | 28.47% | 9.24% | 11.13% | 103% | 100% | 98% | 101% |

Table 9 Luma sample usage and memory bandwidth results of VTM tool “off” test. (VTM anchor)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | AI |  | RA |  |  | LDB |  |
| Acronym | Sample usage | Sample usage | Ave mem BW | Max mem BW | Sample usage | Ave mem BW | Max mem BW |
| CCLM | 48.72% | 3.71% |  |  | 0.80% |  |  |
| ALF | 99.00% | 54.96% |  |  | 51.76% |  |  |
| AFF |  | 19.05% |  |  | 28.61% |  |  |
| SBTMC |  | 11.54% |  |  | 14.55% |  |  |
| AMVR |  | 5.44% |  |  | 2.59% |  |  |
| TPM |  | 2.09% |  |  | 5.55% |  |  |
| BDOF |  | 44.56% |  |  |  |  |  |
| CIIP |  | 0.86% |  |  | 1.46% |  |  |
| MMVD |  | 6.98% |  |  | 8.42% |  |  |
| BCW |  | 9.83% |  |  | 8.02% |  |  |
| MRLP | 6.41% | 0.59% |  |  | 0.24% |  |  |
| DMVR |  | 39.82% |  |  |  |  |  |
| SBT |  | 2.50% |  |  | 3.91% |  |  |
| SMVD |  | 2.80% |  |  |  |  |  |
| MIP | 23.73% | 5.12% |  |  | 2.44% |  |  |
| LFNST | 9.41% | 0.86% |  |  | 0.39% |  |  |
| JCCR | 10.81% | 0.52% |  |  | 0.12% |  |  |
| SAO | 31.33% | 7.10% |  |  | 7.88% |  |  |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **VTM RA** |  |  |
| **Abbreviation** | **VTM3** | **VTM4** | **VTM5** | **VTM6** | **VTM7** |
| CST | 0.74% | 1.25% | 1.47% | 0.99% | 0.91% |
| DQ | 1.39% | 1.36% | 1.24% | 1.32% | 1.33% |
| CCLM | 4.09% | 4.20% | 4.00% | 3.33% | 3.37% |
| MTS | 1.25% | 0.80% | 0.36% | 0.68% | 0.69% |
| ALF | 3.61% | 3.73% | 4.79% | 4.65% | 4.64% |
| AFF | 2.42% | 2.46% | 2.38% | 2.84% | 2.81% |
| SbTMVP | 0.52% | 0.43% | 0.40% | 0.48% | 0.44% |
| AMVR | 0.98% | 1.13% | 1.14% | 1.59% | 1.58% |
| TPM | 0.43% | 0.43% | 0.41% | 0.39% | 0.44% |
| BDOF | 1.02% | 0.63% | 0.66% | 0.68% | 0.67% |
| CIIP | 0.43% | 0.51% | 0.31% | 0.24% | 0.23% |
| MMVD | 0.81% | 0.52% | 0.59% | 0.52% | 0.51% |
| BCW | 0.48% | 0.45% | 0.45% | 0.43% | 0.41% |
| MRLP | 0.24% | 0.18% | 0.16% | 0.18% | 0.15% |
| IBC | 0.07% | 0.00% | 0.05% | -0.01% | -0.02% |
| ISP |  | 0.24% | 0.12% | 0.20% | 0.31% |
| DMVR |  | 0.80% | 0.87% | 0.87% | 0.88% |
| SBT |  | 0.33% | 0.33% | 0.32% | 0.32% |
| LMCS |  | 0.62% | 0.57% | 1.03% | 1.37% |
| SMVD |  | 0.26% | 0.24% | 0.27% | 0.26% |
| BDPCM |  |  | -0.02% | -0.03% | -0.01% |
| MIP |  |  | 0.27% | 0.32% | 0.36% |
| LFNST |  |  | 0.75% | 0.61% | 0.76% |
| JCCR |  |  | 0.34% | 0.42% | 0.41% |
| SAO | 0.81% | 0.64% | 0.17% | 0.13% | 0.12% |
| PROF |  |  |  | 0.41% | 0.40% |

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

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)

The AHG recommends the following:

* Consider the reported tool test results during tool adoption decision making
* Review related contributions
* Refine list of tested tools and test methodology for the next meeting cycle
  + Consider the reported tool test results as a benchmark for CE tests
  + Consider including reporting of compute system information for testers and cross-checkers

Three tools were mentioned as having less than 0.3% BD benefit in RA configuration without a compensating subjective rationale:

* Combined intra/inter prediction (CIIP)
* Multi-reference line prediction (MRLP)
* Symmetric motion vector difference (SMVD)

It was commented that it would not be difficult to somewhat improve the CIIP with encoder optimization if that is desired.

It was commented that these three features are not difficult from a decoder perspective.

It was also commented that design stability favours not making changes, that people have already started implementing the draft standard, and that the tradeoffs are sometimes quite different in a real implementation. There are also interactions between features, such that trying to remove things could have unexpected side effects.

It was noted that the adaptive colour transform (ACT) is primarily intended for RGB content and does not provide a significant benefit for YCbCr sequences.

It was noted that we do not have a CTC for 4:4:4, and it was suggested that such CTC should be established.

It was also suggested that having a way to routinely test RPR would be desirable (although the rationale for this was suggested for a somewhat different purpose – just testing whether the feature functions properly). Having a way of exercising and testing the coding efficiency impact of tiles was also suggested.

As noted previously, it would be highly desirable to improve the test sequence selection for SCC.

Development of the following types of tests was planned:

* The CE2 coordinators were asked to work on preparing a CTC (which should include both camera and SCC content and RGB as well as YCbCr content and 4:4:4, 4:2:2 and monochrome testing).
* For an RPR functionality confirmation testing (FCT) output, we can base this on the prior CE test scheme. J. Luo volunteered to prepare that.
* For lossless and near lossless, we can produce CTC based on CE3 conditions, requesting this to be prepared by the CE3 coordinators.

Revisit for review of drafts.

[JVET-Q0014](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9374) JVET AHG report: Lossless and near-lossless coding (AHG14) [T. Nguyen, T.-C. Ma, M. Ikeda, H. Jang, X. Zhao]

This AHG report was discussed Wednesday 8 January 2020 at 1445 (chaired by GJS & JRO).

This document reports the activity of AHG 14 on lossless and near-lossless coding tools between the 16th JVET meeting in Geneva and the 17th Meeting in Brussels.

Discussions related to AHG14 used the JVET email reflector ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de)), and the AHG chairs sent a kick-off message on 28th October 2019. No emails have been exchanged related to the AHG. The AHG chairs provided a software implementation (encoder only) that enables lossless capability in VTM-7.0. The performance of VTM-7.0 are as follows.

The results for HEVC RExt relative to HEVC Main/Main10 are as follows using HM-16.20 and CE3 test conditions.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | **Random Access** | | |
| **ratio** | | bit-rate impact | **ratio** | | bit-rate savings |
| HM-16.20 | HM-16.20 Rext | HM-16.20 | HM-16.20 Rext |
| Class A1 | 2.2 | 2.3 | -4.50% | 2.3 | 2.4 | -3.88% |
| Class A2 | 1.7 | 1.8 | -5.88% | 1.8 | 1.9 | -4.52% |
| Class B | 2.2 | 2.3 | -5.06% | 2.3 | 2.4 | -2.59% |
| Class C | 1.9 | 2.0 | -5.42% | 2.5 | 2.5 | -2.22% |
| Class D | 1.9 | 2.1 | -7.85% | 2.8 | 2.9 | -2.56% |
| Class E | 2.7 | 3.0 | -8.22% |  |  |  |
| Class F | 4.5 | 5.2 | -12.17% | 26.6 | 30.6 | -8.54% |
| TGM | 6.1 | 8.1 | -22.91% | 74.4 | 99.5 | -20.65% |
| **Overall** | **2.1** | **2.3** | **-5.71%** | **2.3** | **2.3** | **-3.14%** |
| Enc Time[%] | 95% | | | 105% | | |
| Dec Time[%] | 93% | | | 90% | | |

The results for VVC VTM-7.0 relative to HEVC Main/Main10 are as follows.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | **Random Access** | | |
| **ratio** | | bit-rate impact | **ratio** | | bit-rate savings |
| HM-16.20 | VTM-7.0 | HM-16.20 | VTM-7.0 |
| Class A1 | 2.2 | 2.2 | -0.24% | 2.3 | 2.2 | 1.49% |
| Class A2 | 1.7 | 1.6 | 5.96% | 1.8 | 1.7 | 5.45% |
| Class B | 2.2 | 2.2 | -0.30% | 2.3 | 2.3 | 0.11% |
| Class C | 1.9 | 1.9 | -0.36% | 2.5 | 2.4 | 1.55% |
| Class D | 1.9 | 1.9 | -0.82% | 2.8 | 2.8 | 1.20% |
| Class E | 2.7 | 2.8 | -2.18% |  |  |  |
| Class F | 4.5 | 5.3 | -13.28% | 26.6 | 33.7 | -10.55% |
| TGM | 6.1 | 11.8 | -44.31% | 74.4 | 107.1 | -30.87% |
| **Overall** | **2.1** | **2.1** | **0.43%** | **2.3** | **2.2** | **1.84%** |
| Enc Time[%] | 3133% | | | 1339% | | |
| Dec Time[%] | 172% | | | 136% | | |

The results for VVC VTM-7.0 relative to HEVC RExt are as follows.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | **Random Access** | | |
| **ratio** | | bit-rate impact | **ratio** | | bit-rate savings |
| HM-16.20 Rext | VTM-7.0 | HM-16.20 Rext | VTM-7.0 |
| Class A1 | 2.3 | 2.2 | 4.47% | 2.4 | 2.2 | 5.59% |
| Class A2 | 1.8 | 1.6 | 12.66% | 1.9 | 1.7 | 10.50% |
| Class B | 2.3 | 2.2 | 5.06% | 2.4 | 2.3 | 2.81% |
| Class C | 2.0 | 1.9 | 5.37% | 2.5 | 2.4 | 3.86% |
| Class D | 2.1 | 1.9 | 7.65% | 2.9 | 2.8 | 3.86% |
| Class E | 3.0 | 2.8 | 6.59% |  |  |  |
| Class F | 5.2 | 5.3 | -1.51% | 30.6 | 33.7 | -2.52% |
| TGM | 8.1 | 11.8 | -28.31% | 99.5 | 107.1 | -12.06% |
| **Overall** | **2.3** | **2.1** | **6.55%** | **2.3** | **2.2** | **5.18%** |
| Enc Time[%] | 3285% | | | 1270% | | |
| Dec Time[%] | 185% | | | 151% | | |

The related input contributions were discriminated into three groups:

* AHG14 related: high throughput and lossless operation mode (4)
* CE3 related: proposals further improving the lossless performance (see section 5.3)
* CE3 input documents: input documents for the tests conducted in CE3 (see section 6.3)

The AHG recommended:

* To review all related contributions
* To continue the investigation on lossless and near-lossless performance of VVC
  + for high throughput
  + for chroma 4:4:4 chroma format

It was noted that these results do not include comparison with the SCC profiles of HEVC, which affects class F and TGM test sequences.

A benefit relative to HEVC was not evident in general. Contributions to the current meeting showed that it is feasible to improve that behaviour.

[JVET-Q0015](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9375) JVET AHG report: Quantization control (AHG15) [R. Chernyak, E. François, C. Helmrich, S. McCarthy, A. Segall]

This AHG report was discussed Wednesday 8 January 2020 at 1555 (chaired by GJS & JRO).

This document summarizes the activity of AHG15: Quantization control between the 16th meeting in Geneva, CH (1-11, Oct. 2019 and the 17th meeting in Brussels, BE (7-17, Jan. 2019).

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

Input documents related to AHG15 were summarized as follows

***Quantization matrices related (4)***

1. [JVET-Q0148](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0148-v1.zip), AHG15: Additional coefficients for low frequency region of 64x64 scaling matrix, K. Abe, T. Toma (Panasonic).
2. [JVET-Q0421](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0421-v1.zip), AHG15: Clean up for signaling quantization matrix, Hendry, J. Zhao, S. Kim (LGE).
3. [JVET-Q0472](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0472-v2.zip), AHG15: Quantization matrix signalling, P. de Lagrange, F. Leléannec, E. François, K. Naser (InterDigital).
4. [JVET-Q0505](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0505-v1.zip), AHG15: Improvement for Quantization Matrix Signaling, H. Zhang, X. Li, G. Li, L. Li, S. Liu (Tencent).

***Chroma QP offsets related (8)***

1. [JVET-Q0126](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0126-v1.zip), Initializations and propagation of Chroma QP Offset, K. Kawamura, S. Naito (KDDI).
2. [JVET-Q0209](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0209-v1.zip), [AHG9][AHG15]: On chroma Qp offsets, Hendry, J. Zhao, S. Kim (LGE).
3. [JVET-Q0267](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0267-v1.zip), AHG16: On Propagation of Chroma CU QP Offsets, B. Heng, M. Zhou, W. Wan (Broadcom).
4. [JVET-Q0425](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0425-v1.zip), AHG15: QP offsets for adaptive colour transform, R. Sjöberg, M. Pettersson, M. Damghanian, D. Saffar (Ericsson).
5. [JVET-Q0476](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0476-v1.zip), On chroma QP offsets for zero-CBF leading chroma coding blocks, A. K. Ramasubramonian, B. Ray, G. Van der Auwera, M. Karczewicz (Qualcomm).
6. [JVET-Q0484](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0484-v1.zip), AHG9: HLS control of chroma QP offset, W. Wan, B. Heng, P. Chen, T. Hellman, M. Zhou (Broadcom).
7. [JVET-Q0570](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0570-v2.zip), AHG15: Reset chroma QP offsets when starting a CTU, P. de Lagrange (InterDigital).
8. [JVET-Q0576](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0576-v1.zip), AHG15: History of local chroma QP offsets, P. de Lagrange (InterDigital).

***QP Adjustment for Adaptive Color Transform related (3)***

1. [JVET-Q0098](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0098-v2.zip), On QP Adjustment for Adaptive Color Transform, T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony).
2. [JVET-Q0241](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0241-v1.zip), On QP adjustment in adaptive color transform, J. Jung, D. Kim, G. Ko, J.-H. Son, J. Kwak (WILUS).
3. [JVET-Q0511](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9340), On ACT QP clipping, J. Zhao, Hendry, S.-H. Kim (LGE), X. Xiu, Y.-W. Chen, T.‑C. Ma, H.-J. Jhu, X. Wang (Kwai), W. Zhu, J. Xu, L. Zhang (Bytedance).

***Others (5)***

1. [JVET-Q0142](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0142-v1.zip), Clipping of minimum QP prime value, K. Unno, K. Kawamura, S. Naito (KDDI).
2. [JVET-Q0227](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0227-v1.zip), Dependent Quantization with Qp offset adaptation, P. de Lagrange, F. Hiron, F. Le Léannec, E. Francois (InterDigital).
3. [JVET-Q0410](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0410-v1.zip), AHG12: Bitstream merging with variable initial Qp, N. Ouedraogo, E. Nassor, G. Kergourlay, F. Mazé (Canon).
4. [JVET-Q0473](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0473-v2.zip), AHG15: Demultiplexing joint CbCr before dequantization, P. de Lagrange, F. Leléannec, E. François, P. Bordes (InterDigital).
5. [JVET-Q0474](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/17_Brussels/wg11/JVET-Q0474-v2.zip), AHG15: defining QP at TU level, P. de Lagrange, F. Leléannec, F. Urban, K. Naser (InterDigital).

The AHG recommended to:

* Review all related contributions;
* Continue investigating VVC Quantization control techniques.

[JVET-Q0016](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9376) JVET AHG report: Implementation studies (AHG16) [M. Zhou, J. An, E. Chai, K. Choi, S. Sethuraman, T. Hsieh, X. Xiu]

This AHG report was discussed Wednesday 8 January 2020 at 1600 (chaired by GJS & JRO).

This document summarizes the activity of AHG16: Implementation studies, between the 16th JVET meeting in Geneva, CH (1–11 October 2019) and the 17th JVET meeting in Brussels, BE (7–17 January 2020).

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

Topics discussed on the email reflector

Entry point offset signalling:

1. In the current design the signalling of entry point offsets is optional for tiles.
2. It was commented that without entry point offsets decoder implementation of raster scan order processing is impossible for single slice/multi-tile streams.
3. It was suggested that if the signaling of entry point offset in ES is optional the system level spec definition of entry point offsets be made mandatory.
4. It was commented without mandating tiles parallel decoding is not guaranteed even if the entry point offsets are made mandatory, unless the parsing and pixel processing are fully decoupled (in which case, however, decoder implementation of raster scan order processing is possible without entry point offsets).
5. It was further commented that even if entry point offsets are made mandatory the parallel parsing/decoding may still be not be guaranteed because of bit-rate unbalancing among tiles.
   1. **Feedback provided on tools being tested in CEs**
6. CE4 GEO (Geometric partitions)
   1. The JVET-P0884/ JVET-P0885 (a combination of JVET-P0107/JVET-P0264/JVET-P0304) version of GEO removes the original GEO elements of partial transform and deriving the motion mask from the blending mask, which addresses the majority of implementation concerns.
   2. The newly proposed slope-based GEO (JVET-P0107/JVET-P0264) removes the multiplications from the blending mask/motion mask derivation and provides a second option of on-the-fly derivation. This simplifies the design and provides more implementation flexibility. There is no big difference between those two options in terms of implementation complexity. Compared to other designs such as the one tested in CE4-1.14, this kind of simplification does not seem to be critical if it hurts coding efficiency (visual quality).
   3. The newly proposed idea of deriving the blending/motion mask of different sizes by cropping directly from the pre-stored masks of the largest sizes would be the simplest because only (offsetX, offsetY) needs to be computed at CU level. However, this is not practical for implementation as it is too costly due to the large table size (still needs about ~300 KB for 80 modes according to JVET-P0304). Not sure whether giving up on this would help improve coding efficiency and/or simplify the design.
   4. It is desirable to reduce the number of GEO partitions and supported PU sizes. In particular, PU sizes of 64x128/128x64/128x128 should be disabled.  JVET-P0663 and JVET-P0107 have some good ideas that are worth trying out. Unlike the angular intra prediction in which a subset of the modes supported by a less capable encoder still provides decent gain (the angular intra prediction has increased from 9 modes in AVC to 33 modes in HEVC, and to 65 modes in VVC), the GEO design of JVET-P0884/JVET-P0885 does not seem to be quality scalable on the encoder side. Using the JVET-P0884 code and supporting the first 16 modes out of 82 modes on the encoder side led to 0.19% loss in RA as opposed to -0.22% RA gain if all the 82 modes would be supported. It would be more practical to support a reasonable amount of partitions and PU sizes. Otherwise, the GEO becomes just an off-line coding tool, but imposes unnecessary burden on the testing and verification of decoder designs. As a comparison, the wedge mode has 16 partitions and supports 9 PU sizes in an existing standard.
   5. The last round of subjective testing is disappointing in many senses. Nevertheless, it might be worth testing it again to make sure that the proposed technology at least does not hurt visual quality.
7. CE5 Cross-Component ALF (CCALF)
   1. Recommended adding the combination tests of the CE anchor with the joint Cb/Cr CC-ALF and the multiplication removal, to see whether further reduction of buffering and multiplication costs is possible without compromising coding efficiency.
8. CE3 Lossless mode
   1. In terms of signalling, lots of tests seem to assume that a picture or a slice is either entirely coded in lossy or in lossless mode, but the real use case might be that only portion of a picture/slice is coded in lossless mode.
      1. Examples include: TSRC/RRC switch in CE3-1.3, CE3-2.3/2.4, CE3-2.5.3, residual rotation in CE3-1.4 and lossless IBC blocks using RRC in CE3-2.6/2.7.
      2. Signalling using high-level flags to control those switches may not be sufficient in mixed lossy/lossless coding environment.
   2. Also, the high-level signalling used in CE3-2.5.1/CE3-2.5.2 (TU/CU level TSRC/RRC switch) may not be that relevant.
   3. **Additional comments posted on the email reflector**
9. With the adoption of JVET-P1001, the actual chroma QPs (instead of QPs derived from luma QPs) are now used for chroma de-blocking, including those for not-coded TUs. However, in the current design the chroma QP derivation for not-coded TUs is not defined. The spec is broken in this regard and needs to be fixed.
10. In the current spec text **alf\_chroma\_num\_alt\_filters\_minus1** is signalled using ue(v) but no maximum value for this element is defined, which leads to unbounded ALF APS size.  In the adopted test of JVET-O0090 variant CE5-4.2 and in VTM7.0 the maximum number of alternative chroma ALF filter sets is set to 8. (Note: the spec text is since fixed)
11. The adoption of JVET-P1026 has opened up the possibility of signaling non-zero MTS coefficients outside the top-left 16x16 TU region. The current design of checking last\_sig\_coeff\_pos <= (15, 15) does not guarantee at syntax level that all coefficients outside 16x16 are zero. The temporary fix is to impose a bitstream restriction, but a much more preferred solution is to prevent it at syntax level.
12. At the last meeting the chroma transform skip was adopted to support lossless mode, but the combination of LFNST and chroma TS was not disabled in the syntax table. Due to the adoption of JVET-P0365 which can disable scaling lists for LFNST, a decoder does not know what kind of inverse quantization and inverse transform to apply before the lfnst\_idx is decoded, which is signaled at the end of CU after luma/chroma transform coefficients. Allowing the combination of chroma TS and LFNST doubles transform coefficient buffering and processing latency.

* 1. **Memory bandwidth study for VTM7.0**

Broadcom conducted a memory bandwidth study by running both the VTM7.0 and VTM6.0 for CTC with a commercial motion compensation cache model integrated. The summary results of the random access configuration are provided in the table below (for informational purposes).

For class F, the peak memory bandwidth consumption (see MBW\_diff column) has roughly 2% increases for non-obvious reasons.

***Memory bandwidth comparison (VTM7.0 vs. VTM6.0, RA)***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access Main 10** | | | | | | | |
|  | **Over VTM-6.0** | | | | | | | |
|  | Y | U | V | TCM\_diff | ABW\_diff | MBW\_diff | EncT | DecT |
| Class A1 | 0.00% | -3.16% | -2.57% | -0.17% | -0.14% | -0.64% | 97% | 96% |
| Class A2 | 0.26% | -1.39% | -1.61% | 0.22% | 0.28% | 0.94% | 102% | 99% |
| Class B | 0.00% | -2.65% | -2.09% | 0.20% | 0.21% | 0.40% | 95% | 92% |
| Class C | 0.08% | -2.90% | -2.66% | 0.22% | 0.20% | -0.24% | 98% | 96% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | 0.07% | -2.56% | -2.24% | 0.12% | 0.14% | 0.12% | 98% | 95% |
| Class D | 0.17% | -1.76% | -1.81% | 0.36% | 0.39% | -1.05% | 92% | 104% |
| Class F (optional) | 0.51% | -1.59% | -1.24% | 1.77% | 2.40% | 1.85% | 101% | 103% |

Where

* TCM\_diff : Total cache misses (over all the frames coded), percentage difference relative to VTM6.0.
* ABW\_diff: Average memory bandwidth (over all the frames coded), percentage difference relative to VTM6.0.
* MBW\_diff : Worst case (Max) memory bandwidth (among all the frames coded), percentage difference relative to VTM6.0.

MBW\_diff is the most important measure, which shows the worst case memory bandwidth consumption difference of VTM7.0 relative to VTM6.0.

* 1. **Bin to bit ratio study for VTM7.0**

JVET-Q0102 reports that the bin to bit ratio remains unchanged from VTM6.0 to VTM7.0. As far as the low-QP (QP =2, 7, 12, 17) AI configuration is concerned, the weighted and un-weighted bin to bit ratio of the VTM7.0 is roughly 18% and 10% higher than that of HM16.19, respectively.

In the weighted bin to bit ratio, a bypass bin is counted at 0.25 context coded bins; in the unweight bin to bit ratio, a bypass bin and a context coded bin carry an equal weight (1:1).

Related contributions

The following contributions are identified for the AHG.

CABAC bin to bit ratio (2)

1. JVET-Q0102, “AHG16: A study of bin to bit ratio for VTM7.0”, M. Zhou (Broadcom)
2. JVET-Q0436, “CABAC zero word threshold”, A. Browne, K. Sharman, S. Keating (Sony)

Entry point offset signalling (2)

1. JVET-Q0151, “AHG12: On entry point offset signalling”, M. Coban, Y.-J. Chang, V. Seregin, A. K. Ramasubramonian, M. Karczewicz (Qualcomm)
2. JVET-Q0205, “AHG12: On the presence of entry point signaling”, Hendry, S. Kim, S. Lee (LGE)

Chroma QP offset signalling (2)

1. JVET-Q0267, “AHG16: On Propagation of Chroma CU QP Offsets”, B. Heng, M. Zhou, W. Wan (Broadcom)
2. JVET-Q0476, “On chroma QP offsets for zero-CBF leading chroma coding blocks”, A. K. Ramasubramonian, B. Ray, G. Van der Auwera, M. Karczewicz (Qualcomm)

Maximum number of Chroma ALF filter sets (1)

1. JVET-Q0378, “Non-CE5: On the number of ALF Chroma filters”, P. Onno, G. Laroche, N. Ouedraogo (Canon)

Prevention of non-zero MTS coefficients in “zero-out” region (5)

1. JVET-Q0055, “On MTS index signaling”, J. Lainema (Nokia)
2. JVET-Q0057, “Coefficient group based restriction on MTS signaling”, M. Coban, M. Karczewicz, H.E. Egilmez, V. Seregin (Qualcomm)
3. JVET-Q0136, “Alignment of MTS index signalling condition with MTS zero-out”, M. Koo, M. Salehifar, J. Lim, S. Kim (LGE)
4. JVET-Q0430, “AHG16: Syntax based MTS zero out”, F. Le LÃ©annec, K. Naser, F. Galpin, P. Delagrange (InterDigital)
5. JVET-Q0448, “MTS dependent coefficient subblock scanning for zero-out”, S. De-Luxán-Hernández,T. Nguyen,B. Bross,H. Schwarz,D. Marpe,T. Wiegand (HHI)

Combination of LFNST with Chroma transform skip (9)

1. JVET-Q0099, “On Interaction of LFNST and Transform Skip”, T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)
2. JVET-Q0103, “LFNST Signaling for Chroma based on Chroma Transform Skip Flags”, H.E. Egilmez, A. Nalci, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)
3. JVET-Q0106, “AHG16: Combination of LFNST with transform skip”, B. Heng, T. Hellman, M. Zhou, W. Wan (Broadcom)
4. JVET-Q0126, “Initializations and propagation of Chroma QP Offset”, K. Kawamura, S. Naito (KDDI)
5. JVET-Q0138, “Separate transform skip checking of Luma and Chroma for LFNST index signaling”, M. Koo, M. Salehifar, J. Lim, S. Kim (LGE)
6. JVET-Q0193, “LFNST signalling cleanup with TS checking”, M.-S. Chiang, C.-W. Hsu, C.-M. Tsai, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)
7. JVET-Q0328, “On LFNST signalling and transform skip”, C. Rosewarne, J. Gan (Canon)
8. JVET-Q0499, “On LFNST signaling with Transform-skip mode”, T.-C. Ma, X. Xiu, Y.-W. Chen, H.-J. Jhu, X. Wang (Kwai Inc.)
9. JVET-Q0529, “On LFNST index and MTS index signaling”, Z.-Y. Lin, M.-S. Chiang, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)

Parallel merge and merge estimation region (3)

1. JVET-Q0185, “AHG16: On merge estimation region for VVC”, Y.-L. Hsiao, C.-C. Chen, C.-W. Hsu, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek), H. Huang, W.-J. Chien, T. Hsieh, V. Seregin, C.-C. Chen, K. Reuze, M. Karczewicz (Qualcomm)
2. JVET-Q0297, “AHG16: Merge estimation region with constrain in HMVP update”, H. Huang, W.-J. Chien, T. Hsieh, V. Seregin, C.-C. Chen, K. Reuze, M. Karczewicz (Qualcomm)
3. JVET-Q0356, “AHG16: Parallel Merge Estimation for VVC”, S. Esenlik, H. Gao, B. Wang, A. M. Kotra, E. Alshina (Huawei), Y.-L. Hsiao, C.-C. Chen, C.-W. Hsu, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)

VVC decoder implementation (2)

1. JVET-Q0211, “AHG16: VVC software decoder and performance analysis”, S. Gudumasu, S. Bandyopadhyay, A. Srivastava, Y. He, Y. He (InterDigital)
2. JVET-Q0386, “AHG16: Feature-rich implementation of VVC real-time decoding and playback on ARM based mobile clients”, J.Arumugam, S.Kotecha, S.Ramamurthy (Ittiam)

Other AHG16-related contributions (4)

1. JVET-Q0495, “AHG16: Simplified clip ranges for NL-ALF”, Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)
2. JVET-Q0496, “AHG16: On motion shift derivation of SbTMVP “, Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)
3. JVET-Q0500, “AHG16: On derivation of CCLM predictors”, Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)
4. JVET-Q0513, “AHG16: Clipping residual samples for JCCR”, X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai)

The AHG recommended reviewing the input contributions.

# Project development

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

## Text and software development and general guidance (1)

[JVET-Q0041](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8866) AHG2: Editorial input on VVC draft text [Y.-K. Wang (Bytedance), B. Bross (HHI), V. Drugeon (Panasonic), J. Chen (Futurewei)]

This contribution was discussed Wednesday 8 January 2020 at 1015 (chaired by GJS & JRO).

This document provides integrations of a number of bug fixes reported in the bug tracking system as well as some other editorial changes made by the authors, based on the latest JVET output draft VVC text in JVET-P2001-vE.

It is suggested to use the attached spec text as the basis for integration of adoptions of the 17th JVET meeting. And proponents are encouraged to use this text as the basis for their proposed text changes.

List of logged changes:

* Fixed the bugs [#672](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/672), [#700](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/700), [#711](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/711), [#715](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/715), [#716](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/716), [#720](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/720), [#729](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/729), [#737](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/737), [#739](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/739).
* Fixed subpicture figure together with accompanying text ([#740](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/740)).
* Removed the editing note comment in the semantics of tile\_idx\_delta[ i ], which was concluded not needed after a study (input: Hendry).
* Fixed quite some format and style consistency issues in syntax tables, equations, etc. as well as some bugs in those places.
* Made some fixes in the semantics of DPS and VPS.
* Fixed the semantics of sps\_loop\_filter\_across\_virtual\_boundaries\_disabled\_present\_flag and ph\_loop\_filter\_across\_virtual\_boundaries\_disabled\_present\_flag, and changed the syntax element names to sps\_virtual\_boundaries\_present\_flag and ph\_virtual\_boundaries\_present\_flag.
* Fixed the following issues:
  + The definition of the sub-bitstream extraction process still referred to a target LayerId: "A specified process by which NAL units in a bitstream that do not belong to a target set, determined by a target OLS index and a target highest TemporalId and a target LayerId, are removed from the bitstream, …". However, the process in clause C.6 only mentions a target OLS index and a target highest TemporalId in the inputs, but no target LayerId.
  + In the VPS syntax: "ols\_hrd\_parameters( firstSubLayer, hrd\_max\_temporal\_id[ i ] )". hrd\_max\_temporal\_id is not defined anywhere. It should be "hrd\_max\_tid" instead.
  + In the VPS semantics, when deriving LayerUsedAsRefLayerFlag, it was initialised as follows: "LayerUsedAsRefLayerFlag[ j ] = 0." But j is not defined at this point, since it gets defined in the following loop.
  + Fixed a bug in Equation 40 by changing "layerIncludedFlag[ i ][ j ] = 1" to "layerIncludedFlag[ i ][ k ] = 1" and then changed the variable name to layerIncludedInOlsFlag[ ][ ] to be more intuitive.
  + In the semantics of dpb\_size\_only\_flag, only the value 1 was specified, twice, and in a contradicting way. The second sentence should be: "dpb\_size\_only\_flag[ i ] equal to 0 specifies that…".
  + In the semantics of num\_ols\_hrd\_params\_minus1: "When TotalNumOlss is greater than 1, the value of num\_ols\_hrd\_params\_minus1 is inferred to be equal to 0". However, num\_ols\_hrd\_params\_minus1 is signalled when TotalNumOlss is greater than 1. It should be "When TotalNumOlss is equal to 1, the value of num\_ols\_hrd\_params\_minus1 is inferred to be equal to 0".
  + In the semantics of hrd\_max\_tid, there should be an inference for this syntax element when the value of vps\_max\_sublayers\_minus1 is greater than 0, but vps\_all\_layers\_same\_num\_sublayers\_flag is 1, similarly as in the semantics of ptl\_max\_temporal\_id[ i ] and dpb\_max\_temporal\_id[ i ].
  + In the semantics of sps\_ptl\_dpb\_hrd\_params\_present\_flag: "The value of sps\_ptl\_dpb\_hrd\_params\_present\_flag shall be equal to vps\_independent\_layer\_flag[ nuh\_layer\_id ]." Everywhere else vps\_independent\_layer\_flag is indexed by the layer index rather than the layer identifier. It should be the following instead: "The value of sps\_ptl\_dpb\_hrd\_params\_present\_flag shall be equal to vps\_independent\_layer\_flag[ GeneralLayerIdx[ nuh\_layer\_id ] ]."
  + Annex A still mentioned bit\_depth\_luma\_minus8 and bit\_depth\_chroma\_minus8, although these two syntax elements have been replaced by bit\_depth\_minus8.
  + Annex A still mentioned num\_tile\_columns\_minus1 and num\_tile\_rows\_minus1, although these syntax elements do not exist anymore.
  + The list NestingLayerId[ ] and the variable NestingNumLayers specified in the semantics of the scalable nesting SEI message are not used in other places, thus two variable names were changed to be local variables, i.e., nestingLayerId[ ] and nestingNumLayers.
* Fixed the bugs [#600](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/600), [#713](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/713) and some typos.
* Fixed the bugs [#604](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/604), [#613](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/613), [#710](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/710), [#717](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/717), [#723](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/723) and some typos.
* Fixed the bugs [#742](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/742), [#751](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/751) and some other editorial bugs.
* Changed numerous occurences of recPictureL[ hx, vy ] etc. to recPicture[ hx ][ vy ] etc. (removal of 'L' and to be in the form of two-dimention array; input: Yang Wang).

Decision (Ed.&BF): It was agreed to use this as the basis of the further work.

## Test conditions (0)

## Performance assessment (3)

### Tool level analysis (AHG13) (3)

[JVET-Q0050](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8875) AHG13: Decoding Time and Energy Assessment of VTM-7.0 [M. Kränzler, C. J. Herglotz, A. Kaup]

TBP

[JVET-Q0053](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8878) AHG13: Analysis of the Energy Demand and Time Complexity of Several Coding Tools in VTM-7.0 [M. Kränzler, C. J. Herglotz, A. Kaup]

TBP

[JVET-Q0320](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9145) AHG13: Performance of VVC field coding [H.-W. Sun, H.-B. Teo, C.-S. Lim (Panasonic)]

TBP

### Overall VVC performance (0)

## Coding studies and tools on specific use cases (3)

[JVET-Q0424](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9249) Mandatory film grain [R. Sjöberg, D. Saffar, M. Pettersson, M. Damghanian (Ericsson)]

This contribution was discussed in the plenary Sunday 12 January (chaired by GJS & JRO).

Q0424 and Q0533 propose a new tool for consideration as a mandatory required feature of profiles (without evidence or complete text). The proposal is different from what was used for an SEI message in AVC and HEVC.

It was commented that this is interesting but does not seem feasible for inclusion in v1 of VVC.

Further study in an AHG was encouraged, but not planned as a potential mandatory feature of v1 of VVC.

The AHG study should include development of evidence, text and software for an SEI message approach.

Transcoding was a suggested relevant use case.

It was agreed that we do not necessarily need to remove the existing SEI method (whic was carried over from HEVC and from AVC to HEVC) from the text or to require a comparison of the proposed new method with the prior two models, since software for the prior models is not available. However, having software for the existing draft models would be highly desirable.

[JVET-Q0533](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9379) Film Grain Synthesis Support [A. Norkin (Netflix)] [late]

See notes for Q0424.

[JVET-Q0614](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9460) Film Grain Synthesis Support in VVC [A. M. Tourapis, K. Rapaka, D. Singer, K. Kolarov (Apple)] [late]

See notes for Q0424.

## Test material (1)

[JVET-Q0791](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9637) AHG4: Multiformat Berlin Test Sequences [B. Bross, H. Kirchhoffer, C. Bartnik, M. Palkow, D. Marpe (HHI)]

TBP

## Conformance (2)

[JVET-Q0479](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9306) Updates to conformance testing for versatile video coding [I. Moccagatta, J. Boyce (Intel)]

This contribution was presented on Sunday 12 January at 1145 in the plenary session (chaired by GJS and JRO).

This contribution proposes an update to Table 1 and 2 of the Video Versatile Coding Conformance Draft 1 [JVET-P2008] by i) adding a new column named “Categories” to Table 1 and 2 to classify the bitstreams, and ii) adding Adaptive Color Transform (ACT) for 4:4:4 to Table 1. Additions are highlighted in green in the attachment.

The attachment also includes updates to Submitter columns in Table 1 and 2 of JVET-P2008 to include new volunteers, highlighted in green.

The -v2 version also describes the ftp file directory structure, which includes directories per VTM decoder release version. It is proposed to include in the associated .txt file an indication of the release version of the VTM decoder that is able to correctly decode the bitstream by generating the same .yuv.md5 and .opl files associated with the bitstream. If no version of the VTM decoder is able to correctly decode the bitstream, bitstream submitters are encouraged to file an error tracker report, and reference it in the associated .txt file.

Bitstream submitters are encouraged to regularly update their bitstreams to be compatible with the latest available VTM version.

It was agreed that company names can be included in the bitstream filenames, at the discretion of the contributor.

Further work in the tracks was planned to help identify additional volunteers and test configurations.

[JVET-Q0799](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9645) AHG5/AHG9: Suggested HLS conformance testing for versatile video coding [K. Kawamura (KDDI), J. Boyce, I. Moccagatta (Intel)] [late]

TBP?

## Implementation studies (AHG16) (3)

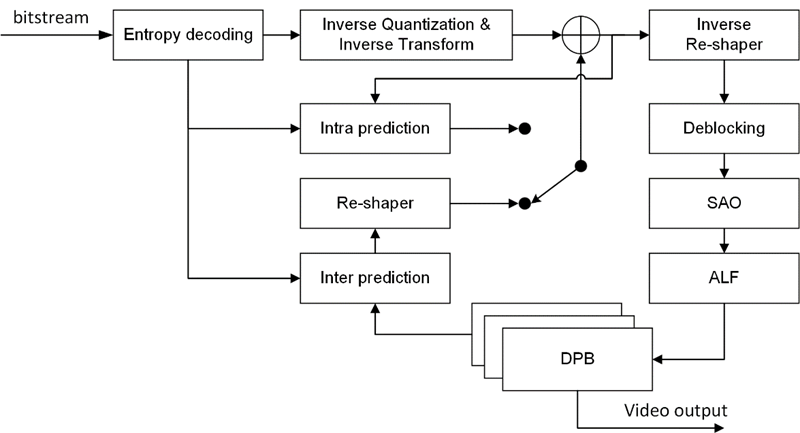
[JVET-Q0211](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9036) [AHG16] VVC software decoder and performance analysis [S. Gudumasu, S. Bandyopadhyay, A. Srivastava, Y. He, Y. He (InterDigital)]

This contribution was presented on Sunday 12 January at 1105 in the plenary session (chaired by GJS and JRO).

This contribution describes a software-based VVC decoder implementation using parallel processing. The design explores both task and data parallelization to distribute the decoding modules on a general-purpose multiprocessor platform. The implementation is based on VTM5.0 without compromising on the coding efficiency or memory bandwidth, an average 89% decoding time reduction is reported for 4K sequences with random access CTC test conditions on a 10-core processor.

The VVC decoding process is divided into the following tasks.

1. CABAC decoding
2. Motion Vector Component Derivation
3. Inter CU & CIIP inter reconstruction
4. Intra CU & CIIP intra reconstruction
5. LMCS
6. In-loop filtering
   1. De-blocking Filter
   2. Sample Adaptive Offset
   3. Adaptive Loop Filter



Substantial detail describing the decoder implementation approach is provided in the contribution, along with measurements of aspects of its performance.

The decoder is primarily oriented for single-tile, singe-thread operation. Intra requires sequential aspects within each CTU row.

Measurements are mostly based on the CTC.

Decoding speed improves up to about 10 threads.

About 85% average reduction in decoding time is reported for 4K test sequences.

[JVET-Q0386](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9211) AHG16: Feature-rich implementation of VVC real-time decoding and playback on ARM based mobile clients [J. Arumugam, S. Kotecha, S. Ramamurthy (Ittiam)]

This contribution was presented on Sunday 12 January at 1120 in the plenary session (chaired by GJS and JRO).

This informative input contribution describes a real-time implementation of a VVC software decoder running on ARM based mobile clients. This implementation encompasses all tools that are essential for random-access VVC configuration. The software decoder has been implemented by Ittiam, with all critical modules optimized for ARM, is compatible with the syntax of VTM 7.0

There was a contribution JVET-P0307 at the previous meeting; this contribution supports all coding features of RA operation for VTM 7.

One of the implementation’s major focus areas is embedded software implementations optimized for the widely-prevalent ARM based mobile platform.

Using Single Instruction Multiple Data (SIMD) on ARM, the performance achieved for the VVC decoder demo is characterized below.

* 1920x1080@24fps on with 4 cores of Cortex-A75 clocked at 2.5GHz. 4 Tiles have been used towards a multi-threaded decoding application
* All tools essential for random access configuration of VVC are included in this implementation. All the critical modules/tools are optimized for ARM architecture.
* For effective parallelization during VVC decoding, a general recommendation is to have multiple tiles configured during VVC video encoding and stream creation.

The demo is using tiles. However; the impact of single-tile encoding would only be an estimated 10% slower.

The decoding speed penalty relative to HEVC was estimated as 60-70% (i.e., less than 2x decoding complexity).

ALF and deblocking and MC contribute most of the decoding time; roughly equally.

RPR is not used.

The implementation reportedly uses about 80% of the CPU. The device has 8 cores, half of which are higher-performance cores, and only those 4 cores are being used.

It was commented that power usage information would be desirable.

The implementation is optimized for 8-bit. The proponent estimated the penalty of 10 bit coding at about 20-30%.

The contribution said that based on this “full-fledged” implementation of a VVC software decoder on ARM Cortex-A75/76, the results reportedly confirm that a real-time implementation of VVC decoding on mobile clients is immensely feasible, exercising the complete tools of VTM7.0.

[JVET-Q0102](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8927) AHG16: A study of bin to bit ratio for VTM7.0 [M. Zhou (Broadcom)]

No need to present – see AHG16 report.

## Profile/level specification (4)

[JVET-Q0065](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8890) Level restrictions on maximum tile width for line buffer reduction [M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

[JVET-Q0111](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8936) A proposal of an 8-bit profile [L. Zhang, Y.-K. Wang, J. Wang (Bytedance)]

[JVET-Q0112](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8937) On level definitions [Y.-K. Wang (Bytedance), Y. He (InterDigital), P. Wu (ZTE)]

See also the AHG8 report, which describes relevant email reflector discussion.

[JVET-Q0485](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9312) Profile and Level Definitions [W. Wan, T. Hellman, M. Zhou, B. Heng, P. Chen (Broadcom)]

# Core Experiments

## CE1: Deblocking filtering (5)

Contributions in this category were discussed Tuesday 8 Jan. 1645-1750 in Track B (chaired by JRO).

[JVET-Q0021](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9333) CE1: Summary Report on Deblocking Filtering [K. Andersson, A. Norkin]

Initially presented Wed 8 Jan 1645-1750

CE1-1.1: Long-tap deblocking filter JVET-Q0054

Long luma deblocking is unaware of samples at p6 and q6 since no gradient check include them.

- This can enable long luma deblocking although it should not be used

Add additional gradient calculation when maxFilterLengthP or maxFilterLengthQ is equal to 7

CE1-1.2 Modification to long-tap deblocking filter (gradient computation only) [JVET-Q0054](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8879)

Long luma deblocking is unaware of samples at p6 and q6 since no gradient check include them.

- This can enable long luma deblocking although it should not be used

Add additional gradient calculation when maxFilterLengthP or maxFilterLengthQ is equal to 7

CE1-1.3 Modification to long-tap deblocking filter (threshold change only) [JVET-Q0054](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8879)

Threshold for ramp insensitive long luma filter decision is too high for samples p0 to p5 and q0 to q5.

- This can enable long deblocking although it should not be used

Reduce beta threshold for ramp insensitive gradient calculations

CE1-1.4 Non-normative modification to beta threshold using beta offset (VTM / VVC Draft )

Reduce beta threshold for this test by using a beta threshold offset equivalent to setting beta\_offset\_div2 to -6.

Comments from cross-checkers on subjective quality

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test #** | **Cross-checker** | **PSNR&BR Match (Y/N)** | **RunT matched? (Y/N)** | **SW studied? (Y/N)** | **Significant inconsistencies between description and SW? (Y/N)** | **Studied visual quality? (Y/N)** | **Visual quality observations** | **Other comments** |
| CE1-1.1 | K. Misra | Y | Y | Y | N | Y | Observed in increase in blocking artifacts for some sequences; observed visual quality improvement in sequences that were over smoothed. |  |
| CE1-1.2 | F. Pu | Y | Similar as anchor | Y | N | Y | Local texture improvement for some clips, others are similar to/no worse than anchor |  |
| CE1-1.3 | S. Iwamura | Y | Y | Y | N | Y | Improvements on texture area can be observed in some sequences. For others, no worser than anchor | Viewed in full speed with professional monitor for some SDR/HDR sequences |
| CE1-1.4 | K. Andersson | Y | Similar as anchor | Y | N | Y | Improves on some of problem sequences but still remaining problems |  |

these comments, CE1-1.1 seems most promising in terms of improvement among those which would require a change of spec. CE1-1.4 which is non-normative also seems to improve on some cases.

There are also some HDR sequences but there is no viewing equipment for HDR -> restrict the viewing to SDR sequences.

In previous rounds of viewing, there was a problem that selected sequences had different resolutions.

Among the SDR sequences, 4 1920x1080 are available. Investigate the possibility of conducting a viewing session with 4 sequences at QP32/37 for CE1-1.1 and CE1-1.4. If possible, 2 LDB and 2 RA sequences. It was requested to make a preliminary pre-check with relevant people involved in previous viewing actions and report back if involvement of more experts makes sense.

It was reported on Thu. 9 that differences are there, but it highly depends on the view direction if they are seen or not. Very likely, a similar test as used e.g. in Marrakesh (where the differences for the support of long deblocking filter were more evident) might not indicate benefit.

CE1-2 Deblocking for TPM [JVET-Q0084](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8909)

Set BS (Boundary Strength) for luma to be 1 if the boundary is between TPM blending area and another CU by adding one condition to the BS derivation process

Cross-checker’s comments:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| CE1-2 | G. Li | Y | Y | Y | N | Y | Mostly equal visual quality when playing in full speed. Some slight differences can be observed when doing side-by-side viewing of single frames, sometimes better details than anchor. |  |

It does seem to be difficult to see improvements according to the cross-checkers comments. It was requested to perform an informal viewing with relevant people involved in previous viewing actions and report back if involvement of more experts makes sense.

It was reported back (Thu. 1400) that it would be even less likely that differences are seen than for case of CE1-1. The independent experts were not able to see different artifacts caused by different encoder decisions, without clear tendency. It would not make sense to involve more experts in a more formal viewing exercise.

CE1-3.1 Deblocking for blocks with different BCW weights [JVET-Q0063](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8888)

In VTM6.0, the deblocking bS derivation process does not consider the cases when the prediction weights of the two adjacent blocks are not the same. For example, if the two adjacent blocks both have all-zero prediction residuals, the same motion vectors, and the same reference pictures, but one block is coded with unequal weighted bi-prediction (e.g., nonzero BCW index or TPM) and the other block is coded with an equal weighted bi-prediction, a potential block artifact would appear at the current edge. In VTM6.0, the bS value is set to 0 (i.e., no deblocking) for the edge of the given example.

CE1-3.2 Aspect 2: Boundary strength derivation for CUs with BCW [JVET-Q0096](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8921)

Neighbouring CUs can have different BCW weights which can cause blocking artifacts.

The proposed modification of the specification [1] of the BS derivation.

Cross-checker’s comments:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| CE1-3.1 | K. Misra |  |  |  |  |  |  |  |
| CE1-3.2 | C.-M. Tsai | Y | Y | Y | N | Y | Mostly equal visual quality by viewing in full speed |  |

It does seem to be difficult to see improvements according to the cross-checkers comments. It was requested to perform an informal viewing with relevant people involved in previous viewing actions and report back if involvement of more experts makes sense.

It was reported back (Thu. 1400) that it would be even less likely that differences are seen than for case of CE1-1. The independent experts were not able to see different artifacts caused by different encoder decisions, without clear tendency. It would not make sense to involve more experts in a more formal viewing exercise.

Revisit: Organize an informal viewing session regarding CE1-1, CE1-2, CE1-3, record opinion of more experts. Proponents and cross-checkers should also be present.

CE1-4: Deblocking on affine sub-PU with PROF

Proposal in this sub-CE investigates disabling deblocking on affine sub-PU boundaries when the PROF tool is used.

Cross-checker’s comments:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| CE1-4 | X. Meng | Y | Similar as anchor | Y | N | Y | No obvious harm on visual quality |  |

There seems to be no impact on visual quality. The intent of this proposal is simplification. It is however not obvious that the saving of computation would be relevant, and even more specific condition check would be necessary whether deblocking is to be applied or not at a given subblock level. Does not decrease the worst case complexity. For hardware, there would be no benefit. The decoding runtime is increased to 99%. The benefit is too small to justify an adoption.

[JVET-Q0769](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9615) Report on CE1 informal viewing session [M. Wien (RWTH)]

An informal viewing session was performed on January 9th 2020 from 19:00h to 20:45h in the BOZAR viewing room. The meeting was announced on the JVET email reflector in the afternoon of the same day. There were 12 viewing participants, including four proponents representing all assessed sub-CEs. A total of 15 A-B comparisons of proposals against their anchors were performed, with a randomized and undisclosed assignment of the anchor and the proposal to A or B. The presented sequences were selected by recommendation of the proponents. Each set was shown multiple times according to the request of the participants and participants were encouraged to watch each set from different viewing positions. Non-proponent comments and expressions of preference were collected first before allowing proponents to comment. Only after completion of this assessment, the A-B assignment of anchor and proposal was disclosed. For CE1-1 a slight preference for the proposed changes of CE1-1.1 and CE1-1.4 as found, without a clear preference for one of the two variants. For CE1-2 and CE1-3, no clear preference for the proposals or the anchor was found. In some cases, artifacts not related to the CE proposals, such as pumping and artifacts on CTU boundaries were observed.

It was generally commented that the informal viewing was an appropriate method due to the very close quality.

**CE1-1**

Proposals might filter (i.e. remove) less content, potentially remove some flickering artifacts.

|  |  |
| --- | --- |
| **Test point** | **Comments** |
| S08 EBUKidsSoccer QP37 | - CE1-1-1: Preference for proposal - CE1-1-4: Preference for proposal - CE1-1-1 indicated to be slightly better than 1-1-4  General comment: Pumping effect observed, especially in the trees |
| S04 Cactus QP37 | - CE1-1-1: Slight preference for anchor - CE1-1-4: Slight preference for proposal - CE1-1-1 and CE1-1-4 very similar in effect |
| S06 AlohaWave QP37 | No clear preference (some favor proposals, but also anchor). Potentially very slight benefit for 1.1.4 (only one expert) |

Conclusion: Proposals both show a slight benefit, no clear preference between the two.

The necessary text change was reviewed during the track B discussion, is straightforward and introduces only two additional checks (not increasing worst case complexity). Several experts expressed that it is better to have this problem resolved by a normativc change, as it may be difficult to identify automatically by an encoder.

Decision: Adopt JVET-Q0054, variant CE1-1-1. Text which is currently only in the proposal doc shall be integrated into the draft text.

From the findings on CE1-1-4, which resolved the problem by adapting the beta parameter to its maximum, it is further agreed that the abs range of beta should be extended from 6 to 12. (it is noted that JVET-Q0121 may relate to that aspect).

**CE1-2**

Proponent expresses that only subtle differences are to be expected, mainly due to different encoder decisions. Changes to be expected in the corner of blocks.

|  |  |
| --- | --- |
| **Test point** | **Comments** |
| S01 BasketballDrill QP32 | No preference for A or B |
| S01 BasketballDrill QP37 | Some experts express preference for A or for B, at same numbers  General comments:   1. CTU boundaries visible, especially on the diagonal structures in the content (likely not due to deblocking) 2. Persistent artifacts of crossing objects on the floor area visible |
| S04 Cactus QP37 | Slight preference for B (the proposal) |
| S05 KristenAndSara QP37 | Slight preference for A (the anchor) |
| S02 Campfire QP37 | Some experts express preference for A or for B, at same numbers  General comment: Pumping visible |

No clear preference identified.

Conclusion from track B: No action on CE1-2

**CE1-3**

Variant 1-3.2 considered the more exact approach. Effect expected to be more visible on LDB sequences, also more difference between the two variants.

|  |  |
| --- | --- |
| **Test point** | **Comments** |
| S01 BasketballDrill QP37 CE1-3.2 | Slight preference for A (the proposal) |
| S04 Cactus QP37 CE1-3.2 | No preference for A or B |
| S05 KristenAndSara QP37 CE1-3.2 | Slight preference for A (the anchor) |
| S01 BasketballDrill QP32 CE1-3.1 | Slight preference for A (the anchor) |

No clear preference identified.

Conclusion from track B: No action on CE1-3

[JVET-Q0054](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8879) CE1: CE1-1.1 to CE1-1.3: Fixes for long luma deblocking filter decision [K. Andersson, J. Enhorn (Ericsson)]

[JVET-Q0063](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8888) CE1-3.1: Deblocking for blocks with different BCW weights [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), X. Meng, S. Wang, S. Ma (PKU), X. Zheng (DJI)]

[JVET-Q0084](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8909) CE1-2: Deblocking for TPM (Triangular Partition Mode) [X.W. Meng, S.S. Wang, S.W. Ma (PKU), S. Iwamura, S. Nemoto, A. Ichigaya(NHK), X.Zheng (DJI)]

[JVET-Q0094](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8919) CE1-4: Disable deblocking for affine sub-PU edges when PROF is applied [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

[JVET-Q0096](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8921) CE1-3.2: Boundary strength derivation for blocks with BCW [S. Iwamura, S. Nemoto, A. Ichigaya (NHK), K. Andersson, R. Yu, J. Enjorn (Ericsson)]

## CE2: Palette mode coding (5)

Contributions in this category were discussed Tuesday 8 Jan. 1900–2150 in Track B (chaired by JRO).

[JVET-Q0022](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9259) CE2: Summary Report on Palette Mode Coding [X. Xu, Y.-H. Chao, Y.-C. Sun, J. Xu]

Initially discussed Jan. 07, 1900-2150

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test** | **Tester** | **Document** | **Tool description** | **Cross checker** |
| CE2-1.1 | W. Zhu  (ByteDance) | JVET-Q0075 | QP dependent fixed-length binarization for escape coding | D. Luo  (Alibaba) |
| CE2-1.2 | H.-J. Jhu  (Kwai) | JVET-Q0066 | Escape value is binarized by fixed-length code with a length determine by maximum quantized value no change on escape de-quantization | Y.-H. Chao  (Qualcomm) |
| CE2-1.3 | H.-J. Jhu  (Kwai)  S. Yoo  (LGE) | JVET-Q0067 | Escape value is binarized by truncated binary code with a length determine by maximum quantized value | Y.-H. Chao  (Qualcomm) |
| CE2-2.1 | W. Zhu  (ByteDance)  H. Jang  (LGE) | JVET-Q0076 | Resetting predictor palette at CTU row | M.G. Sarwer  (Alibaba) |
| CE2-3.1a | Y.-H. Chao  (Qualcomm) | JVET-Q0064 | Simplified palette predictor update process for small blocks: restrict entries allowed for prediction to the first W x H entries | H.-J. Jhu  (Kwai) |
| CE2-3.1b | Y.-H. Chao | JVET-Q0064 | Simplified palette predictor update process for small blocks: restrict entries allowed for prediction to the first (W x H ) / 2 entries | H.-J. Jhu  (Kwai) |
| CE2-3.1c | Y.-H. Chao | JVET-Q0064 | Simplified palette predictor update process for small blocks: Bypass predictor update for CU size < 8x8 | H.-J. Jhu  (Kwai) |
| CE2-3.1d | Y.-H. Chao | JVET-Q0064 | Simplified palette predictor update process for small blocks: Bypass predictor update for CU size <= 8x8 | H.-J. Jhu  (Kwai) |

CE2-1.x is on escape coding modification. Results:

Table 3: CE2-1.x test results with VTM-7.0+DualTree=1, normal QP range

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **AI Over VTM-7.0** | | | | | | **RA Over VTM-7.0** | | | | | |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | | **U** | **V** | **EncT** | **DecT** |
| TGM 1080p | CE2-1.1 | 0.07% | 0.00% | 0.01% | 99% | 100% | 0.07% | | -0.06% | -0.06% | 99% | 100% |
| CE2-1.2 | -0.09% | -0.07% | -0.06% | 101% | 100% | -0.03% | | -0.06% | -0.04% | 100% | 100% |
| CE2-1.3 | -0.10% | -0.07% | -0.05% | 97% | 99% | -0.05% | | -0.11% | -0.06% | 100% | 102% |
| TGM 720p | CE2-1.1 | 0.00% | -0.01% | 0.07% | 100% | 99% | 0.05% | | 0.00% | -0.09% | 100% | 100% |
| CE2-1.2 | -0.01% | -0.08% | -0.02% | 100% | 100% | 0.01% | | -0.01% | 0.09% | 100% | 100% |
| CE2-1.3 | -0.02% | -0.08% | -0.05% | 97% | 96% | 0.00% | | 0.00% | 0.09% | 100% | 100% |
| Animation | CE2-1.1 | -0.01% | 0.00% | 0.02% | 99% | 99% | 0.07% | | 0.07% | 0.06% | 99% | 99% |
| CE2-1.2 | -0.03% | -0.01% | 0.03% | 101% | 99% | 0.05% | | 0.03% | 0.11% | 99% | 100% |
| CE2-1.3 | -0.03% | -0.03% | 0.00% | 98% | 95% | 0.00% | | 0.00% | 0.04% | 100% | 101% |
| Mixed Content | CE2-1.1 | 0.05% | 0.04% | -0.01% | 99% | 99% | 0.11% | | -0.01% | 0.02% | 100% | 100% |
| CE2-1.2 | -0.04% | 0.02% | -0.03% | 100% | 100% | 0.14% | | 0.29% | 0.28% | 100% | 100% |
| CE2-1.3 | -0.03% | 0.01% | -0.02% | 98% | 97% | 0.06% | | 0.14% | 0.20% | 100% | 99% |
| Camera-Captured | CE2-1.1 | -0.01% | -0.01% | 0.00% | 100% | 99% | 0.01% | | 0.00% | 0.04% | 99% | 99% |
| CE2-1.2 | 0.00% | -0.01% | 0.00% | 100% | 101% | 0.01% | | -0.03% | 0.02% | 100% | 101% |
| CE2-1.3 | 0.00% | -0.01% | 0.01% | 98% | 97% | 0.01% | | -0.03% | 0.02% | 100% | 102% |

Table 4: CE2-1.x test results with VTM-7.0+DualTree=0, normal QP range

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **AI Over VTM-7.0** | | | | | | **RA Over VTM-7.0** | | | | | |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | | **U** | **V** | **EncT** | **DecT** |
| TGM 1080p | CE2-1.1 | -0.02% | -0.18% | -0.16% | 100% | 100% | -0.10% | | -0.38% | -0.29% | 100% | 99% |
| CE2-1.2 | -0.20% | -0.08% | -0.04% | 100% | 99% | -0.15% | | 0.04% | -0.09% | 100% | 100% |
| CE2-1.3 | -0.24% | -0.22% | -0.16% | 98% | 98% | -0.16% | | 0.02% | -0.09% | 100% | 101% |
| TGM 720p | CE2-1.1 | -0.02% | -0.03% | -0.03% | 100% | 100% | -0.06% | | -0.09% | -0.28% | 100% | 99% |
| CE2-1.2 | -0.04% | -0.03% | -0.01% | 101% | 100% | -0.03% | | 0.05% | -0.02% | 100% | 100% |
| CE2-1.3 | -0.07% | -0.03% | -0.05% | 97% | 96% | -0.03% | | 0.09% | 0.03% | 100% | 102% |
| Animation | CE2-1.1 | 0.01% | -0.02% | -0.04% | 100% | 100% | 0.08% | | 0.08% | 0.04% | 100% | 100% |
| CE2-1.2 | -0.01% | 0.04% | 0.00% | 100% | 100% | 0.09% | | 0.05% | 0.07% | 100% | 100% |
| CE2-1.3 | -0.04% | 0.01% | -0.02% | 97% | 98% | 0.07% | | 0.09% | 0.09% | 100% | 102% |
| Mixed Content | CE2-1.1 | -0.08% | -0.16% | -0.21% | 100% | 99% | -0.20% | | -0.42% | -0.57% | 99% | 99% |
| CE2-1.2 | -0.05% | 0.02% | 0.03% | 100% | 100% | 0.01% | | 0.09% | 0.01% | 99% | 100% |
| CE2-1.3 | -0.06% | -0.02% | -0.02% | 97% | 96% | -0.03% | | 0.13% | 0.01% | 100% | 101% |
| Camera-Captured | CE2-1.1 | 0.00% | 0.00% | 0.00% | 100% | 99% | 0.00% | | 0.00% | -0.01% | 99% | 100% |
| CE2-1.2 | 0.00% | 0.00% | 0.00% | 100% | 101% | 0.00% | | 0.00% | -0.01% | 101% | 100% |
| CE2-1.3 | 0.00% | 0.00% | 0.00% | 98% | 96% | 0.00% | | 0.00% | -0.01% | 100% | 100% |

5: CE2-1.x test results with VTM-7.0+DualTree=1, low QP range

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **AI Over VTM-7.0** | | | | | | **RA Over VTM-7.0** | | | | | |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | | **U** | **V** | **EncT** | **DecT** |
| TGM 1080p | CE2-1.1 | -1.10% | -1.46% | -1.54% | 100% | 100% | -1.28% | | -1.58% | -1.48% | 100% | 99% |
| CE2-1.2 | -1.40% | -1.26% | -1.31% | 101% | 100% | -1.23% | | -1.23% | -1.25% | 100% | 100% |
| CE2-1.3 | -1.47% | -1.32% | -1.38% | 97% | 99% | -1.42% | | -1.51% | -1.48% | 100% | 101% |
| TGM 720p | CE2-1.1 | -0.57% | -0.63% | -0.50% | 100% | 100% | -0.73% | | -0.29% | -0.39% | 100% | 100% |
| CE2-1.2 | -0.46% | -0.42% | -0.44% | 100% | 100% | -0.30% | | -0.19% | -0.34% | 100% | 100% |
| CE2-1.3 | -0.54% | -0.47% | -0.46% | 98% | 96% | -0.28% | | -0.20% | -0.32% | 100% | 101% |
| Animation | CE2-1.1 | -0.33% | -0.33% | -0.38% | 99% | 100% | -0.21% | | -0.39% | -0.37% | 99% | 99% |
| CE2-1.2 | -0.31% | -0.18% | -0.17% | 100% | 100% | -0.24% | | -0.34% | -0.33% | 100% | 100% |
| CE2-1.3 | -0.42% | -0.26% | -0.32% | 98% | 99% | -0.24% | | -0.37% | -0.38% | 102% | 102% |
| Mixed Content | CE2-1.1 | -1.02% | -1.38% | -1.47% | 100% | 100% | -0.84% | | -0.07% | -0.16% | 100% | 99% |
| CE2-1.2 | -0.94% | -1.08% | -1.13% | 100% | 99% | -0.39% | | 0.30% | 0.24% | 100% | 100% |
| CE2-1.3 | -0.96% | -1.12% | -1.15% | 98% | 98% | -0.52% | | 0.29% | 0.25% | 100% | 103% |
| Camera-Captured | CE2-1.1 | 0.00% | -0.01% | -0.02% | 99% | 100% | -0.01% | | -0.01% | 0.02% | 99% | 100% |
| CE2-1.2 | 0.00% | 0.00% | -0.02% | 101% | 99% | -0.01% | | -0.01% | 0.03% | 100% | 101% |
| CE2-1.3 | 0.00% | 0.00% | -0.02% | 97% | 99% | -0.01% | | -0.01% | 0.04% | 103% | 105% |

6: CE2-1.x test results with VTM-7.0+DualTree=0, low QP range

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **AI Over VTM-7.0** | | | | | | **RA Over VTM-7.0** | | | | | |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | | **U** | **V** | **EncT** | **DecT** |
| TGM 1080p | CE2-1.1 | -2.80% | -3.63% | -3.46% | 100% | 100% | -2.08% | | -2.45% | -2.27% | 99% | 98% |
| CE2-1.2 | -2.58% | -3.03% | -2.93% | 99% | 101% | -1.80% | | -1.95% | -1.84% | 100% | 100% |
| CE2-1.3 | -2.83% | -3.28% | -3.19% | 98% | 102% | -2.10% | | -2.27% | -2.17% | 100% | 100% |
| TGM 720p | CE2-1.1 | -1.06% | -1.13% | -1.33% | 100% | 98% | -0.75% | | -0.95% | -0.99% | 99% | 98% |
| CE2-1.2 | -0.91% | -0.79% | -1.13% | 101% | 99% | -0.42% | | -0.32% | -0.57% | 100% | 100% |
| CE2-1.3 | -0.93% | -0.84% | -1.16% | 98% | 97% | -0.52% | | -0.43% | -0.69% | 100% | 102% |
| Animation | CE2-1.1 | -0.36% | -1.27% | -1.22% | 99% | 100% | -0.31% | | -0.51% | -0.56% | 100% | 98% |
| CE2-1.2 | -0.37% | -0.63% | -0.69% | 100% | 101% | -0.29% | | -0.36% | -0.40% | 100% | 100% |
| CE2-1.3 | -0.52% | -0.87% | -0.92% | 98% | 100% | -0.34% | | -0.47% | -0.47% | 102% | 105% |
| Mixed Content | CE2-1.1 | -1.75% | -2.35% | -2.38% | 99% | 98% | -1.09% | | -1.43% | -1.33% | 99% | 100% |
| CE2-1.2 | -1.39% | -1.74% | -1.71% | 100% | 100% | -0.63% | | -0.55% | -0.49% | 99% | 101% |
| CE2-1.3 | -1.48% | -1.81% | -1.78% | 99% | 96% | -0.79% | | -0.65% | -0.59% | 101% | 102% |
| Camera-Captured | CE2-1.1 | 0.00% | 0.00% | -0.01% | 100% | 100% | 0.00% | | 0.00% | 0.02% | 99% | 100% |
| CE2-1.2 | 0.00% | 0.01% | 0.00% | 101% | 99% | -0.01% | | -0.01% | 0.00% | 100% | 101% |
| CE2-1.3 | 0.00% | 0.01% | 0.00% | 98% | 98% | 0.00% | | -0.01% | 0.01% | 104% | 105% |

The benefit at normal QP range is negligible.

For low QP, the BD rates indicate higher gain. From the RD plots, this is mostly contributed at the very low end, where palette escape coding would be lossless for QP=2. However, BD rates may be misleading here, as the PSNR values are extremely high with large fluctuations over the sequence, such that the averaging of PSNR in the BD computation is misleading (and still, gains in the range of 2% are relatively low for screen content classes).

The current results therefore do not allow a real quantification of the benefit.

It was requested to report results that compute BD rate for low QP range based on sequence PSNR (i.e. compute average MSE and then PSNR), as e.g. suggested in JVET-P0393. Such results were made available in v5 of JVET-Q0022. It turned out that the results are similar.

The current method of EG3 coding of escape is likely not optimum for low QP. On the other hand, the range of binarization is made QP dependent in the CE2-1.x proposals, which is also undesirable (as currently QP is currently not required in parsing, such that in particular with local QP adaptation this is highly undesirable and should not be adopted by design principle. It is mentioned that there are non-CE contributions that resolve this issue.

Beyond that, it is also suggested to study the potential benefit of palette for lossless coding of screen content. It could be the case that the impact of a modified escape coding would be even more apparent in the lossless mode.

CE2-2.1 (JVET-Q0076)

Predictor palette is reset at the beginning of decoding each CTU row to enable parallel processing. The setting of using multiple tile columns are used to test to evaluate the performance changes caused by resetting. Furthermore, a picture is divided into 4 tile columns. The version “\*” has 4 tile columns, the other version 1 tile column.

7: CE2-2.1 test results with VTM-7.0+DualTree=1, normal QP range

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **AI Over VTM-7.0** | | | | | | **RA Over VTM-7.0** | | | | | |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | | **U** | **V** | **EncT** | **DecT** |
| TGM 1080p | CE2-2.1 | 0.09% | 0.11% | 0.08% | 99% | 99% | 0.36% | | 0.52% | 0.46% | 99% | 99% |
| CE2-2.1\* | 0.37% | 0.50% | 0.34% | 99% | 100% | 0.47% | | 0.64% | 0.52% | 99% | 100% |
| TGM 720p | CE2-2.1 | 0.35% | 0.06% | 0.11% | 100% | 99% | 0.37% | | 0.42% | 0.64% | 99% | 98% |
| CE2-2.1\* | 0.33% | 0.20% | 0.43% | 99% | 101% | 0.41% | | 0.42% | 0.67% | 100% | 101% |
| Animation | CE2-2.1 | 0.10% | 0.25% | 0.32% | 98% | 98% | -0.03% | | 0.22% | 0.36% | 98% | 99% |
| CE2-2.1\* | 0.08% | 0.29% | 0.23% | 100% | 100% | 0.00% | | 0.18% | 0.33% | 100% | 100% |
| Mixed Content | CE2-2.1 | 0.07% | 0.41% | 0.31% | 98% | 99% | 0.21% | | 0.57% | 0.53% | 98% | 100% |
| CE2-2.1\* | 0.16% | 0.46% | 0.38% | 99% | 101% | 0.27% | | 0.71% | 0.64% | 100% | 101% |
| Camera-Captured | CE2-2.1 | 0.00% | -0.01% | 0.00% | 98% | 100% | -0.02% | | -0.04% | 0.03% | 98% | 100% |
| CE2-2.1\* | 0.01% | -0.03% | 0.00% | 97% | 98% | 0.00% | | 0.01% | -0.01% | 101% | 101% |

"\*" refer to using 4 tile columns per picture setting.

8: CE2-2.1 test results with VTM-7.0+DualTree=0, normal QP range

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **AI Over VTM-7.0** | | | | | | **RA Over VTM-7.0** | | | | | |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | | **U** | **V** | **EncT** | **DecT** |
| TGM 1080p | CE2-2.1 | 0.74% | 1.09% | 0.98% | 100% | 99% | 0.53% | | 0.85% | 0.69% | 99% | 99% |
| CE2-2.1\* | 1.90% | 2.34% | 2.15% | 100% | 101% | 0.94% | | 1.20% | 1.03% | 100% | 100% |
| TGM 720p | CE2-2.1 | 1.00% | 1.43% | 2.05% | 97% | 95% | 0.76% | | 1.25% | 1.96% | 98% | 96% |
| CE2-2.1\* | 1.36% | 1.97% | 2.08% | 97% | 98% | 1.14% | | 1.71% | 2.30% | 100% | 99% |
| Animation | CE2-2.1 | 0.77% | 1.71% | 1.75% | 98% | 100% | 0.14% | | 0.74% | 0.93% | 98% | 98% |
| CE2-2.1\* | 0.71% | 1.47% | 1.60% | 99% | 100% | 0.10% | | 0.62% | 0.76% | 101% | 101% |
| Mixed Content | CE2-2.1 | 0.67% | 0.90% | 0.68% | 98% | 98% | 0.52% | | 0.92% | 0.70% | 97% | 100% |
| CE2-2.1\* | 1.09% | 1.40% | 1.35% | 100% | 101% | 0.72% | | 1.03% | 0.73% | 100% | 101% |
| Camera-Captured | CE2-2.1 | 0.00% | 0.00% | 0.00% | 99% | 102% | 0.00% | | 0.00% | 0.00% | 97% | 98% |
| CE2-2.1\* | 0.00% | 0.00% | 0.00% | 100% | 101% | 0.00% | | 0.00% | 0.00% | 101% | 101% |

"\*" refer to using 4 tile columns per picture setting.

The reset is done as for WPP, but the proposal is doing it always (even if WPP is not used). Benefit is not clear, it causes some loss under CTC, and it could also be done as encoder choice (see JVET-Q0502).

CE2-3.x (JVET-Q0064)

Two methods are tested to simplify the palette predictor update for small coding units in order to solve the issue of pipeline latency. In the first method, the elements in the palette predictor that are allowed to be used in predicting palette table is restricted to the first W x H elements (W and H stands for width and height of the CU). In the second method, palette predictor update is bypasses for CU size < T.

Subtests:

* Restrict the entries in the palette predictor that are allowed to be used in prediction to the first W x H elements
* Restrict the entries in the palette predictor that are allowed to be used in prediction to the first ( W x H ) / 2 elements
* Palette predictor update is bypassed for CU size (W x H ) < 64
* Palette predictor update is bypassed for CU size (W x H ) <= 64

9: CE2-3.1x test results with VTM-7.0+DualTree=1, normal QP range

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **AI Over VTM-7.0** | | | | | | **RA Over VTM-7.0** | | | | | |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | | **U** | **V** | **EncT** | **DecT** |
| TGM 1080p | CE2-3.1a | -0.04% | -0.01% | -0.01% | 100% | 101% | 0.01% | | 0.00% | 0.02% | 100% | 100% |
| CE2-3.1b | -0.06% | -0.01% | -0.02% | 100% | 102% | 0.07% | | 0.06% | 0.10% | 101% | 101% |
| CE2-3.1c | 0.05% | 0.04% | 0.04% | 100% | 105% | 0.12% | | 0.14% | 0.13% | 100% | 101% |
| CE2-3.1d | 0.15% | 0.09% | 0.09% | 100% | 102% | 0.24% | | 0.30% | 0.24% | 101% | 101% |
| TGM 720p | CE2-3.1a | 0.02% | -0.01% | 0.05% | 99% | 102% | -0.01% | | -0.01% | 0.05% | 100% | 98% |
| CE2-3.1b | 0.04% | -0.04% | -0.03% | 100% | 102% | 0.09% | | 0.07% | 0.08% | 101% | 99% |
| CE2-3.1c | 0.04% | -0.01% | 0.07% | 100% | 101% | 0.07% | | 0.08% | 0.09% | 100% | 102% |
| CE2-3.1d | 0.14% | -0.04% | 0.10% | 100% | 100% | 0.19% | | 0.13% | 0.22% | 100% | 101% |
| Animation | CE2-3.1a | 0.01% | 0.01% | 0.00% | 100% | 102% | 0.00% | | 0.03% | 0.00% | 100% | 99% |
| CE2-3.1b | -0.01% | 0.03% | 0.02% | 101% | 102% | -0.05% | | 0.00% | -0.02% | 100% | 99% |
| CE2-3.1c | 0.02% | 0.06% | 0.07% | 100% | 100% | 0.05% | | 0.07% | 0.06% | 100% | 101% |
| CE2-3.1d | 0.05% | 0.11% | 0.14% | 101% | 98% | 0.01% | | 0.02% | 0.09% | 100% | 99% |
| Mixed Content | CE2-3.1a | -0.02% | 0.01% | 0.01% | 100% | 100% | 0.07% | | 0.11% | 0.14% | 100% | 100% |
| CE2-3.1b | 0.01% | 0.01% | -0.01% | 100% | 102% | 0.09% | | 0.10% | 0.22% | 101% | 100% |
| CE2-3.1c | 0.02% | 0.05% | 0.02% | 100% | 99% | 0.09% | | 0.12% | 0.22% | 99% | 100% |
| CE2-3.1d | 0.06% | 0.08% | 0.06% | 100% | 101% | 0.13% | | 0.13% | 0.16% | 102% | 101% |
| Camera-Captured | CE2-3.1a | 0.00% | 0.00% | 0.00% | 100% | 107% | 0.00% | | 0.00% | 0.00% | 101% | 99% |
| CE2-3.1b | 0.00% | 0.00% | 0.00% | 101% | 104% | 0.00% | | 0.00% | 0.00% | 101% | 100% |
| CE2-3.1c | 0.00% | -0.02% | -0.01% | 100% | 104% | -0.01% | | -0.01% | 0.03% | 101% | 101% |
| CE2-3.1d | 0.00% | -0.02% | -0.01% | 101% | 101% | -0.01% | | 0.00% | 0.00% | 101% | 102% |

* 10: CE2-3.1x test results with VTM-7.0+DualTree=0, normal QP range

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **AI Over VTM-7.0** | | | | | | **RA Over VTM-7.0** | | | | | |
|  | **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | | **U** | **V** | **EncT** | **DecT** |
| TGM 1080p | CE2-3.1a | 0.08% | 0.09% | 0.12% | 101% | 100% | 0.06% | | 0.06% | 0.05% | 100% | 99% |
| CE2-3.1b | 0.47% | 0.48% | 0.48% | 102% | 100% | 0.33% | | 0.33% | 0.30% | 101% | 100% |
| CE2-3.1c | 0.13% | 0.19% | 0.16% | 101% | 102% | 0.12% | | 0.17% | 0.13% | 100% | 100% |
| CE2-3.1d | 0.41% | 0.55% | 0.47% | 101% | 99% | 0.38% | | 0.49% | 0.40% | 101% | 100% |
| TGM 720p | CE2-3.1a | 0.04% | 0.00% | 0.05% | 100% | 101% | 0.02% | | 0.09% | 0.16% | 100% | 103% |
| CE2-3.1b | 0.13% | 0.14% | 0.20% | 100% | 99% | 0.17% | | 0.16% | 0.26% | 100% | 100% |
| CE2-3.1c | 0.03% | 0.12% | 0.11% | 100% | 99% | 0.03% | | 0.09% | 0.18% | 100% | 99% |
| CE2-3.1d | 0.22% | 0.34% | 0.42% | 100% | 99% | 0.07% | | 0.15% | 0.30% | 100% | 99% |
| Animation | CE2-3.1a | -0.02% | -0.01% | -0.04% | 100% | 103% | 0.02% | | 0.06% | 0.02% | 100% | 99% |
| CE2-3.1b | 0.04% | 0.02% | 0.01% | 101% | 103% | 0.03% | | 0.02% | -0.01% | 101% | 100% |
| CE2-3.1c | 0.10% | 0.20% | 0.18% | 100% | 102% | 0.09% | | 0.21% | 0.30% | 101% | 99% |
| CE2-3.1d | 0.21% | 0.35% | 0.38% | 100% | 100% | 0.10% | | 0.14% | 0.19% | 101% | 99% |
| Mixed Content | CE2-3.1a | 0.08% | 0.01% | 0.00% | 100% | 102% | 0.02% | | 0.07% | 0.11% | 100% | 100% |
| CE2-3.1b | 0.33% | 0.25% | 0.21% | 101% | 101% | 0.28% | | 0.29% | 0.15% | 101% | 100% |
| CE2-3.1c | 0.06% | 0.03% | 0.06% | 100% | 102% | 0.00% | | 0.01% | 0.00% | 100% | 100% |
| CE2-3.1d | 0.13% | 0.23% | 0.20% | 100% | 100% | 0.22% | | 0.27% | 0.24% | 101% | 100% |
| Camera-Captured | CE2-3.1a | 0.00% | 0.00% | 0.00% | 99% | 96% | 0.00% | | 0.00% | 0.00% | 101% | 97% |
| CE2-3.1b | 0.00% | 0.00% | 0.00% | 101% | 98% | 0.00% | | 0.00% | 0.00% | 101% | 98% |
| CE2-3.1c | 0.00% | 0.00% | 0.00% | 100% | 97% | 0.00% | | 0.00% | 0.00% | 101% | 97% |
| CE2-3.1d | 0.00% | 0.00% | 0.00% | 101% | 96% | 0.00% | | 0.00% | 0.00% | 101% | 98% |

The current design requires checking maximum 64 predictors regardless of the block size. Worst case would be 4x4 blocks with this regard.

- Method a restricts the number of checks to 16 for 4x4, 32, for 4x8/8x4, 64 for >=64 samples.

- Methods b is even more restrictive, but also has slightly more loss

- Methods c and d completely inhibit the update for small blocks

Method a is the most appropriate solution in terms of complexity benefit vs. compression.

It is however not obvious that the latency problem in palette mode is really severe, compared to other elements of VVC with 4x4 block size (in particular, intra and IBC).

No need for action.

[JVET-Q0064](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8889) CE2-3.1: Simplification of palette predictor update for small CUs [Y.-H. Chao, T. Hsieh, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-Q0066](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8891) CE2-1.2: Fixed-length binarization of palette escape value [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-Q0067](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8892) CE2-1.3: Truncated binarization of palette escape value [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.), S. Yoo, J. Zhao, J. Nam, J. Choi, S. H. Kim, J. H. Lim (LGE)]

[JVET-Q0075](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8900) CE2-1.1: QP dependent fixed-length binarization for escape coding [W. Zhu, J. Xu, L. Zhang (Bytedance)]

[JVET-Q0076](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8901) CE2-2.1: Resetting palette predictor at CTU row [W. Zhu, L. Zhang, J. Xu (Bytedance), H. Jang, J. Nam, S. Kim, J. Lim (LGE)]

## CE3: Lossless coding (12)

Contributions in this category were discussed Wednesday 8 Jan. 2150–2250 and Thursday 9 Jan. 0800-1015 in Track B (chaired by JRO).

[JVET-Q0023](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9302) CE3: Summary Report on Lossless Coding [T. Nguyen, T.-C. Ma, A. Nalci]

Initially discussed Jan. 08, 2150-2250

CE3-1: Regular and TS residual coding (RRC, TSRC) for lossless coding, and modifications to RRC and TSRC for lossless and lossy operation modes

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tester** | **Tool** | **Cross checker** |
| CE3-1.1\* | H. Wang (Qualcomm) | JVET-P0559: Modified RRC and TSRC for lossless   1. modification to RRC as discussed in JVET-P0559-m1 2. modification to rice parameter as discussed in JVET-P0559-m1, without the normalization 3. modification to TSRC as discussed in JVET-P0559-m2 4. similar modification to TSRC as 3 without normalization | T. Nguyen (HHI) ST 1 & 2  M. Sarwer (Alibaba) ST 2 & 3 |
| CE3-1.2\* | H. Wang (Qualcomm) | JVET-P1028: Modified TSRC for lossless | Z.-Y. Lin (MediaTek) |
| CE3-1.3 | T.-C. Ma (Kwai)  Z.-Y. Lin (MediaTek)  A. Nalci (Qualcomm)  M. Sarwer (Alibaba) | JVET-P0148/JVET-P0258: Using RRC for lossless coding without state transition | T. Tsukuba (Sony) |
| CE3-1.4 | T. -C. Ma (Kwai) | JVET-P0528: On residual scanning order for lossless coding | J. Choi (LGE) |
| CE3-1.5\* | M. Sarwer (Alibaba) | JVET-P0463/JVET-P0072: Rice parameter derivation of TSRC for lossless | T.-C Ma (Kwai) |

Tests with \* modified the RRC, and had also to report on CTC normal range

(Insert new results tables including RExt as were provided in v3)

Results on lossless:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Overall** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| CR-A | CR-T | BRS | Enc | Dec | CR-A | CR-T | BRS | Enc | Dec | CR-A | CR-T | BRS | Enc | Dec |
| **CE3-1.1a** | 2.1 | 2.3 | -5.75% | 96% | 104% | 2.2 | 2.4 | -5.88% | 101% | 101% | 2.6 | 2.7 | -4.98% | 97% | 105% |
| **CE3-1.1b** | 2.1 | 2.2 | -5.38% | 93% | 105% | 2.2 | 2.3 | -5.64% | 98% | 100% | 2.6 | 2.7 | -4.98% | 97% | 105% |
| **CE3-1.1c** | 2.1 | 2.2 | -5.09% | 104% | 105% | 2.2 | 2.3 | -3.49% | 105% | 104% | 2.6 | 2.6 | -2.48% | 103% | 105% |
| **CE3-1.1d** | 2.1 | 2.2 | -4.51% | 101% | 104% | 2.2 | 2.3 | -3.01% | 103% | 104% | 2.6 | 2.6 | -2.31% | 102% | 106% |
| **CE3-1.2** | 2.1 | 2.2 | -4.31% | 93% | 103% | 2.2 | 2.3 | -2.94% | 100% | 101% | 2.6 | 2.6 | -2.29% | 100% | 103% |
| **CE3-1.3** | 2.1 | 2.2 | -5.23% | 93% | 102% | 2.2 | 2.3 | -5.58% | 97% | 97% | 2.6 | 2.7 | -4.97% | 98% | 106% |
| **CE3-1.4** | 2.1 | 2.3 | -5.63% | 98% | 105% | 2.2 | 2.4 | -5.72% | 97% | 100% | 2.6 | 2.7 | -5.09% | 100% | 110% |
| **CE3-1.5** | 2.1 | 2.2 | -2.52% | 98% | 104% | 2.2 | 2.2 | -0.82% | 99% | 107% | 2.6 | 2.6 | -0.91% | 101% | 108% |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Class F** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| CR-A | CR-T | BRS | Enc | Dec | CR-A | CR-T | BRS | Enc | Dec | CR-A | CR-T | BRS | Enc | Dec |
| **CE3-1.1a** | 5.3 | 5.4 | -1.72% |  |  | 33.7 | 34.0 | -2.64% |  |  | 50.7 | 50.4 | -2.27% |  |  |
| **CE3-1.1b** | 5.3 | 5.3 | -1.53% |  |  | 33.7 | 33.9 | -2.50% |  |  | 50.7 | 50.2 | -2.19% |  |  |
| **CE3-1.1c** | 5.3 | 5.6 | -4.21% |  |  | 33.7 | 35.0 | -3.30% |  |  | 50.7 | 52.4 | -3.06% |  |  |
| **CE3-1.1d** | 5.3 | 5.5 | -3.94% |  |  | 33.7 | 34.9 | -3.14% |  |  | 50.7 | 52.3 | -2.94% |  |  |
| **CE3-1.2** | 5.3 | 5.5 | -3.67% |  |  | 33.7 | 34.8 | -2.97% |  |  | 50.7 | 52.1 | -2.83% |  |  |
| **CE3-1.3** | 5.3 | 5.3 | -1.33% |  |  | 33.7 | 33.8 | -2.35% |  |  | 50.7 | 50.8 | -2.36% |  |  |
| **CE3-1.4** | 5.3 | 5.4 | -1.86% |  |  | 33.7 | 33.8 | -2.45% |  |  | 50.7 | 50.8 | -2.40% |  |  |
| **CE7-1.5** | 5.3 | 5.5 | -2.67% |  |  | 33.7 | 34.5 | -2.38% |  |  | 50.7 | 51.8 | -2.28% |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **TGM** | **All Intra (AI)** | | | | | **Random Access (RA)** | | | | | **Low Delay B (LB)** | | | | |
| CR-A | CR-T | BRS | Enc | Dec | CR-A | CR-T | BRS | Enc | Dec | CR-A | CR-T | BRS | Enc | Dec |
| **CE3-1.1a** | 11.8 | 11.8 | -0.17% |  |  | 107.1 | 107.3 | -0.46% |  |  | 124.9 | 122.9 | 0.68% |  |  |
| **CE3-1.1b** | 11.8 | 11.6 | 1.10% |  |  | 107.1 | 106.4 | 0.36% |  |  | 124.9 | 122.9 | 0.97% |  |  |
| **CE3-1.1c** | 11.8 | 12.5 | -5.09% |  |  | 107.1 | 116.7 | -6.75% |  |  | 124.9 | 137.0 | -6.89% |  |  |
| **CE3-1.1d** | 11.8 | 12.4 | -4.53% |  |  | 107.1 | 116.2 | -6.37% |  |  | 124.9 | 136.6 | -6.63% |  |  |
| **CE3-1.2** | 11.8 | 12.3 | -3.79% |  |  | 107.1 | 115.7 | -5.96% |  |  | 124.9 | 136.0 | -6.16% |  |  |
| **CE3-1.3** | 11.8 | 11.8 | 0.00% |  |  | 107.1 | 107.1 | 0.00% |  |  | 124.9 | 124.9 | 0.00% |  |  |
| **CE3-1.4** | 11.8 | 11.8 | 0.00% |  |  | 107.1 | 107.1 | 0.00% |  |  | 124.9 | 124.9 | 0.00% |  |  |
| **CE3-1.5** | 11.8 | 12.3 | -3.40% |  |  | 107.1 | 114.8 | -5.36% |  |  | 124.9 | 135.0 | -5.67% |  |  |

CE3-2 switches on BDPCM in different ways, luma only, luma+chroma.

With CE3-1, no method is better than RExt (probably because the latter is using RDPCM)

6 different methods of residual coding. All indicate additional gain when BDPCM is enabled, best results when it is done for both luma and chroma.

Best results are in the range of 8%/6% rate saving versus VTM7 anchor (without BDPCM) in case of AI, whereas RExt has 6%/4.8% rate saving

CE3-2.2 enables BDPCM in VTM7 both for luma and chroma, which saves around 2.7%/0.8% (still worse than RExt lossless, but indicates that Chroma BDPCM is beneficial for 4:2:0 as well).

Revisit: Adopt CE3-2.2 chroma BDPCM for 4:2:0 upon availability of complete results under CTC, indicating that there would be no loss. This would be an adoption of JVET-Q0089, which is a superset of JVET-Q0088

The CE shows that it is possible to have VVC compression that is better than HEVC in lossless mode, it is however coming at extreme increase of encoder run time, and approximately doubling decoder run time. From this, it may be questionable if applications of lossless coding such as archiving would ever use VVC. However, the option of lossless compression is rather important to be used locally in pictures. Even though it can be concluded that the gain observed here would also partially be observed in case of local usage, it would probably be less (depending on the portion of the picture that is lossless coded, and its content).

The best performing methods are 2-8a-2 (8.2%/6.5%), 2-8b-2 (7.8%/6.3%), 2-4 (7.7%/6.2%)

CE2-4 uses regular residual coding instead of TS residual coding, invoked by HL

CE2-8a-2 is changing the Rice parameter derivation for regular residual coding. This is improving the performance of RRC for lossless and low QP, but does not have impact on CTC.

CE2-8b-2 is doing an additional change omitting the normalization in the remainder coding (so it is simpler)

CE2-8c-2 is applying the same modification on Rice parameter derivation of CE2-8a-2 to TS residual coding, and uses that for lossless. CE2-8d-2 corressponds similarly to the CE2-8b-2, c/d don’t have a high-level switch

These modifications applied to TS residual coding are giving worse results for natural content in lossless mode, but different for screen content (AI/RA -0.7%/+0.3% class F, -2.8%/-6% for TGM)

For screen content, CE2-8a/b is also using the modified RRC in lossless case, but in lossy case (also near lossless) still uses the TS residual coding.

It can be concluded from these results, that TS residual coding is mainly good for screen content, however for lossless coding it would require a modification of Rice parameter derivation for being competitive with RRC (even the non-modified RRC of CE2-4) even for screen content.

If two different methods of residual coding are kept, some kind of switching (not implicitly coupled to TS) is needed to achieve reasonable performance in lossless coding.

Question: What is the gain of TSRC currently in CTC?

JVET-Q0363 provides results that indicates that diabling it would end up in 3.8% loss in class F, but also some loss for natural content. This indicates that the existence of an alternative entropy coding for screen content is still beneficial, even though it only performs good in lossy mode. For achieving te desited performance for lossless, CE3-2.3/4 (high-level switch between one and the other method of RC for TS) is a simple change and achieves the desirable performance.

Decision: Adopt JVET-Q0088. However, only a slice-level flag should be implemented (no SPS/PPS) Revisit: This decision may be superceded by a decision on chroma DPCM (JVET-Q0089 is a superset).

[JVET-Q0068](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8893) CE3-1.3: Using RRC for lossless coding without state transition [T.-C. Ma, H.-J. Jhu, X. Xiu, Y.-W. Chen, X. Wang (Kwai Inc.), Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek), A. Nalci, H. E. Egilmez, M. Coban, M. Karczewicz (Qualcomm), M. G. Sarwer, R. Liao, J. Luo, Y. Ye (Alibaba)]

[JVET-Q0069](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8894) CE3-1.4: On residual scanning order for lossless coding [T.-C. Ma, H.-J. Jhu, X. Xiu, Y.-W. Chen, X. Wang (Kwai Inc.)]

[JVET-Q0070](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8895) CE3-2.5: Residual coding selection signaling for lossless coding [T.-C. Ma, H.-J. Jhu, X. Xiu, Y.-W. Chen, X. Wang (Kwai Inc.), Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek), A. Nalci, H. E. Egilmez, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-Q0071](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8896) CE3-2.10: Luma BDPCM for lossless coding with RRC and residual rotation [T.-C. Ma, H.-J. Jhu, X. Xiu, Y.-W. Chen, X. Wang (Kwai Inc.), A. Nalci, H. E. Egilmez, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-Q0072](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8897) CE3-2.11: Luma and Chroma BDPCM for lossless coding with RRC and residual rotation [[T.-C. Ma](mailto:tsung-chuanma@kwai.com), [H.-J. Jhu](mailto:jhuhong-jheng@kwai.com), [X. Xiu](mailto:xiaoyuxiu@kwai.com), [Y.-W. Chen](mailto:yiwenchen@kwai.com), [X. Wang (Kwai Inc.)](mailto:xianglinwang@kwai.com), A. Nalci, H. E. Egilmez, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-Q0080](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8905) CE3-1.5: Rice parameter derivation of transform skip residual coding [M. G. Sarwer, R. -L. Liao, Y. Ye, J. Luo (Alibaba)]

[JVET-Q0081](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8906) CE3-2.6: Luma BDPCM and IBC with TSRC for lossless coding [J. Choi, H. Jang, S. Yoo, J. Heo, J. Lim, S. Kim (LGE)]

[JVET-Q0082](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8907) CE3-2.7: Luma and chroma BDPCM and IBC with TSRC for lossless coding [J. Choi, H. Jang, S. Yoo, J. Heo, J. Lim, S. Kim (LGE), A. Nalci, H. Wang, M. Coban, M. Karczewicz (Qualcomm), Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0086](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8911) CE3-2.1 and CE3-2.2: Luma/Chroma BDPCM for Lossless Coding with Transform Skip Residual Coding [A. Nalci, H. Wang, M. Coban, M. Karczewicz (Qualcomm), J. Choi, H. Jang, S. Yoo, J. Heo, J. Lim, S. Kim (LGE), Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0088](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8913) CE3-2.3: Luma BDPCM for Lossless Coding with Regular Residual Coding [A. Nalci, H. Wang, M. Coban, M. Karczewicz (Qualcomm), T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony), Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek), M. G. Sarwer, R. Liao, Y. Ye, J. Luo (Alibaba), T.-C. Ma, H.-J. Jhu, X. Xiu, Y.-W. Chen, X. Wang (Kwai), H. Jang, J. Choi, S. Kim, J. Lim (LGE)]

[JVET-Q0089](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8914) CE3-2.4: Luma and Chroma BDPCM for Lossless Coding with Regular Residual Coding [A. Nalci, H. Wang, M. Coban, M. Karczewicz (Qualcomm), T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony), Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek), T.-C. Ma, H.-J. Jhu, X. Xiu, Y.-W. Chen, X. Wang (Kwai)]

[JVET-Q0092](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8917) CE3: Modified Rice Parameter Derivation for Residual Coding (CE3-1.1, CE3-1.2, CE3-2.8 and CE3-2.9) [H. Wang, M. Karczewicz, A. Nalci, Y.-H. Chao, M. Coban (Qualcomm)]

## CE4: Inter prediction with geometric partitioning (7)

Contributions in this category were discussed Wednesday 8 Jan. 1640–XXXX in Track A (chaired by GJS).

[JVET-Q0024](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9353) CE4: Summary report on inter prediction with geometric partitioning [C.-C. Chen, R.-L. Liao, X. Xiu, H. Yang]

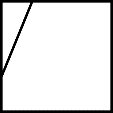
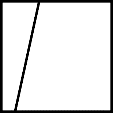
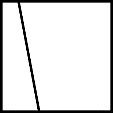
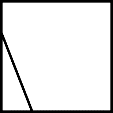
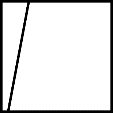
This contribution provides a summary report of Core Experiment 4 on inter prediction with geometric partitioning.

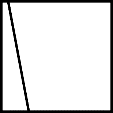
The technique proposed in JVET-P0884/JVET-P0885 was suggested to be the common base for this core experiment. All other techniques to be tested is implemented on top of the common base.

For performance evaluation, the common base is requested to be compared with both VTM-7.0 and VTM-7.0 with TPM off. All other tests is requested to be compared with the common base.

***Common base in JVET-Q0079 (Huawei, Alibaba, Qualcomm, RWTH Aachen)***

*VVC-7.0 TPM Generalized as GEO*

Ein Bild, das Objekt enthält.

Automatisch generierte Beschreibung

……**…**

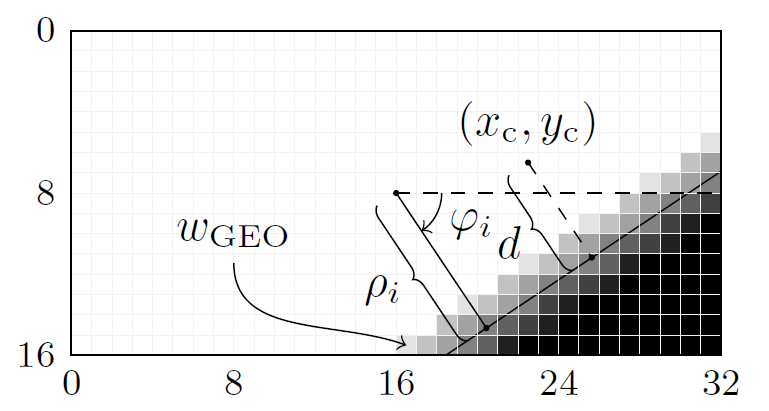
Examples for GEO modes

The common base of geometric partitioning is defined as the method descripted in JVET-P0884&JVET-P0885. The total number of geometric partitioning mode is 82, which is composed with 24 slope based angle and 4 distance for each angle. For angles larger than or equal to slope -1, the distance 0 is redundant and is removed. Besides, the horizontal and vertical angles with distance 0 is removed since it is overlapped with binary tree split. Therefore, the total number of geometric partitioning mode is 24×4 − 12 – 2 = 82. Note that the VTM-7.0 TPM is harmonized into the design of the common base as the two diagonal partitioning modes.



Angles distribution of GEO partitions in the common base

The GEO mode is applied to a merge block whose width and height are larger than or equal to 8. When a block coded using GEO mode, an index is signaled to indicate which one of 82 partitioning modes is used to split the block into two partitions. Each partition is inter predicted with its own motion vector. After predicting each of the partition, the sample values along the partitioning edge are adjusted using a blending processing with weights. This is the prediction signal for the whole block, and transform and quantization process will be applied to the whole block as in other prediction modes.



An example of blending mask for GEO

|  |  |  |
| --- | --- | --- |
| **Test #** | **Description** | **Source** |
| Common base | Geometric partitioning for merge mode as in JVET-P0884&JVET-P0885 | JVET-Q0079 |
| 4-1 | Common base simplification by reducing the number of partition mode to e.g. 64 | JVET-Q0059 |
| 4-2.1 | Block size restriction of GEO, disable GEO for block size greater than 64×64 | JVET-Q0077 |
| 4-2.2 | Block size restriction of GEO, disable GEO for block size greater than 32×32 | JVET-Q0077 |
| 4-3.1 | Disallow SBT for GEO mode | JVET-Q0062 |
| 4-3.2 | Disallow SBT for GEO mode when displacement is 0 | JVET-Q0062 |
| 4-4 | Adaptive blending for screen content | JVET-Q0060 |
| 4-5 | GEO with a single mode for 4xN and Nx4 CU | JVET-Q0091 |
| 4-6 | Combination of geometric partitioning and CIIP | JVET-Q0078 |
| Combined test 1\* | CE4-1+CE4-2.1+CE4-3.1 | JVET-Q0061 |
| Combined test 2\* | CE4-1+CE4-2.1+CE4-3.2 | JVET-Q0061 |

\* It was requested by the proponents and agreed on CE reflector to include the results of combined tests of test 4-1, 4-2 and 4-3 in CE4 report for providing more information for consideration.

The common base is compared against two anchors, VTM-7.0 and VTM-7.0 with TPM off. The two sets of results are shown in the table below.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access Main 10** | | | | | **Low delay B Main10** | | | | |
| **Anchor** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| VTM-7.0 | -0.28% | -0.35% | -0.34% | 103% | 100% | -0.70% | -0.67% | -0.77% | 103% | 100% |
| VTM-7.0 w/o TPM | -0.66% | -0.98% | -1.01% | 104% | 99% | -1.61% | -1.93% | -1.98% | 106% | 98% |

All other tests are compared against the common base.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access Main 10** | | | | | **Low delay B Main10** | | | | |
| **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| 4-1 | 0.00% | -0.01% | 0.03% | 99% | 100% | 0.00% | 0.10% | 0.10% | 99% | 99% |
| 4-2.1\* | -0.01% | -0.01% | -0.03% | 99% | 99% | 0.06% | -0.06% | 0.06% | 100% | 98% |
| 4-2.2\* | 0.00% | -0.03% | -0.03% | 99% | 99% | 0.22% | 0.10% | 0.24% | 99% | 99% |
| 4-3.1 | 0.04% | 0.08% | 0.04% | 96% | 95% | 0.11% | -0.04% | -0.05% | 95% | 98% |
| 4-3.2 | -0.01% | 0.01% | 0.00% | 97% | 95% | 0.07% | 0.05% | 0.19% | 96% | 97% |
| 4-4 | / | / | / | / | / | / | / | / | / |  |
| 4-5 | -0.05% | -0.02% | -0.09% | 100% | 97% | -0.03% | -0.10% | 0.13% | 100% | 95% |
| 4-6 | -0.05% | 0.00% | 0.01% | 102% | 101% | -0.08% | -0.21% | -0.19% | 102% | 103% |
| Combined test 1 | 0.03% | 0.01% | 0.02% | 98% | 98% | 0.12% | 0.07% | 0.39% | 98% | 96% |
| Combined test 2 | -0.01% | 0.04% | 0.06% | 98% | 98% | 0.06% | 0.15% | 0.24% | 98% | 97% |

\* It was pointed out in the CE4 reflector that the number of SATD and RDO checkings are increased to 60 and 8.

Results for Class F and Class SCC is shown for CE4-4 since the test applies to screen content only. The performance compared against the common base, VTM-7.0, and VTM-7.0 without TPM are shown separately, since the data reflecting the behaviour of the common base on screen content are not provided elsewhere in CE4 report.

CE4-4 test results for SCC-oriented content

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Random Access Main 10** | | | | | **Low delay B Main10** | | | | |
| **Anchor** | **Sequence** | Y | U | V | EncT | DecT | Y | U | V | EncT | DecT |
| VTM-7.0 | Class F | -0.51% | -0.51% | -0.46% | 100% | 99% | -0.70% | -1.03% | -0.27% | 102% | 98% |
|  | TGM420 | -2.50% | -2.19% | -2.12% | 99% | 99% | -3.26% | -2.95% | -2.94% | 101% | 99% |
| VTM-7.0 | Class F | -0.76% | -0.92% | -0.85% | 102% | 100% | -1.14% | -1.10% | -1.43% | 105% | 99% |
| w/o TPM | TGM420 | -2.54% | -2.33% | -2.27% | 101% | 99% | -3.33% | -3.08% | -3.02% | 103% | 99% |
| Common | Class F | -0.19% | -0.12% | -0.13% | 100% | 100% | -0.20% | -0.12% | 0.03% | 100% | 101% |
| base | TGM420 | -2.03% | -1.52% | -1.46% | 99% | 99% | -2.82% | -2.19% | -2.10% | 99% | 100% |

From an implementation perspective, the generalized scheme was said to not be substantially more difficult to implement than the triangle-only method in the VTM.

A proponent asserted that the generalized scheme has a subjective benefit. At the previous meeting, there had been some benefit preliminarily reported from snapshot viewing, but testing of video sequences was inconclusive.

Another participant commented that if the scheme was optimized for subjective quality rather than PSNR maximization, this tool has more potential for benefit than others, as it improves the ability to align segmentation boundaries with true object boundaries.

A similar method, known as wedge coding, has been used for depth coding in 3D-HEVC, and was helpful for its edge alignment benefit.

It was commented that real-time encoders may choose to use edge detection to assist with determining the wedge segmentation with the scheme.

The benefit in the low-delay case, as well as potential subjective benefit, was emphasized by some participants.

At the previous meeting, the tested CE proposal had been to have a separate mode from TPM rather than a replacement with a generalized mode. The generalized scheme, referred to here as the “common base”, had then been established as one of two anchors for this CE cycle.

A concern was expressed about verification effort. However, the implementation impact of this is otherwise not significant. The text impact is also minor. Aside from removing the use of TPM as a separate mode, the design of the geometric partitioning has been stable for two meeting cycles.

Among the schemes tested in the CE, it was agreed to adopt some form of the generalized geometric partitioning with 64 modes and no CUs with width or height greater than 64 or with width or height less than 8, and allow SBT in geometric partitioned CUs, with no flag for disabling blending and with no CIIP combination scheme. This corresponds to the common base plus 4-1 and 4-2.1 (i.e., 4-1 with a block size restriction). Text is in Q0059 and the block restriction text (a single conditioning test in a syntax table) is in Q0077.

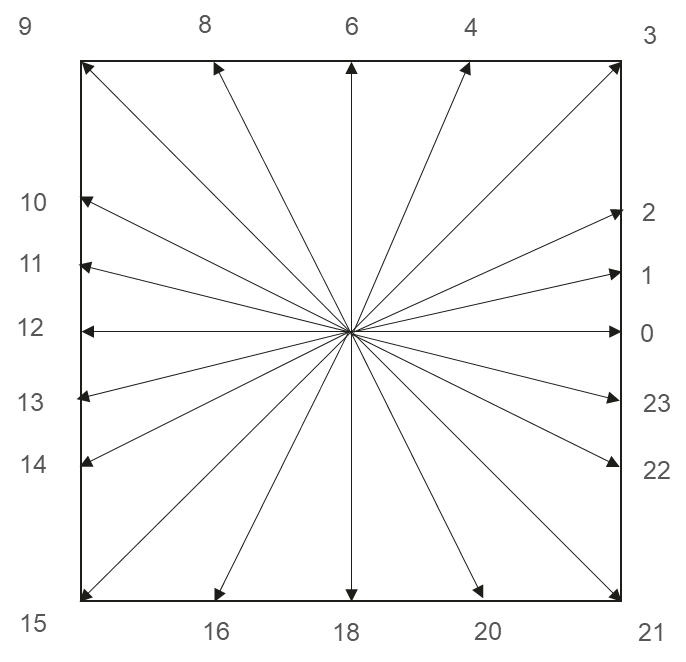
Decision: Adopt Q0059 with the block size restriction of Q0077. The Q0059 proponent will provide the software.

The following is integrated text of the entire GEO package:

[JVET-Q0806](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9652) Integrated Text for GEO [?? (Huawei), ??] [late] [miss]

TBP?

***Test 4-1 in JVET-Q0059 (Huawei, Alibaba, Qualcomm RWTH Aachen)***

(a) 82 partition modes in the common base (b) 64 partition modes in test 4-1

Figure: Angles distribution of GEO partitions

In test 4-1, the number of GEO partitions of the common base is reduced from 82 modes to 64 modes. i.e. 20 angles and 4 distances. Comparing to the common base, the angles {5, 7, 17, 19} are removed since in nature video sequences the motion objects are mostly vertical layout and the near horizontal split modes are less frequently used. Besides, the horizontal angles {0, 12} and vertical angles {6, 18} with distance index 0 are removed since these partitioning are overlapped with ternary tree splitting. The total number of geometric partitioning mode can be calculated as 20×3 + 10×3 − 4 − 2 = 64.

***Test 4-2.1 & 4-2.2 in JVET-Q0077 (Bytedance)***

In test 4-2.1, GEO mode is disabled for a block which width or height is greater than 64.

In test 4-2.2, GEO mode is disabled for a block which width or height is greater than 32.

***Test 4-3.1 & 4-3.2 in JVET-Q0062 (Qualcomm, Hikvision)***

In test 4-3.1, SBT is disabled for GEO mode.

In test 4-3.2, SBT is disabled for GEO mode when displacement is 0.

***Test 4-4 in JVET-Q0060 (Huawei, RWTH Aachen)***

In test 4-4 the blending process is turned off for SCC in order to avoid over smoothing the sharp edges of screen contents. A SPS-level control flag and a picture header blending-off flag is introduced to control the blending process on and off.

***Test 4-5 in JVET-Q0091 (Nokia)***

In test 4-5, the GEO of common base is extended to support 4xN and Nx4 CU. For these CU dimensions, GEO skips wedge\_partition\_idx syntax, and allows one partitioning angle (either horizontal or vertical) and one distance. For 4xN CU, GEO employs vertical angle blending weights. For Nx4 CU, GEO employs horizontal angle blending weights. Motion vector prediction and blending operation of GEO with a single mode for 4xN and Nx4 CU are aligned with the GEO of common base.

***Test 4-6 in JVET-Q0078 (BBC)***

An intra predictor and an inter predictor are computed for a block. The inter predictor and the intra predictor are combined using the geometric partitioning scheme as in the common base. The intra predictor is generated as Planar mode and is used in one of the two GEO partitions, and the inter predictor is used in the other GEO partition. The blending scheme as used in GEO is used to blend the two GEO partitions.

There are four candidate GEO partition modes available and the syntax geo\_ciip\_mode is signalled for indication. The set of the four candidates is adaptively selected based on whether the above and the left neighbouring CU is intra coded or not, using a pre-computed LUT.

[JVET-Q0079](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8904) CE4 Common Base: Geometric inter prediction [H. Gao, S. Esenlik, E. Alshina, A. M. Kotra, B. Wang (Huawei), K. Reuze, C.-C. Chen, H. Huang, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm), R.-L. Liao, J. Chen, Y. Ye, J. Luo (Alibaba), M. Bläser, J. Sauer (RWTH Aachen)]

[JVET-Q0059](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8884) CE4-1: Geometric Inter Prediction with 64 Modes [H. Gao, S. Esenlik, E. Alshina, A. M. Kotra, B. Wang (Huawei), R.-L. Liao, J. Chen, Y. Ye, J. Luo (Alibaba), K. Reuzé, C.-C. Chen, H. Huang, W.-J. Chien, V. Seregin (Qualcomm), M. Bläser, J. Sauer (RWTH Aachen)]

[JVET-Q0060](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8885) CE4-4: Geometric Inter Prediction with Adaptive Blending for SCC [H. Gao, S. Esenlik, E. Alshina, A. M. Kotra, B. Wang (Huawei), M. Bläser, J. Sauer (RWTH Aachen)]

[JVET-Q0062](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8887) CE4-3: Constrain SBT for GEO mode [H. Huang, T. Hsieh, V. Seregin, K. Reuze, C.-C. Chen, H.E. Egilmez, W.-J. Chien, M. Karczewicz (Qualcomm), L. Xu, X. Cao, Y. Sun, F. Chen, L. Wang (Hikvision)]

[JVET-Q0077](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8902) CE4-2: Block size restriction of GEO [Z. Deng, L. Zhang, H. Liu, K. Zhang, Y. Wang (Bytedance)]

[JVET-Q0078](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8903) CE4-6: Combination of geometric partitioning and CIIP [S. Blasi, G. Kulupana (BBC)]

[JVET-Q0091](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8916) CE4-5: Single mode partition for 4xN and Nx4 CU [K. Panusopone, S. Hong, L. Wang (Nokia)]

## CE5: Cross-component adaptive loop filtering (7)

Contributions in this category were discussed Wednesday 8 Jan. 1750–1900 in Track B (chaired by JRO).

[JVET-Q0025](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9317) CE5: Summary Report on Cross Component Adaptive Loop Filtering [C.-Y. Chen, A. Segall]

Initially presented Wed. 8 Jan. 1750-1900

|  |  |  |
| --- | --- | --- |
| **Test #** | **Description** | **Source** |
| Common base | Cross-component Adaptive Loop Filter as in JVET-P1008 (Option 1) | JVET-Q0058 |
| CE5-1 (Alternative Filter Shapes) | | |
| CE5-1.1 | 5x4 filter shape with 8 coefficients | JVET-Q0085 |
| CE5-1.2 | 3x2 filter shape with 6 coefficients | JVET-Q0097 |
| CE5-1.3 | 3x4 filter shape with 6 coefficients | JVET-Q0093 |
| CE5-1.4 | Joint Cb/Cr CC-ALF with one additional weight and CTU level selection | JVET-Q0229 |
| CE5-1.5 | Joint Cb/Cr CC-ALF with one additional weight and block level selection | Withdrawn |
| CE5-2 (Complexity reduction of the filtering process) | | |
| CE5-2.1 | Multiplication removal with coefficient range in [-64, 64] | JVET-Q0073 |
| CE5-2.2 | Multiplication removal with coefficient range in [-8, 8] | JVET-Q0095 |
| CE5-3 (Combination Tests) | | |
| CE5-3.1 | CE5-2.1 + 5x5 filter shape with 13 coefficients | JVET-Q0073 |
| CE5-3.2 | CE5-1.4 + CE5-2.1  Joint Cb/Cr CC-ALF with one additional weight and CTU-level selection combined with multiplication removal with coefficient range in [-64,64] | JVET-Q0229 |
| CE5-Supplemental | | |
| S1 | Performance of CE5 common base with 8-bit dynamic range | JVET-Q0074 |

Results on AI and RA

The common base is compared against VTM-7.0 and results are shown in the table below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | | | | **Random Access Main10** | | | | | | | | | |
| **Anchor** | **Y** | **U** | | **V** | | **EncT** | | **DecT** | | **Y** | | **U** | | **V** | **EncT** | | | **DecT** | |
| VTM-7.0 | 0.17% | -8.31% | | -7.06% | | 99% | | 101% | | 0.14% | | -10.14% | | -9.82% | 102% | | | 101% | |
|  | **All Intra Main 10** | | | | | | | | **Random Access B Main10** | | | | | | | | | |
| **Test#** | **Y** | **U** | **V** | | **EncT** | | **DecT** | | **Y** | | **U** | | **V** | | | **EncT** | **DecT** | |
| CE5-1 (Alternative Filter Shapes) | | | | | | | | | | | | | | | | | | |
| CE5-1.1 | 0.00% | 0.13% | 0.01% | | 100% | | 98% | | 0.01% | | -0.43% | | -0.35% | | | 100% | 100% | |
| CE5-1.2 | -0.02% | 0.69% | 0.88% | | 100% | | 100% | | -0.02% | | 0.93% | | 1.08% | | | 100% | 98% | |
| CE5-1.3 | -0.02% | 0.39% | 0.26% | | 99% | | 98% | | -0.01% | | 0.22% | | 0.31% | | | 99% | 99% | |
| CE5-1.4 | -0.06% | 2.15% | 2.03% | | 100% | | 99% | | 0.01% | | 1.34% | | 1.34% | | | 100% | 99% | |
| CE5-2 (Complexity reduction of the filtering process) | | | | | | | | | | | | | | | | | | |
| CE5-2.1 | -0.03% | 0.53% | 0.36% | | 100% | | 100% | | 0.01% | | 0.08% | | 0.06% | | | 100% | 100% | |
| CE5-2.2 | -0.03% | 0.74% | 0.60% | | 100% | | 100% | | 0.00% | | 0.35% | | 0.45% | | | 100% | 100% | |
| CE5-3 (Combination Tests) | | | | | | | | | | | | | | | | | | |
| CE5-3.1 | 0.01% | -0.20% | -0.61% | | 100% | | 101% | | 0.01% | | -0.55% | | -0.71% | | | 100% | 101% | |
| CE5.3.2 | -0.07% | 2.59% | 2.28% | | 99% | | 97% | | 0.01% | | 1.44% | | 1.48% | | | 99% | 97% | |
| CE5-Supplemental | | | | | | | | | | | | | | | | | | |
| S1 | 0.02% | -0.08% | 0.12% | | 100% | | 100% | | 0.00% | | 0.05% | | 0.13% | | | 100% | 101% | |

Results on low delay

The common base is compared against VTM-7.0 and results are shown in the table below.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low Delay B Main 10** | | | | | **Low Delay P Main10** | | | | |
| VTM-7.0 | 0.12% | -13.00% | -9.48% | 99% | 98% | 0.13% | -12.89% | -9.29% | 98% | 100% |

All other tests are compared against the common base.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low Delay B Main 10** | | | | | **Low Delay P Main10** | | | | |
| **Test#** | **Y** | **U** | **V** | **EncT** | **DecT** | **Y** | **U** | **V** | **EncT** | **DecT** |
| CE5-1 (Alternative Filter Shapes) | | | | | | | | | | |
| CE5-1.1 | -0.03% | -0.50% | -0.81% | 101% | 101% | -0.01% | -0.70% | -0.93% | 101% | 101% |
| CE5-1.2 | -0.01% | 1.95% | 1.54% | 101% | 102% | - | - | - | - | - |
| CE5-1.3 | 0.01% | 0.22% | 0.23% | 100% | 99% | - | - | - | - | - |
| CE5-1.4 | -0.01% | 0.25% | -0.01% | 100% | 100% | -0.01% | 0.12% | -0.03% | - | - |
| CE5-2 (Complexity reduction of the filtering process) | | | | | | | | | | |
| CE5-2.1 | -0.01% | -0.24% | -0.13% | 100% | 101% | 0.02% | -0.17% | -0.31% | 100% | 99% |
| CE5-2.2 | 0.02% | -0.08% | -0.10% | 100% | 99% | 0.00% | -0.13% | -0.25% | 100% | 99% |
| CE5-3 (Combination Tests) | | | | | | | | | | |
| CE5-3.1 | -0.01% | -1.52% | -1.82% | 100% | 101% | 0.01% | -1.52% | -1.73% | 99% | 99% |
| CE5.3.2 | -0.01% | 0.16% | -0.08% | 99% | 97% | - | - | - | - | - |
| CE5-Supplemental | | | | | | | | | | |
| S1 | -0.02% | 0.31% | 0.70% | 100% | 100% | 0.01% | 0.33% | 0.56% | 100% | 99% |

These results indicate that the additional parameters cause some rate increase reflected by the luma loss, whereas the chroma components have significant gain.

In previous, there had been experiments shifting back some of the chroma gain to luma (by QP adjustment), which suggested an overall gain around 1% AI, 1.16% RA, 0.5% LDB/LDP

To address the unequal balance of luma/chroma gains, the method established in AHG 13 (Y/Cb/Cr weighted averaging of BD rates with 8:1:1) was used additionally, giving the following results, whoch are somewhat suggesting higher overall gains:

The common base is compared against VTM-7.0 and results are shown in the table below.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **YUV Metric** | | | | **EncT** | | **DecT** | |
| **Anchor** | **AI** | **RA** | **LDB** | **LDP** | **Min** | **Max** | **Min** | **Max** |
| VTM-7.0 | -1.40% | -1.88% | -2.15% | -2.11% | 98% | 102% | 98% | 101% |

All other tests are compared against the common base.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **YUV Metric** | | | | **EncT** | | **DecT** | |
| **Test #** | **AI** | **RA** | **LDB** | **LDP** | **Min** | **Max** | **Min** | **Max** |
| CE5-1 (Alternative Filter Shapes) | | | | | | | | |
| CE5-1.1 | 0.01% | -0.07% | -0.16% | -0.17% | 100% | 101% | 98% | 101% |
| CE5-1.2 | 0.14% | 0.19% | 0.34% | - | - | - | - | - |
| CE5-1.3 | 0.05% | 0.05% | 0.05% | - | 99% | 100% | 98% | 99% |
| CE5-1.4 | 0.37% | 0.28% | 0.02% | - | - | - | - | - |
| CE5-2 (Complexity reduction of the filtering process) | | | | | | | | |
| CE5-2.1 | 0.07% | 0.02% | -0.05% | -0.03% | 100% | 100% | 99% | 101% |
| CE5-2.2 | 0.11% | 0.08% | 0.00% | -0.04% | 100% | 100% | 99% | 100% |
| CE5-3 (Combination Tests) | | | | | | | | |
| CE5-3.1 | -0.07% | -0.12% | -0.34% | -0.32% | 99% | 100% | 99% | 101% |
| CE5.3.2 | 0.43% | 0.30% | 0.00% | - | - | - | - | - |
| CE5-Supplemental | | | | | | | | |
| S1 | 0.02% | 0.02% | 0.09% | 0.10% | 100% | 100% | 99% | 101% |

Additional results shown for HDR:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **wYUV Metric** | | **YUV Metric** | | **EncT** | | **DecT** | |
| **Anchor** | **AI** | **RA** | **AI** | **RA** | **Min** | **Max** | **Min** | **Max** |
| VTM-7.0 | -3.01% | -3.32% | -3.19% | -3.38% | 100% | 101% | 102% | 102% |
|  |  |  |  |  |  |  |  |  |
|  | **wYUV Metric** | | **YUV Metric** | | **EncT** | | **DecT** | |
| **Test #** | **AI** | **RA** | **AI** | **RA** | **Min** | **Max** | **Min** | **Max** |
| CE5-1 (Alternative Filter Shapes) | | |  |  |  |  |  |  |
| CE5-1.1 | 0.19% | 0.12% | 0.20% | 0.07% | 100% | 100% | 98% | 99% |

Notes from discussion:

-It is noted that the gain suggested by the “YUV metric” above may not really reflect the rate saving. It is the metric that had previously been used in AHG13. It is not the weighted PSNR, which unveils rather 1% for AI, 1.28% for RA, 1% for LB/LP. Similar gains had been reported previously when shifting rate from luma to chroma by QP adjustment.

- CE5-1.1 has a larger filter shape – even though having same number of coefficient values (and side information to be coded) as the common base, it increases the complexity of CCALF in terms of number of operations, as the filter shape is larger. This may not be justified by the small additional benefit in compression.

- CE5-1.2 and CE5-1.3 are both reducing number of operations (6 instead of 8 multiplications), and alse need less parameters. For CE5-1.3, the loss is marginal (0.05%), for CE5-1.2, somewhat high (0.15-0.2%) compared to the common base.

- CE5-1.4 uses only one filter for Cb and Cr, but in the end applies an addional weight on one of them. This requires less parameters and also less operations (significant reduction of number of multiplications). However, the loss is larger than for the other two (0.3%-0.4% compared to common base).

More detailed complexity analysis is being prepared. Revisit on this

Since the last meeting, a mechanism has been implemented in the base encoder which disables CCALF locally in cases where it might produce artifacts. All proposals are using this, however it is noted that some of the proponents were not aware that the common base had such a mechanism.

Prepare visual testing preferably with highest possible QP (37/42), however exclude cases where the encoder has made a decision disabling the tool in most CUs

It is asserted that the difference between common base (C.B.), 5-1.1, 5-1.2 and 5-1.3 would be marginal in terms of the threat of visual artifacts. 5-1.4 might cause more chroma artifacts.

Revisit:

- Provide data about the percentage use of encoder disabling CCALF (separate fore frame types)

- Prepare viewing sessions for C.B. and 5-1.4, excluding cases where CCALF would be disabled for the vast majority of regions.

CE5-2: Complexity reduction in filtering process

Both of the following proposals are replacing multiplications by shift operations. At the same time the coding of the coefficients is modified from 6 bit to 4 bit or zero flag with subsequent 3 bit for non-zero.

CE5-2.1: Multiplication removal for cross component adaptive loop filter (JVET-P0557)

Filter coefficients are restricted to have values: {-64, -32, -16, -8, -4, -2, -1, 0, 1, 2, 4, 8, 16, 32, 64}, which are signalled as {-7, -6, -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, 6, 7} respectively before binarization in order to reduce the signalling overhead. Fixed length codes of 3 bits are used to signal the absolute values of the coefficients. Another sign bit is signalled for non-zero coefficients.

CE5-2.2: Multiplication removal for cross component adaptive loop filter (JVET-P0666)

Filter coefficients are restricted to have values: {-8, -4, -2, -1, 0, 1, 2, 4, 8}. A bit is first signalled to indicate whether it is a zero coefficient. If not, a fixed length code of 2 bits is used to signal the absolute value of the coefficient followed by a sign bit.

Both come with loss, but the loss of CE5-2.1 is less, and the additional complexity advantage is low. CE5-2.1 could be interesting as additional complexity reduction, but it is not necessary to conduct viewing, as the source of artifacts is likely not due to quantization of filter coefficients. Could be an interesting candidate as add-on to whatever base is used.

CE5-3-1 is not really a combination test, but using a 5x5 filter shape (larger than C.B., and even larger than 5-1.1), and also sends 13 coefficients instead of 8. This increases the overall number of operations, and in particular for software could decrease the throughput.

CE5-3-2 combines the complexity reduction of 5-1.4 and 5-2.1. This is the most aggressive reduction of complexity that is investigated in this CE, however also decreasing the performance (0.3-0.4% relative to C.B.). Better investigate this in terms of visual quality rather than 5-1.4.

Revisit after further complexity analysis, and after conducting the visual investigation of C.B. and 5-3.2. Provided that there are no visual problems, further decision for possible adoption to be made on basis of tradeoff objective performance vs. complexity.

Further discussion Fri 10 Jan. 1120:

- Complexity analysis prepared -> update CE report

- BoG has met Fri morning, further meeting in the afternoon

- Informal viewing prepared for Friday

- further review on Sat.

It is noted that informal viewing might be better suitable to identify if there are visual artifacts.

[JVET-Q0778](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9624) Report on CE5 informal viewing session [M. Wien (RWTH)]

An informative viewing session was held on January 10th 2020 from 19:00h to 20:00h in the BOZAR viewing room. The meeting was announced on the JVET email reflector in the afternoon of the same day. There were 8 viewing participants, including 2 proponents. A group of two non-proponents and two proponents additionally inspected some sequences on January 11th at 11:00h. The CE5 Common Base and CE5-3.2 were assessed in comparison to the VTM7 anchor. A total of 5 A-B comparisons of proposals against their anchors were performed, with a randomized and undisclosed assignment of the anchor and the proposal to A or B. The presented sequences were selected by decreasing frequency of tool usage. Each set was shown multiple times according to the request of the participants and participants were encouraged to watch each set from different viewing positions. Non-proponent comments and expressions of preference were collected first before allowing proponents to comment. Only after completion of this assessment, the A-B assignment of anchor and proposal was disclosed. A slight preference for the anchor was expressed in some cases, a slight preference for the Common Base was expressed in one case. It was noted that CCALF seems to slightly amplify chroma in some cases. For the Cactus sequence, also the uncompressed test sequence was assessed and some chroma misalignment issues were identified. For one test point, a divergence in the sequence length was only identified during the session and the test point was excluded from the assessment.

The sub-CE results are recorded here in the order of the conducted visual assessments. The proponents were requested to recommend the sequences to assess. It was suggested to sort the test points by decreasing frequency of usage of CCALF. Due to very low to zero usage, QP42 test points were skipped and only one QP37 test point was assessed. Before starting the assessment, the proponents were asked to briefly summarize tool under test and indicate the expected changes.

For all test points, the Common Base (C.B.) test cell was shown, followed by the CE5-3.2 test cell. The participants were asked to change their viewing position before repeating the same presentation order. Comments were collected after each test cell was shown at least twice.

|  |  |
| --- | --- |
| **Test point** | **Comments** |
| S03 RedKayak QP32 | One viewer expressed very slight undefined preference for proposal in the C.B. test cell but overall no preference for both C.B. and 5-3.2. Some subtle differences noted. |
| S02 Campfire QP32 | Two expressions of slight undefined preference for anchor in C.B. case, no preferences otherwise |
| S04 Cactus QP32 | Two slight undefined preferences for anchor for 5-3.2 were recorded |
| S01 FoodMarket QP32 | C.B.: no preference.  5-3.2 Version has wrong number of frames, and therefore not assessed |
| S02 Campfire QP37 | Two slight undefined preferences for Anchor for C.B. |

For the Cactus sequence, also the uncompressed test sequence was assessed and some chroma misalignment issues were identified.

Campfire, RedKayak, and Cactus were further inspected by a group of two non-proponents and two proponents in a second session on January 11th. Some differences were observed between C.B. and the anchor for Campfire which might have been induced by variations in encoder decisions. Some chroma amplification was observed for C.B. compared to the VTM also for RedKayak. An assessment of the original sequence revealed chroma misalignment issues in these areas. Some of the chroma amplification observed in Cactus for C.B. compared to VMT was assessed to potentially be induced by similar variations in the original sequence.

Generally, only very subtle differences were observed and no clear sources for indicated preferences could be recorded. It was noted that CCALF seems to slightly amplify chroma in some cases. It could not be excluded that these would stem from features in the original sequences.

Overall conclusion:

- visual problems of colour artifacts observed in last meeting seem to be resolved

- no improvement of quality, though

Following comments are further made:

- It should be clear that, if CCALF is wrongly used, it might introduce artifacts (however, an encoder exists that resolves that

- If adopted, it would be desirable having an SPS flag for disabling, as encoders targeting best subjective quality might not want to use it.

- If adopted, how would we deal with the balance of the luma/chroma gain?

A complexity analysis was made that will be uploaded with a revision of JVET-Q0025.

CE5-1.1 is slightly more complex than C.B.

Simplified proposals that keep almost all gain of C.B. are CE5-1.3 and CE5-2.1, where the first is reducing number of mul/add from 4 to 3, whereas the latter keeps 4 adds, and replaces 4 mul by 4 shift ops.

CE5-1.4 uses joint filter op for both chroma components, which reduces the number of mul/add from 4 to 2.25.

CE5-3.2 (the least complex solution) is like CE5-1.4, but replaces mul by shift.

Both CE5-1.4 and CE5-3.2 have higher loss in objective performance.

Is 1% gain in AI, 1.2-1.3% in RA, 1% in LB/LP justifying the increase of complexity with 3 mul/add or 4 shi/add? This seems to be in a similar range of complexity vs. compression benefit as with ALF.

It is agreed that 5-2.1 is the preferrable solution because it retains the gain of C.B., uses the same filter shape (whereas 5-1.3 introduces an asymmetry), and replaces multiplies by shift operations. From the CE5 results, 5-2.1 is considered as adopted. The BoG should investigate potential further improvements of that method.

In terms of signalling, it is suggested that, as it is unlikely that CCALF would be used without ALF, to have an enabling mechanism in SPS that invokes CCALF only when ALF is on. It is noted this is a similar case as BDPCM which can only be enabled when TS is on.

Further mechanisms of disabling at lower level to be considered in BoG.

The maximum of filter sets in CCALF is 8 per APS (as in the C.B.).

[JVET-Q0058](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8883) CE5 Common Base: Cross Component Adaptive Loop Filter [K. Misra, F. Bossen, P. Cowan, A. Segall (Sharp Labs of America), N. Hu, J. Dong, V. Seregin, M. Karczewicz (Qualcomm), P. Onno, C. Gisquet, G. Laroche (Canon), J. Li, C.S. Lim, C.-W. Kuo (Panasonic), J. Nam, J. Choi, J. Lim, S. Kim (LGE), O. Chubach, C.-Y. Lai, C.-Y. Chen, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0073](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8898) CE5-2.1, CE5-3.1: Multiplication removal for cross component adaptive loop filter and 5x5 filter shape [N. Hu, J. Dong, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-Q0085](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8910) CE5-1.1: CCALF with 5x4 filter shape and 8 filter coefficients [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)]

[JVET-Q0093](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8918) CE5-1.3: CCALF with 6 filter coefficients [Y. Zhao, A.M. Kotra, H. Yang (Huawei)]

[JVET-Q0095](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8920) CE5-2.2: Multiplication removal for CCALF with coefficient range in [-8, 8] [G. Li, X. Li, X. Zhao, L. Zhao, Y. Du, S. Liu (Tencent), N. Hu, J. Dong, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-Q0097](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8922) CE5-1.2: Cross-component ALF simplification with 6-tap filter [J. Li, C. S. Lim (Panasonic)] [late]

[JVET-Q0229](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9054) CE5: Report of CE5-1.4 and CE5-3.2 on Joint chroma cross-component adaptive loop filtering [Y. He, F. Le Léannec, E. François (InterDigital)] [late]

# Non-CE Technology proposals

## CE1 related – Deblocking filtering (4)

Contributions in this category were discussed Friday 10 Jan. 1710–1815 in Track B (chaired by JRO).

[JVET-Q0141](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8966) Non-CE1/Non-CE3: Deblocking filter control for lossless blocks [K. Unno, K. Kawamura, S. Naito (KDDI)]

In this contribution, it is proposed that disabling deblocking filter for inside a TU when transform skip is applied to the TU and Qp′of the TU is less than or equal to 4. In terms of deblocking filter control, it can be guaranteed that the TU is completely lossless by the proposed method. This functionality is supported by HEVC RExt.

The intended lossless coding can be achieved if the encoder takes care that adjacent blocks have sufficient small QP values. The proposal would impose more conditions on the deblocking filter which is undesirable.

No action.

[JVET-Q0191](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9016) Deblocking filter process with considering dependent quantization [C.-M. Tsai, C.-W. Hsu, C.-Y. Lai, Z.-Y. Lin, O. Chubach, T.-D. Chuang, C.-C. Chen, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

In this contribution, a bugfix is proposed to consider the effective quantization parameter (QP) in deblocking filter (DF) process when the dependent quantization (DQ) process is applied. In VVC Draft 7, when DQ is applied, the QP for dequantization is equal to QP minus 5. However, the QP minus 5 effect is not considered in deriving DF parameters (β and tc). As a simple fix, if one side of the current deblocking edge is quantized by using DQ (i.e., not coded with transform skip), the QP at the side is subtracted by 5 for deriving DF parameters. It is asserted that the proposed bugfix can reduce over-smoothing.

There is no clear evidence that there is a problem. The proposal shows some gain in BD rate, but it is well known that such gain can be achieved in deblocking by encoder tuning of parameters, whereas that might sometimes result in quality loss.

No action.

[JVET-Q0678](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9524) Cross-check of JVET-Q0191 (Deblocking filter process with considering dependent quantization) [K. Andersson (Ericsson)] [late]

[JVET-Q0321](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9146) Non-CE1: Deblocking filter decision simplification [H.-B. Teo, C. Wang, C.-S. Lim, H.-W. Sun (Panasonic)]

This contribution proposed to simplify the decision processes which selects normal or strong filtering in the deblocking filter. The proposed technique removes the multiplication steps in the decision process. The BDR impact versus VTM-7.0 is 0.00%, 0.00%, 0.00%, 0.01% for AI/RA/LDB/LDP.

It is commented that the change is changing the precision in the comparison against the beta parameters. It is not a significant simplification, as the multiplication by 2 is a simple shift, anyway.

No action.

[JVET-Q0734](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9580) Crosscheck of JVET-Q0321 (Non-CE1: Deblocking filter decision simplification) [X.W. Meng (PKU)] [late]

[JVET-Q0322](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9147) CE1-related: Long luma deblocking filter decision modification [H.-B. Teo, C. Wang, C.-S. Lim (Panasonic)]

It is claimed that sometimes filtering for long luma deblocking is applied, although it should not. The wrong decision sometime causes visual artifacts. This contribution proposed to fix the problem by changing the position of the samples used for the gradient checks when max filter length equal to 7.

The BDR impact versus VTM-7.0 is 0.00%, 0.01%, -0.02%, 0.03% for AI/RA/LDB/LDP.

It is commented that the solution adopted in CE1-1 targets solving the same problem of oversmoothing of the long filter. It is further pointed out that the suggested approach does not consider the gradient between p0/p1 and q0/q1 which are rather important in deblocking (gradient close to the block edge) which might cause other problems.

It would be too much of an effort, considering the short time until finalization of the standard, to investigate this in detail.

No action.

[JVET-Q0733](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9579) Crosscheck of JVET-Q0322 (CE1-related: Long luma deblocking filter decision modification) [X.W. Meng (PKU)] [late]

[JVET-Q0325](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9150) CE1-related: Deblocking modification for GEO [X. W. Meng (PKU), X. Zheng (DJI), S. S. Wang, S. W. Ma (PKU)]

In this contribution, deblocking filter for GEO (Geometric Partition Mode) CU boundaries is proposed. This contribution addresses the potential blocking artifacts of the current deblocking design for GEO. The potential discontinuity of block boundary is mainly caused by the discrepancy of the weights in GEO. To resolve this problem, this contribution proposes to conduct deblocking filtering on these overlooked boundaries between GEO blending area and another CU in the current VVC.

Extension of CE1-2 for GEO. No need for presentation.

[JVET-Q0634](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9480) Crosscheck of JVET-Q0325 (CE1-related: Deblocking modification for GEO) [H.-B. Teo, C. Wang (Panasonic)] [late]

[JVET-Q0478](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9305) Non-CE1: QP fix for deblocking [W. Zhu, L. Zhang, J. Xu (Bytedance)]

JVET-P1001 and JVET-P1002 proposed to align chroma deblocking QP to dequantization QP. However, in the current draft, it is not the case for transform skip coded blocks. This document proposes to clean it up, which leads to a full alignment. It is asserted that the proposed change does not influence CTC performance.

It is not obvious that there is a problem to be solved. A smart encoder can handle the case.

No action.

## CE2 related – Palette mode coding (10)

Contributions in this category were discussed Friday 10 Jan. 2050–2150 and Sat. Jan 11 0800-1035 in Track B (chaired by JRO).

(v5 of JVET-Q0022 was also presented at the beginning of that session)

[JVET-Q0291](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9116) CE2-related: On maximum palette size of VVC [M. G. Sarwer, Y. Ye, J. Luo, R. -L. Liao (Alibaba)]

In VVC7, the maximum predictor size for both joint and separate palettes are set to 63 and the maximum palette size for both joint and separate palettes are set to 31. However, the complexity of the palette generation and predictor update of separate tree is roughly double that of single palette since the separate tree need to process two palette tables for luma and chroma. This contribution proposes to reduce the maximum predictor and palette size of separate palette to the half of that of joint palette.

Following results are reported as compared to VTM-7.0.

 YUV444 (dual tree ON):

 Overall: -0.03% (AI), 0.05% (RA), 0.01% (LB) BD-rate saving

It is also proposed to signal the parameters for max palette size and max predictor size in SPS (as is the case in HEVC).

Question: Is there really a decoder complexity problem? In dual tree, probably operations can be performed in parallel. Nevertheless, the processing power for the palette prediction and table generation is doubled.

It is also mentioned that palette is more efficient in single tree case; the loss is marginal.

The suggested change of reducing the palette size to 15 and predictor size to 31 for dual tree appears reasonable. This aspect was agreed for adoption.

For the aspect of table size signalling, see further notes under JVET-Q0519.

Decision: Adopt JVET-Q0291, only the aspect that the palette size is reduced to 15 and the predictor size to 31 for dual tree case.

[JVET-Q0637](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9483) Crosscheck of JVET-Q0291: CE2-related: On maximum palette size of VVC [W. Zhu (Bytedance)] [late]

[JVET-Q0435](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9261) CE8-related: Modification of palette coding syntax structure [W. Lim, G. Bang (ETRI)] [late]

This contribution proposes to fix palette coding syntax structure described in the current VVC specification for logical correctness. In the current VVC specification, the decoding procedure of a coding unit contains palette coding for both luma and chroma components and then chroma non-palette coding syntax elements are parsed in a certain condition. Therefore, it needs to be checked whether the current coding unit is palette mode coded or not. For this correction, a simple syntax change of the current specification for coding unit is proposed.

There is obviously a bug in the spec, as obviously for the single tree case, some non-palette coding is invoked for chroma after the joint palette coding. It could be that this was introduced in the context of ACT and Chroma BDPCM.

It was confirmed later by an independent expert that the suggested text change is matching with the software (assuming the latter is correct).

Decision(BF/text): Adopt JVET-Q0435

[JVET-Q0445](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9271) AHG9/Non-CE2: On predictor palette initialization [J. Luo, Y. Ye, R. Liao, M. Sarwer, J. Chen (Alibaba)]

In VVC draft 7, the predictor palette is reset when the coding CTU is the first CTU of a slice or a tile, or the first CTU of a CTU row when entropy\_coding\_sync\_enabled\_flag is equal to 1. It is asserted that the reset of predictor palette interrupts the palette propagation and may cause undesirable coding performance loss. The contribution proposed to initialize the predictor palette with customized predictor palette signaled in APS. When a customized predictor palette is not present, the predictor palette size is reset to 0. It is reportedly shown the proposed change provide gains over VTM-7.1 in the following tests:

Test case 1: WPP synchronization is on

DualTree on : -0.19%(AI), -0.39%(RA) and -0.39%(LDB) BD rate saving

DualTree off: -0.95%(AI), -0.61%(RA) and -0.50%(LDB) BD rate saving

Test case 2: 1 CTU per tile

DualTree on : -0.78%(AI), -0.84%(RA) and -0.73%(LDB) BD rate saving

DualTree off: -2.74%(AI), -1.54%(RA) and -0.90%(LDB) BD rate saving

It is noted that the gain is relatively low, which may indicate that it might be difficult to find 64 values as predictor table which are representative for the entire picture.

DT off WPP loses 1.15%/1.62%/2.02% for AI/RA/LB

For AI, most of that loss is recovered by the proposal.

The question arises whether it is reasonable to define a new APS for a realtively specific use case (combination of palette with APS, and two-pass coding), and a gain of 0.95% for AI is relatively for the case screen content. The size of that APS is in a similar range as for ALF, which would need to be stored locally.

Part of the loss could also be recovered by the approach of JVET-Q0501, which is somewhat simpler, requires less memory, and no 2-pass encoding.

Test case 2 appears relatively unrealistic. It would be interesting to see how much loss the test cases without the change are causing to judge the benefit.

See further notes under JVET-Q702.

[JVET-Q0605](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9451) Crosscheck of JVET-Q0445 (Non-CE2: On predictor palette initialization) [T. Lu (Dolby)] [late]

[JVET-Q0477](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9304) Non-CE2: Modified coding order of syntax elements in palette mode [W. Zhu, L. Zhang, J. Xu, H-C. Chuang (Bytedance)]

In the current CG based palette mode coding, up to three stages (i.e., all copy flags and run types; palette indices; and escape values) are required to be performed for a CG coding process and for each stage, all related syntax elements for all pixels in a CG are coded. Therefore, to decode one pixel, all syntax elements in a CG must be fully decoded. This contribution presents to decode all syntax elements for a pixel together before coding a next pixel. It is asserted that higher throughput of the line-based CG palette coding could be achieved by the proposed method due to two reasons: 1) the number decoding cycles can be reduced by nearly 30%, 2) each pixel can be directly reconstructed without waiting for the whole CG. The simulation follows CE 2 test condition and results are summarized as follows.

Dual tree on:

TGM1080P: AI: 0.00%, 98%, 97%; RA: 0.00%, 98%, 100%; LDB: 0.00%, 99%, 99%.

Dual tree off:

AI: 0.00%, 98%, 98%; RA: 0.00%, 98%, 98%; LDB: 0.00%, 98%, 98%.

Highly dependent on architecture if it provides benefit. No action.

[JVET-Q0621](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9467) Crosscheck report for JVET-Q0477 (Non-CE2: Modified coding order of syntax elements in palette mode) [H. Jang (LGE)] [late]

[JVET-Q0491](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9319) CE2-related: Palette escape binarization [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

In this contribution, a new binarization method for palette escape coding is tested. The binarization of quantized escape samples is derived by invoking the fifth order Exp-Golomb binarization process. The proposed method is implemented in VTM7 and evaluated based on CE2 [1] test conditions. Simulation results are:

Dual tree OFF:

Standard QP (22, 27, 32, 37): -0.02% AI, 0.00% RA, -0.03% LB

Low QP (2, 7, 12, 17): -0.62% AI, -0.36% RA, -0.24% LB

Dual tree ON:

Standard QP (22, 27, 32, 37): -0.04% AI, 0.03% RA, 0.02% LB

Low QP (2, 7, 12, 17): -0.34% AI, -0.22% RA, -0.21% LB

The method does not have the QP dependency as the CE2-1.x methods

Gain in normal QP range is about 0, in low QP it is 0.34%/0.22%/0.21% for AI/RA/LB. This is considerably smaller than for CE2-1.x. Dual tree on somewhat larger, but that by itself is worse than DT off.

It is asked by one expert why not using EG3? Proponents respond that EG5 was found better.

In lossless, it gives 0.6% for the Dual-tree-off case.

It is just one value change in text (EG3->EG5). Confirmed by cross-checker.

Decision: Adopt JVET-Q0491 Change EG3 to EG5 in palette escape coding.

[JVET-Q0715](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9561) Crosscheck of JVET-Q0491 (CE2-related: Palette escape binarization) [Y.-H. Chao (Qualcomm)] [late]

[JVET-Q0501](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9329) Non-CE2: On palette predictor initialization in WPP [Y.-H. Chao, C.-H. Hung, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm)]

In VVC draft 7, palette predictor will be reset to 0 at the beginning of each CTU row if Wavefront Parallel Processing (WPP) is enabled. This proposal proposes to unify the initialization scheme of palette predictors used in WPP with CABAC synchronization: The palette predictor at the beginning of each CTU row will be initialized to the predictor derived from the first CTU in the previous CTU row.

The results on YUV4:4:4 sequences compared to WPP (–WaveFrontSynchro=1) in VTM7.0 are as follows:

Dual tree OFF: -0.33% AI, -0.18 % RA, -0.15% LB

Dual tree ON: -0.06% AI, -0.08 % RA, -0.02 % LB

Same method was used in HEVC for WPP. The palette predictor table from the first CTU in a CTU row needs to be stored, which requires a memory of 3x64xbitdepth.

Decision: adopt JVET-Q0501.

[JVET-Q0656](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9502) Cross-check of JVET-Q0501 (Non-CE2: On palette predictor initialization in WPP) [Y.-W. Chen (Kwai Inc.)] [late]

[JVET-Q0504](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9332) CE2-related: Palette mode for non 4:4:4 color format [R.-L. Liao, M. Sarwer, J. Chen, Y. Ye, J. Luo (Alibaba), Y.-H. Chao, C.-H. Hung, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm)]

This contribution proposes to enable the palette mode for non 4:4:4 color format including 4:2:0, 4:2:2 and monochrome color formats. To support the palette mode for non 4:4:4 color format, two modifications are made to VVC draft 7. Firstly, for a sample only containing luma component, only the luma value is signaled if the sample is coded using escape mode. This is the same as in the HEVC SCC extension. Secondly, for a local dual tree block, a default value, defined as (1 << (component bit depth - 1)), is set to the new palette entry before the palette predictor update. It is reported that, for class TGM in 4:2:0 color format, the overall performance impact for {Y, U, V} is {-6.35%, -6.21%, -5.88%} for AI, {-3.96%, -3.68%, -3.53%} for RA and {-1.42%, -1.28%, -1.27%} for LB.

The approach is similar as in HEVC. Tests are with dual tree on

For class F, the luma gains are 1.24%/1.35%/0.64% in AI/RA/LB.gains for dual tree on in case of class TGM with 4:4:4 palette were in the range of 16%/11%/5% (AI/RA/LB) for AI

The gains for 4:2:0 are somewhat still in the same range (or even lower) as they were several meeting cycles ago (in March 2019, it was reported that palette gain for AI in TGM 4:2:0 could have around 8% gain). Since then, other competing tools such as BDPCM and TS have been included.

There is no evidence why the decision made earlier (not including palette for possible 4:2:0 profile) should be revised.

The proposed approach is a minimum change to the palette design of VVC draft 7, allowing the combination of palette with local dual tree (such that it would be runnable with 4:2:0 content).

When adopting such a change of the palette tool, this would not mean to include palette in a 4:2:0 profile. It would just enable a 4:4:4 decoder that receives a 4:2:0 or 4:2:2 or 4:0:0 stream using palette tools to decode that stream (where the stream should be compliant with a 4:4:4 profile which includes palette).

Decision: Adopt JVET-Q0504

In a follow-up discussion in the plenary, it is decided not including palette in the current 4:2:0 profile. It is further pointed out that the high-level enabling flag needs to be sent independently of chroma format. The profile constraint needs to be implemented.

[JVET-Q0658](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9504) Cross-check of JVET-Q0504 (CE2-related: Palette mode for non 4:4:4 color format) [Y.-W. Chen (Kwai Inc.)] [late]

[JVET-Q0509](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9338) CE2-1.1-related: Encoder optimization with adjusted palette clustering steps [M. Wang, J. Li, L. Zhang, J. Xu, K. Zhang, H. Liu, S. Wang (Bytedance)]

(include abstract)

On top of CE2-1.1, no need for presentation

[JVET-Q0762](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9608) Crosscheck of JVET-Q0509: CE2-1.1-related: Encoder optimization with adjusted palette clustering steps [J. Luo (Alibaba)]

[JVET-Q0519](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9348) Non-CE2: On signaling of maximum palette size and maximum palette predictor size [X. Xiu, H.-J. Jhu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai)]

In HEVC standard, maximum palette table size and maximum palette predictor size are signaled in sequence parameter set (SPS) while the palette in the VVC draft 7 uses fixed maximum palette table size of 31 and fixed maximum palette predictor size of 63. In this contribution, it is proposed to bring the syntax of signaling maximum palette table size and maximum palette predictor size in the HEVC back to the palette design in the VVC. The proposed signaling was implemented on top of VTM-7.0 and tested using different maximum palette table size and maximum palette predictor size. Compared to VTM-7.0 anchors, the performance for the sequences in the category YCbCr444 TGM 1080p is summarized as

For maximum palette table size of 64 and maximum palette predictor size of 128, for lossy coding, it provides average {Y, Cb, Cr} BD-rate differences of {-0.66%, -1.23%, -0.96%} and {-0.43%, -0.79%, -0.69%} for AI and RA configurations, respectively. For lossless coding, the average AI and RA bit-rate differences are -0.47% and -0.36%.

For maximum palette table size of 32 and maximum palette predictor size of 64, for lossy coding, it provides average {Y, Cb, Cr} BD-rate differences of {2.00%, 2.95%, 2.59%} and {1.46%, 1.84%, 1.73%} for AI and RA configurations, respectively. For lossless coding, the average AI and RA bit-rate differences are 2.30% and 2.17%.

Question: Could that also be achieved by an encoder-only method (e.g. an encoder only using first 32 entries)?

It is not proposed to increase the maximum of the current spec (31 for palette, 63 for predictor). The results with larger tables are only given for information.

The proposal would mainly for the benefit of encoders. Software decoders might benefit having less power consumption when knowing that the table is smaller.

It is shown that the number of checks per CU for constructing the palette table and the predictor table is reduced by half when the configuration PLT16/Pred32 is used. It is not clear from the information given how much reduction of encoder/decoder run time would be achieved by this configurability.

[JVET-Q0716](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9562) Crosscheck of JVET-Q0519 (Non-CE2: On signaling of maximum palette size and maximum palette predictor size) [Y.-H. Chao (Qualcomm)] [late]

[JVET-Q0629](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9475) CE2-related: Palette mode excluding small blocks [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)] [late]

It is observed that applying palette mode on small CUs introduces insignificant coding gain and brings extra complexity on the small blocks. This contribution proposes to disable palette mode for CU that are smaller or equal to 16 pixels. The proposed method reports negligible BD-rate changes compared to VTM7 and reduces complexity.

The worst case complexity (in terms of palette table construction) is reduced by factor of 2, and the loss is close to zero.

The text change is simple, one additional condition on block size for sending the PLT flag.

Decision: Adopt JVET-Q0629, disable palette mode for 4x4 blocks.

Revisit: Proponents to clarify with the proponents of JVET-Q0504 if the restriction is properly expressed for dual tree chroma in 4:2:0 and 4:2:2 cases.

[JVET-Q0718](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9564) Crosscheck of JVET-Q0629 (CE2-related: Palette mode excluding small blocks) [Y.-C. Nien, T.-H. Li, Y.-C. Yang (Foxconn)] [late]

[JVET-Q0702](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9548) Non-CE2: On palette predictor initialization in WPP [Y.-H. Chao, C.-H. Hung, WChien, V. Seregin, M. Karczewicz (Qualcomm), J. Luo, Y. Ye, [R.-L.](mailto:Liao) Liao, M. Sarwer, J. Chen (Alibaba)] [late]

The contribution proposes an initialization scheme of palette predictors used in WPP with CABAC synchronization: The palette predictor at the beginning of each CTU row will be initialized to the predictor derived from the first CTU in the previous CTU row as proposed in JVET-Q0501. When a customized predictor palette APS as proposed in JVETQ-0445 is signaled to use, the customized predictor palette in APS will be used to initialized the first CTU row. Experiment results with WPP on (WaveFrontSynchro=1) in VTM 7.1 are as follows:

Dual tree OFF: -0.91% AI, -0.57 % RA, x.xx% LB

Dual tree ON: -0.18% AI, -0.35% RA, x.xx % LB

The gain of the separate proposals was:

445:

DualTree on : -0.19%(AI), -0.39%(RA) and -0.39%(LDB) BD rate saving

DualTree off: -0.95%(AI), -0.61%(RA) and -0.50%(LDB) BD rate saving

501:

Dual tree OFF: -0.33% AI, -0.18 % RA, -0.15% LB

Dual tree ON: -0.06% AI, -0.08 % RA, -0.02 % LB

The combination does not make much sense, as the standalone gain of JVET-Q0445 is larger.

On the other hand, the approach of JVET-Q0501 is much simpler, as it just needs some additional storage and does not require defining a new APS just for that purpose.

To judge the benefit of these gains, information is requested how large the loss of WPP against not using it is, such that it is possible to see how much of that loss is recovered by the proposals.

Revisit.

[JVET-Q0742](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9588) Crosscheck of JVET-Q0702 (Non-CE2: On palette predictor initialization in WPP) [T. Lu (Dolby)] [late]

[JVET-Q0801](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9647) CE2/CE3-related: Lossless coding for palette coding [S. Yoo, J. Choi, J. Lim, S. Kim (LGE)] [late]

Overall conclusion: No need to continue CE2.

## CE3 related – Lossless coding (25)

Contributions in this category were discussed Thursday 9 Jan. 1100–1300 and 1430-1600 in Track B (chaired by JRO).

[JVET-Q0056](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8881) CE3-related: Level prediction for transform skip samples [J. Lainema (Nokia)]

Current draft VVC standard uses level prediction for transform skip samples when entropy coding is in non-bypass mode. In the current approach, the absolute value of a transform skip sample is predicted by selecting the maximum of the absolute values of its top and left neighbors. In bypass mode this “absLevel prediction” is disabled as in that case the prediction process was already earlier reported to have a negative impact on coding efficiency.

This contribution proposes to use an average based prediction for the values of transform skip coefficients when entropy coding engine is in bypass mode. This is reported to have -3.07 %, -1.05 % and -0.87 % BD-rate impact in lossless AI, RA and LD-B configurations, respectively. In lossy coding, for both standard QP range and low QP range, all configurations are reported have average coding efficiency impact within 0.01 % from the anchors.

Additional results with different configurations of the proposed change and CE3 tests are provided. For example, when the proposed change is applied together with CE3-2.8c and the VTM absLevel prediction for non-bypass transform skip samples is switched off, the lossless coding results are reported as -8.67 %, -5.20 % and -4.60 % for AI, RA and LD-B configurations, respectively.

This method has benefit for TSRC only for lossless. It would still not make TSRC competitive with RRC in lossless mode. On top on of the CE3-2.3 adoption, it would not give benefit.

Though in combination with changes of Rice parameter coding (CE3-2.8..) the method would make modified TSRC competitive with modified RRC in AI case for natural content, this would still not apply for RA, so a switch would still be needed.

No action.

[JVET-Q0706](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9552) Crosscheck of JVET-Q0056 (CE3-related: Level prediction for transform skip samples) [Y. Kato (Panasonic)] [late]

[JVET-Q0107](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8932) CE3-related: Flag-free Lossless Coding in VVC [A. Nalci, M. Karczewicz, H. Wang, H. E. Egilmez, M. Coban (Qualcomm)]

This document proposes a flag-free approach for lossless coding in VVC. Currently, lossless coding is possible via existing syntax with TS residual coding. However, TS residual coding has lesser bit-rate savings as compared to regular coefficient coding as observed in the 16th Geneva meeting. In this document, it is proposed to use regular coefficient coding without additional lossless-specific syntax or signaling. In this case, a lossless coded block or an explicit residual coding switch flag (e.g. as in CE3-2.5) are not signaled but inferred based on the value of the quantization parameter (QP) and TS mode. Based on this inference, RRC coding is used instead of TSRC for lossless.

• The simulation results show overall bit-rate savings of -5.23% AI, -5.58% RA, and -4.96% LDB with Class F: -1.39% AI, -2.40% RA, and -2.12% LDB and Class TGM: 1.54% AI, 0.59% RA, and 1.18% LDB.

• The simulation results with Luma BDPCM enabled show overall bit-rate savings of -6.76% AI, -5.96% RA, and -5.54% LDB with Class F: -5.74% AI, -4.37% RA, and -3.70% LDB and Class TGM: -1.59% AI, -0.71% RA, and 0.16% LDB.

• The simulation results with Luma and Chroma BDPCM enabled show overall bit-rate savings of -7.70% AI, -6.21% RA, and -5.84% LDB with Class F: -7.60% AI, -5.22% RA, and -4.33% LDB and Class TGM: -4.78% AI, -1.90% RA, and -0.05% LDB.

It is suggested to invoke a QP dependent decision on usage of the RC method at block level. There are however some concerns that such dependency would be undesirable.

No action.

[JVET-Q0615](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9461) Crosscheck of JVET-Q0107 (CE3-related: Flag-free Lossless Coding in VVC) [T. Tsukuba (Sony)] [late]

[JVET-Q0108](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8933) CE3-related: On signaling overhead for low-level lossless flags in CE3-2.5 [M. Karczewicz, A. Nalci, H. Wang, H. E. Egilmez, M. Coban (Qualcomm)]

In CE3-2.5 low-level (CU or TU) based flags are discussed for lossless coding. These flags allow switching between the two residual coding methods: (1) transform-skip residual coding and (2) regular residual coding for lossless. The signaling of these low-level flags for lossy case are disabled if the high-level (PPS) option is disabled as “TransformSkipResidualCoding=0”. However, it is important to see the effect of these low-level flags in CE3-2.5 on lossy case if PPS-level flag is not disabled in config (e.g. when “TransformSkipResidualCoding=1”). This document summarizes the signaling overhead of the lossless related flags in CE3-2.5 (sub tests 1, 2, 3). This is achieved by signaling the low-level flags in CE3-2.5 for the lossy case. This document also proposes a modification to sub test 2 of CE3-2.5 (TU-based signaling) to remove the signaling overhead of the TU-based flag for the lossy case.

No need to consider after the CE3 decision.

[JVET-Q0616](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9462) Crosscheck of JVET-Q0108 (CE3-related: On signaling overhead for low-level lossless flags in CE3-2.5) [T. Tsukuba (Sony)] [late]

[JVET-Q0109](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8934) CE3-related: On Last Position Signaling for Lossless Coding [M. Karczewicz, A. Nalci, H. Wang, H. E. Egilmez, M. Coban (Qualcomm)]

In VTM7, lossless coding is possible via existing syntax with transform skip (TS) residual coding. Core experiment (CE3) is investigating high-level (SPS/PPS) and low-level (CU/TU) alternatives for lossless coding for higher bit-rate savings. In this document, it is proposed to disable last position coding when lossless coding uses regular residual coding (RRC) instead of TS residual coding. Here, 3 variants are discussed with the following bit-rate savings:

• For variant 1, the simulation results show overall bit-rate savings of -0.39% AI, -0.43% RA, and -0.52% LD with Class F: 0.23% AI, 0.13% RA, and 0.19% LD and Class TGM: 1.32% AI, 1.08% RA, and 1.42% LD. Max encoder time 104%, max decoder time 101%.

• For variant 2, the simulation results show overall bit-rate savings of -0.39% AI, -0.43% RA, and -0.52% LD with Class F: -0.02% AI, -0.14% RA, and -0.18% LD and Class TGM: 0.36% AI, 0.34% RA, and 0.69% LD. Max encoder time 95%, max decoder time 88%.

• For variant 3, the simulation results show overall bit-rate savings of -0.39% AI, -0.43% RA, and -0.52% LD with Class F: -0.02% AI, -0.13% RA, and -0.10% LD and Class TGM: 0.34% AI, 0.36% RA, and 0.47% LD. Max encoder time 105%, max decoder time 100%.

This approach would likely have a disadvantage for mixed lossy/lossless, as discarding the last position signalling would increase the bitrate for lossy coded regions.

No action.

[JVET-Q0137](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8962) CE3-related: Rice Parameter Derivation with Unified Lookup Table [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

This contribution proposes a rice parameter derivation using a unified lookup table for regular residual coding and transform skip residual coding to simplify CE3-1.1-subset3.

It is reported that, at common QP condition, proposed method provides average BD-rate differences of (-0.01 %, 0.00 %, -0.02 %) for AI, (-0.02 %, -0.01 %, 0.02 %) for RA, and (-0.02%, -0.01%, 0.02%) for LB; For ClassF, (-0.16%, -0.17%, -0.04%) for AI, (-0.18%, -0.03%, -0.17%) for RA, and (-0.13%, -0.58%, 0.62%) for LB; For ClassTGM, (-0.39%, -0.30%, -0.32%) for AI, (-0.19%, -0.20%, -0.16%) for RA, and (-0.20%, -0.35%, -0.26%) for LB.

It is reported that, at low QP condition, proposed method provides average BD-rate differences of (-0.07%, -0.10%, -0.12%) for AI, (-0.02xx%, -0.02yy%, -0.04zz%) for RA, and (-0.02%, -0.02%, -0.01%) for LB; For ClassF, (-1.41%, -0.90%, -0.90%) for AI, (-1.84%, -0.73%, -0.86%) for RA, and (-0.63%, -0.55%, -0.70%) for LB; For ClassTGM, (-1.58%, -1.44%, -1.45%) for AI, (-2.13%, -1.40%, -1.39%) for RA, and (-1.44%, -1.17%, -1.20%) for LB.

It is reported that, at lossless condition, average bitrate differences of -5.08 % for AI, -3.73% for RA, and -2.58% for LB; For ClassF, -3.97% for AI, -3.06% for RA, and -2.78% for LB; For ClassTGM, -4.35% for AI, -6.33% for RA, -6.57% for LB.

In v3, simulation results for ClassA2/RA at low QP condition were updated.

No need to consider after the CE3 decision.

[JVET-Q0707](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9553) Crosscheck of JVET-Q0137 (CE3-related: Rice Parameter Derivation with Unified Lookup Table) [Y. Kato (Panasonic)] [late]

[JVET-Q0139](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8964) CE3-related: Lookup Table Free Rice Parameter Derivation [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

This contribution proposes a lookup table free rice parameter derivation for regular residual coding and transform skip residual coding, where rice parameter is derived simple bit-shift operation.

It is reported that, at common QP condition, proposed method provides average BD-rate differences of (0.00 %, 0.01 %, -0.02 %) for AI, (0.00%, -0.01 %, 0.01%) for RA, and (-0.04%, -0.22 %, -0.15%) for LB; For ClassF, (-0.14%, -0.25%, -0.04%) for AI, (-0.10%, 0.04%, -0.07%) for RA, and (-0.10%, -0.50%, 0.57%) for LB; For ClassTGM, (-0.35%, -0.27%, -0.28%) for AI, (-0.17%, -0.20%, -0.15%) for RA, and (-0.17%, -0.20%, -0.26%) for LB.

It is reported that, at low QP condition, proposed method provides average BD-rate differences of (-0.04%, -0.05%, -0.08%) for AI, (0.xx%, 0.yy%, 0.zz%) for RA, and (0.02%, 0.05%, 0.06%) for LB; For ClassF, (-1.61%, -0.99%, -0.98%) for AI, (-2.02%, -0.89%, -0.96%) for RA, and (-0.62%, -0.58%, -0.73%) for LB; For ClassTGM, (-1.98%, -1.74%, -1.77%) for AI, (-2.47%, -1.54%, -1.53%) for RA, and (-1.51%, -1.27%, -1.26%) for LB.

It is reported that, at lossless condition, average bitrate differences of -5.20 % for AI, -3.57% for RA, and -2.54% for LB; For ClassF, -4.30% for AI, -3.25% for RA, and -3.02% for LB; For ClassTGM, -5.35% for AI, -6.90% for RA, -7.09% for LB.

This proposal replaces the table-based derivation of Rice parameter by a shift operation, which from the results does not seem to provide benefit for the RRC (no gain for natural video). It also introduces Rice parameter derivation in TSRC (which currently has fixed EG1). This introduces a small gain for screnn content, would however also increase the complexity. It is also noted that the BD results in low QP range for screen content may not be conclusive due to the large PSNR values (see discussion under CE2).Question is raised if it provides complexity benefit when only introduced in RRC. The general opinion is that there is no problem with the current table lookup.

No action.

[JVET-Q0638](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9484) Crosscheck of JVET-Q0139 (CE3-related: Lookup Table Free Rice Parameter Derivation) [M. G. Sarwer (Alibaba)] [late]

[JVET-Q0143](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8968) Non-CE3: Issue of Level mapping in transform skip residual [Y. Kato, K. Abe, T. Toma (Panasonic)]

In this contribution, it is proposed to define a new flag in SPS to enable or disable Level mapping in transform skip residual coding. According to the results reported in this contribution, Level mapping has coding loss on camera captured contents for whole QP range including LossLess setting, while it has good coding gain on screen contents. Therefore, this contribution proposes to disable Level mapping from ClassA to ClassE and enable it on ClassF and ClassTGM in all test conditions. Simulation results of Lossless coding, CTC, and LowQP are reportedly shown as follows:

Lossless:

Overall (ClassA-E): -0.54%AI, -0.68%RA, -1.32%LB

CTC:

Overall: 　　　　　-0.00%AI, -0.02%RA, -0.02%LB

LowQP:

Overall: 　　　　　-0.03%AI, -0.XX%RA, -0.01%LB

Provides benefit when TSRC is used in lossless mode. Not relevant after decision of adopting CE3-2.3/4.

No action.

[JVET-Q0622](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9468) Cross-check of JVET-Q0143 (CE3-related: Issue of Level mapping in transform skip residual) in lossless configuration [J. Choi, J. Lim (LGE)] [late]

[JVET-Q0144](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8969) Non-CE3: Contexts in Chroma transform skip residual coding [Y. Kato, K. Abe, T. Toma (Panasonic)]

In this contribution, it is proposed to introduce individual contexts for luma and chroma in all syntaxes of transform skip residual (TSRC) to improve coding gains of Lossless coding. Derivation process for ctxInc for chroma TSRC contexts is completely the same as those for luma TSRC contexts. Simulation results of Lossless coding, CTC, and LowQP are reportedly shown as follows:

Lossless:

Overall: -0.23%AI, -0.65%RA, -0.93%LB

CTC:

ClassF: 0.00%AI, -0.02%RA, 0.00%LB

ClassTGM: -0.11%AI, 0.00%RA, -0.02%LB

LowQP

ClassF: -0.09%AI, -0.05%RA, -0.05%LB

ClassTGM: -0.28%AI, 0.06%RA, -0.20%LB

Provides benefit when TSRC is used in lossless mode. Not relevant after decision of adopting CE3-2.3/4.

No action.

[JVET-Q0646](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9492) Cross-check of JVET-Q0144 (Non-CE3: Contexts in Chroma transform skip residual coding) [T.-C. Ma (Kwai Inc.)] [late]

[JVET-Q0145](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8970) CE3-related: Unified rice parameter derivation of transfrom skip residual [Y. Kato, K. Abe, T. Toma (Panasonic)]

In this contribution, it is proposed to derive Rice parameter in transform skip residual coding (TSRC) in an unified way with transform regular residual coding (RRC). This method is based on adopted rice parameter derivation of CE7-.1.3b-alt [2] in the last meeting. The same Rice parameter table as transform residual coding (RRC) is used for TSRC, and sum value used in deriving Rice parameter is normalized based on the number of reference neighbor coefficients.

Simulation results of Lossless coding, CTC, and LowQP reportedly are shown as follows:

Lossless:

Overall (ClassA-E): -4.87%AI, -3.39%RA, -2.29%LB

ClassF: -3.81%AI, -3.00%RA, -2.74%LB

ClassTGM: -3.80%AI, -6.00%RA, -5.98%LB

CTC:

Overall: -0.01%AI, -0.00%RA, -0.02%LB

ClassF: -0.14%AI, -0.15%RA, -0.15%LB

ClassTGM: -0.36%AI, -0.18%RA, -0.25%LB

LowQP:

Overall: -0.07%AI, -0.02%RA, -0.02%LB

ClassF: -1.30%AI, -1.63%RA, -0.58%LB

ClassTGM: -1.17%AI, -1.83%RA, -1.02%LB

No need for consideration after decision of adopting CE3-2.3/4. Though the combination ofQ0143, Q0144 and Q0145 would make the TSRC competitive with RRC for lossless and would avoid a high level switch of CE3-2.3/4, it would make the TSRC more complex which is undesirable.

No action.

[JVET-Q0548](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9394) Crosscheck of JVET-Q0145 (CE3-related: Unified rice parameter derivation of transform skip residual) [J. Lainema (Nokia)] [late]

[JVET-Q0186](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9011) CE3-related: TB-level residual coding selection for lossless coding [Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

In the current VVC, lossless coding is achieved by always choosing transform skip (TS) mode by signalling TS flag equal to 1 for each transform block (TB), where the TS mode is always combined with transform skip residual coding (TSRC). In the 16th JVET meeting, it was observed that always choosing TS mode by signalling TS flag equal to 1 for each TB and always combining TS mode with regular residual coding (RRC) can bring more bit savings for lossless coding some sequences, especially for camera captured videos. Therefore, to improve lossless coding gain, slice-level switch between TSRC and RRC for lossless coding by signalling TS flag equal to 1 for each TB is planned in CE3. In this contribution, transform block (TB) level switch between TSRC and RRC for lossless coding is proposed to further improve lossless coding gain. First, a new “slice transform disabled flag” is signalled or inferred at slice level, and it is used to indicate whether transform is disabled for the slice. When the slice transform disabled flag is true, the transform process and quantization process are the same as those when TS is applied, and the TS flag is still signalled at TB level but used to select TSRC or RRC. Second, since in VTM7.0 block-wise differential pulse code modulation (BDPCM) blocks are always combined with TS and TSRC, to remove this combination so as to make BDPCM blocks be able to choose between TSRC and RRC, a new “slice BDPCM infer transform skip disabled flag” is signalled or inferred at slice level, and it is used to indicate whether TS and TSRC are combined with BDPCM blocks. If the slice BDPCM infer transform skip disabled flag is true, the TS flag is still signalled for each BDPCM block, and TS is still applied to all BDCM blocks, but the TS flag is used to select TSRC or RRC. Lossless coding bit savings are as follows.

[Anchor: VTM7.0 with BDPCM disabled; Test: Proposed method with BDPCM disabled]

TGM sequences => -3.88% (AI), -4.52% (RA), -4.53% (LB)

CTC sequences (Classes A1, A2, B, C, E) => -5.46% (AI), -5.73% (RA), -5.06% (LB)

[Anchor: VTM7.0 with BDPCM disabled; Test: Proposed method with luma and chroma BDPCM enabled]

TGM sequences => -8.50% (AI), -6.37% (RA), -5.45% (LB)

CTC sequences (Classes A1, A2, B, C, E) => -7.86% (AI), -6.33% (RA), -5.91% (LB)

The proposal is to introduce a slice level flag which would enforce TS for the entire slice, and in that case re-use the TS flag at block level for switching between RRC and TSRC (unmodified versions).

This is only effective for entire-slice lossless coding (no mixed lossy/lossless, which would be the more relevant case). The benefit relative to the adoption (with high-level switch RRC/TSRC) is minor (0.1%) overall, higher for TGM. Encoder runtime is significantly increased due to block level switching. Furthermore, the approach of changing the semantics of TS flag for that purpose is not clean in terms of spec definition.

No action.

[JVET-Q0649](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9495) Cross-check of JVET-Q0186 (CE3-related: TB-level residual coding selection for lossless coding) [T.-C. Ma (Kwai Inc.)] [late]

[JVET-Q0187](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9012) CE3-related: Rice parameter derivation in residual coding [Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

In the current VTM7.0, the rice parameter is always set to 1 in transform skip residual coding (TSRC), which decreases the bit savings in lossless coding since using rice parameter equal to 1 is not efficient especially when the coefficients (i.e., residuals) tend to be larger. This contribution proposes four methods to improve TSRC by using rice parameter other than 1.

Method 1.1 reuses the rice parameter table of regular residual coding (RRC) in the rice parameter derivation of TSRC, the rice parameter derivation is as below.

rice\_tsrc = RRC\_rice\_table[ Clip3(0, 31, absSum – 2\*baseLevel + 5)]

Based on Method 1.1, Method 1.2 applies normalization to the sum of the absolute coefficients in the local template for TSRC, which further considers the number of in-the-same-TB coefficients in the local template.

rice\_tsrc = RRC\_rice\_table[ Clip3(0, 31, ((numAvail == 1)? 2\* absSum: absSum) – 2\*baseLevel + 5)]

Method 2.1 removes the rice parameter table in RRC. The rice parameter derivation is as below.

rice\_rrc = Clip3(0, 39, absSum – 5\*baseLevel) >> 3

rice\_tsrc = Clip3(0, 39, absSum – 2\*baseLevel + 5) >> 3

Based on Method 2.1, Method 2.2 applies normalization to the sum of the absolute coefficients in the local template for TSRC, which further considers the number of in-the-same-TB coefficients in the local template.

rice\_rrc = Clip3(0, 39, absSum – 5\*baseLevel) >> 3

rice\_tsrc = Clip3(0, 39, ((numAvail == 1)? 2\* absSum: absSum) – 2\*baseLevel + 5) >> 3

The compression performance of the four tests are listed below.

Method 1.1:

[classes CTC including A1, A2, B, C, E]

VTM7.0 - standard QPs: { luma BD-rate = -0.01%(AI), 0.00%(RA), -0.02%(LB) }

VTM7.0 - low QPs: { luma BD-rate = -0.07%(AI), -0.02%(RA), -0.02%(LB) }

VTM7.0 - lossless: { bit-rate = -4.90%(AI), -3.69%(RA), -2.39%(LB) }

[class TGM]

VTM7.0 - standard QPs: { luma BD-rate = -0.37%(AI), -0.18%(RA), -0.27%(LB) }

VTM7.0 - low QPs: { luma BD-rate = -1.09%(AI), -1.82%(RA), -0.94%(LB) }

VTM7.0 - lossless: { bit-rate = -3.80%(AI), -6.00%(RA), -6.00%(LB) }

Method 1.2:

[classes CTC including A1, A2, B, C, E]

VTM7.0 - standard QPs: { luma BD-rate = -0.01%(AI), -0.01%(RA), -0.04%(LB) }

VTM7.0 - low QPs: { luma BD-rate = -0.07%(AI), -0.02%(RA), -0.02%(LB) }

VTM7.0 - lossless: { bit-rate = -5.15%(AI), -3.92%(RA), -2.35%(LB) }

[class TGM]

VTM7.0 - standard QPs: { luma BD-rate = -0.35%(AI), -0.21%(RA), -0.29%(LB) }

VTM7.0 - low QPs: { luma BD-rate = -1.33%(AI), -1.97%(RA), -1.14%(LB) }

VTM7.0 - lossless: { bit-rate = -4.20%(AI), -6.26%(RA), -6.33%(LB) }

Method 2.1:

[classes CTC including A1, A2, B, C, E]

VTM7.0 - standard QPs: { luma BD-rate = 0.01%(AI), 0.00%(RA), 0.01%(LB) }

VTM7.0 - low QPs: { luma BD-rate = -0.01%(AI), -0.06%(RA), -0.06%(LB) }

VTM7.0 - lossless: { bit-rate = -4.89%(AI), -3.32%(RA), -2.49%(LB) }

[class TGM]

VTM7.0 - standard QPs: { luma BD-rate = -0.37%(AI), -0.16%(RA), -0.28%(LB) }

VTM7.0 - low QPs: { luma BD-rate = -1.45%(AI), -2.14%(RA), -1.18%(LB) }

VTM7.0 - lossless: { bit-rate = -4.69%(AI), -6.63%(RA), -6.75%(LB) }

Method 2.2:

[classes CTC including A1, A2, B, C, E]

VTM7.0 - standard QPs: { luma BD-rate = 0.01%(AI), -0.01%(RA), 0.01%(LB) }

VTM7.0 - low QPs: { luma BD-rate = -0.02%(AI), X.XX%(RA), -0.06%(LB) }

VTM7.0 - lossless: { bit-rate = -5.19%(AI), -3.58%(RA), -6.94%(LB) }

[class TGM]

VTM7.0 - standard QPs: { luma BD-rate = -0.38%(AI), -0.10%(RA), -0.11%(LB) }

VTM7.0 - low QPs: { luma BD-rate = -1.69%(AI), -2.33%(RA), -1.27%(LB) }

VTM7.0 - lossless: { bit-rate = -5.08%(AI), -6.89%(RA), -6.94%(LB) }

Similar to JVET-Q0139 – no need for action.

[JVET-Q0263](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9088) CE3-related: Bit-exact simplification of Rice parameter selection for regular residual coding [C. Auyeung, X. Li, X. Zhao, S. Liu (Tencent)]

This contribution proposes editorial changes to the VVC Draft 7 to remove the Rice parameter lookup table for regular residual coding and associated software changes to VTM-7.0 to reduce encoding time and decoding time. The proposed modifications to VTM-7.0 result in identical bitstreams from VTM-7.0. For CTC-QP AI/RA/LB configurations, the overall CTC encoding time is 99%/99%/99%, and the decoding time is 98%/98%/100%, respectively. For low-QP AI/RA/LB configurations, the overall CTC encoding time is 99%/xxx/100%, and the decoding time is 98%/xxx/99%, respectively. More accurate decoding timing, by decoding the bitstream multiple times in a single computer, shall be updated in a later revision of this document. This contribution is also applicable to other CE3 and CE3-related proposals with Rice parameter lookup tables.

Purely editorial. To the discretion of editors if that is useful. Current table may be better to understand than the formula.

[JVET-Q0545](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9391) Crosscheck of JVET-Q0263 (CE3-related: Bit-exact simplification of Rice parameter selection for regular residual coding) [Z.-Y. Lin (MediaTek)] [late]

[JVET-Q0264](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9089) CE3-related: Computation reduction in the derivation of Rice parameter for abs\_remainder[ ] in regular residual coding [C. Auyeung, X. Li, X. Zhao, S. Liu (Tencent)]

This contribution proposes to reduce the computation in the derivation of Rice parameter for abs\_remainder[ ] in residual coding without transform skip by replacing the calculation of locSumAbs in VVC Draft 7. Three variants of the proposal (A,B,C) with similar performance are presented.

For proposal A with CTC-QP AI/RA/LB configurations, the BDR is 0.03%/0.03%/-0.01%, the encoding time is 100%/100%/100%, and the decoding time is 99%/99%/101%, respectively. For proposal A low-QP AI/RA/LB configurations, the BDR is 0.17%/0.05%/0.02%, the encoding time is 99%/99%/99%, and the decoding time is 97%/97%/98%, respectively.

For proposal B with CTC-QP AI/RA/LB configurations, the BDR is 0.00%/0.00%/-0.02%, the encoding time is 100%/100%/99%, and the decoding time is 99%/99%/100%, respectively. For proposal B low-QP AI/RA/LB configurations, the BDR is -0.02%/0.00%/0.00%, the encoding time is 100%/100%/100%, and the decoding time is 96%/97%/97%, respectively.

For proposal C with CTC-QP AI/RA/LB configurations, the BDR is 0.00%/0.00%/-0.02%, the encoding time is 99%/99%/99%, and the decoding time is 97%/97%/98%, respectively. For proposal C low-QP AI/RA/LB configurations, the BDR is -0.02%/0.00%/0.01%, the encoding time is 99%/99%/99%, and the decoding time is 96%/96%/95%, respectively.

More accurate decoding timing, by decoding the bitstream multiple times in a single computer, shall be updated in a later revision of this document.

According to the proponent, proposal C is the most robust solution (retaining larger range of variation of Rice parameter).

One expert expresses opinion that due to introducing some sequential dependency on previous decoded value, though the number of operations is reduced, parallel computation of the current design would not be possible, so there may even be worse throughput.

There is no real complexity problem at that stage of entropy coding.

No action.

[JVET-Q0553](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9399) Crosscheck of JVET-Q0264: CE3-related: Computation reduction in the derivation of Rice parameter for abs\_remainder[ ] in regular residual coding [T. Nguyen (HHI)] [late]

[JVET-Q0269](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9094) CE3-related: On transform skip residual coding [M. G. Sarwer, Y. Ye, J. Luo (Alibaba)]

This contribution proposes to reduce the computation in the derivation of Rice parameter for abs\_remainder[ ] in residual coding without transform skip by replacing the calculation of locSumAbs in VVC Draft 7. Three variants of the proposal (A,B,C) with similar performance are presented.

For proposal A with CTC-QP AI/RA/LB configurations, the BDR is 0.03%/0.03%/-0.01%, the encoding time is 100%/100%/100%, and the decoding time is 99%/99%/101%, respectively. For proposal A low-QP AI/RA/LB configurations, the BDR is 0.17%/0.05%/0.02%, the encoding time is 99%/99%/99%, and the decoding time is 97%/97%/98%, respectively.

For proposal B with CTC-QP AI/RA/LB configurations, the BDR is 0.00%/0.00%/-0.02%, the encoding time is 100%/100%/99%, and the decoding time is 99%/99%/100%, respectively. For proposal B low-QP AI/RA/LB configurations, the BDR is -0.02%/0.00%/0.00%, the encoding time is 100%/100%/100%, and the decoding time is 96%/97%/97%, respectively.

For proposal C with CTC-QP AI/RA/LB configurations, the BDR is 0.00%/0.00%/-0.02%, the encoding time is 99%/99%/99%, and the decoding time is 97%/97%/98%, respectively. For proposal C low-QP AI/RA/LB configurations, the BDR is -0.02%/0.00%/0.01%, the encoding time is 99%/99%/99%, and the decoding time is 96%/96%/95%, respectively.

More accurate decoding timing, by decoding the bitstream multiple times in a single computer, shall be updated in a later revision of this document.

No need for presentation upon adoption from CE3.

[JVET-Q0619](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9465) Crosscheck of JVET-Q0269 (CE3-related: On transform skip residual coding) [T. Tsukuba (Sony)] [late]

[JVET-Q0294](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9119) CE3-related: CTU level local lossless coding of VVC [M. G. Sarwer, Y. Ye, J. Luo, J. Chen (Alibaba)]

In order to achieve efficient compression in mixed lossy and lossless coding, this contribution proposes to signal a flag at each coding tree unit (CTU) to indicate whether a CTU is coded as either in lossless or in lossy mode. If a CTU is lossless coded, an additional CTU level flag is signaled to specify the residual coding method, either regular residual coding or transform skip residual coding, used for that CTU.

Following results of are reported as compared to VTM-7.0.

 Test 1: All lossless CTUs use transform skip residual coding (TSRC):

 Overall: -0.01% (AI), -0.01% (RA), -0.01% (LB) bit rate saving

 TGM: -0.01% (AI), 0.09% (RA), -0.09% (LB) bit rate saving

 Test 2: All lossless CTUs use TSRC with rice parameter derivation method proposed in JVET-Q0269:

 Overall: -4.33% (AI), -2.61% (RA), -1.99% (LB) bit rate saving

 TGM: -5.20% (AI), -6.61% (RA), -6.80% (LB) bit rate saving

 Test 3: All lossless CTUs of class F & TGM sequences are coded with TSRC with rice parameter derivation method proposed in JVET-Q0269. All lossless CTUs of other sequences are coded with regular residual coding (RRC):

 Overall: -5.24% (AI), -5.59% (RA), -4.98% (LB) bit rate saving

 TGM: -5.20% (AI), -6.61% (RA), -6.80% (LB) bit rate saving

 Test 4: Test3 + luma BDPCM on

 Overall: -6.77% (AI), -5.97% (RA), -5.55% (LB) bit rate saving

 TGM: -7.01% (AI), -7.44% (RA), -7.39% (LB) bit rate saving

The results do not indicate the benefit for mixed lossy/lossless coding. Therefore, no evidence that a local switch (which should not be called “lossless”) would provide benefit.

Further study – AHG on lossless coding should investigate test cases and conditions for local lossless coding.

[JVET-Q0665](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9511) Cross-check of JVET-Q0294 (CE3-related: CTU level local lossless coding of VVC) [A. Nalci (Qualcomm)] [late]

[JVET-Q0323](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9148) Non-CE3: Encoder optimization for chroma BDPCM [C.-C. Kuo, S.-P. Wang, C.-C. Lin, C.-L. Lin (ITRI)]

Chroma BDPCM can provide benefit on coding efficiency especially for lossless test condition. This contribution proposed 2 methods of encoder optimization for chroma BDPCM. Both methods were implemented on top of CE3-2.2 and CE3-2.4a source codes and compared over the results of them.

When using CE3-2.2 as anchor, the overall bit-rate savings for the proposed method 1 are 0.87% and 0.24%, with encoding time savings -11% and -2% for AI and RA, respectively. For the proposed method 2, the overall bit-rate savings are 0.36% and 0.20%, with encoding time savings -9% and -1% for AI and RA, respectively.

When using CE3-2.4a as anchor, the overall bit-rate savings for the proposed method 1 are 0.84% and 0.17%, with -8% and -1% encoding time saving for AI and RA, respectively. For the proposed method 2, the overall bit-rate savings are 0.38% and 0.14%, with encoding time savings -5% and -1% for AI and RA, respectively.

This reduces encoding time, but also reduces the the performance (gain drops from 7.7% to 7.35% for 5% encoding time saving in AI, whereas for RA no reduction of encoding time, but still some loss in performance). No good tradeoff.

No action.

[JVET-Q0603](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9449) Crosscheck of JVET-Q0323 (Non-CE3: Encoder optimization for chroma BDPCM) [M.-S. Chiang (MediaTek)] [late]

[JVET-Q0439](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9265) CE3 Related: Modified Rice Parameter derivation [S. Keating, K. Sharman (Sony)]

This contribution describes a modified method of deriving the Rice parameter for TS blocks based on CE3-1.1c. An overall gain of 5.76% (over CE3-1.1c gain of 5.09%) for lossless AI is reported, with a gain of 9.13% (over CE3-1.1c gain of 8.12%) for the TGM image class for lossless AI.

No need for presentation – obsolete after decision on CE3.

[JVET-Q0460](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9286) Non-CE3: Inter BDPCM for lossless video coding [G. Kulupana, S. Blasi (BBC)]

This contribution proposes to apply BDPCM on inter-predicted residuals for lossless coding. Identically to intra BDPCM, the proposed inter BDPCM works on quantized residuals. Therefore, the tool re-uses entirely the residual prediction operations used in the intra BDPCM pipeline. Furthermore, the proposed inter BDPCM operation is applied only to luma residuals. As with intra BDPCM, when inter BDPCM is used, residuals are not subjected to any transform operation (i.e., Transform Skip is used). Average BD-rates of -0.96% is reported for RA with 110% encoding time and 98% decoding time with respect to lossless VTM 7.0 anchor. Moreover, the when both inter and intra BDPCM are applied an Average BD-rates of -1.22% is obtained for RA with 114% encoding time and 98% decoding time with respect to lossless VTM 7.0 anchor.

Does not have any (or only minor) benefit for lossy coding. The abov gains are for BDPCM luma only. The additional gain relative to CE3-2.4 (then, including luma and chroma BDPCM in inter as well) is around 0.8% for RA config, with encoding time increase around 10%.

Question is raised how it would perform in CTC – proponent will provide those results, revisit.

Overall, the additional benefit in compression may not justify the additional complexity (both for encoding and the impact on the implementation on the inter decoding stage is not fully clear, would require more study). It is also noted that the modification of parsing may have some impact.

[JVET-Q0636](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9482) Crosscheck of JVET-Q0460 (Non-CE3: Inter BDPCM for lossless video coding) [T. Tsukuba (Sony)] [late]

[JVET-Q0462](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9288) CE3-related: Modified transform skip residual coding for lossless coding [T. Nguyen, B. Bross, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

This input contribution proposes and describes changes to the Transform Skip Residual Coding (TSRC) to further improve the compression efficiency for the lossless operation mode in VTM/VVC. Three parts are changed: using the Rice parameter derivation for regular residual coding (RRC) for TSRC (aspect 1), the level mapping in TSRC is modified (aspect 2) and ZeroPos-based coefficient prediction from RRC is introduced in TSRC (aspect 3). All these changes are only applied if the QP indicates lossless coding and thus only lossless results are affected compared to VTM-7.0 as follows:

Lossless: -6.14% (AI), -3.93% (RA), -4.43% (LB)

The results without the QP dependency and with only the Rice parameter change (aspect 1) are as follows:

Lossless: -5.22% (AI), x.xx% (RA), x.xx% (LB)

Lossy (CTC): x.xx% Y x.xx% Cb x.xx% Cr (AI)

x.xx% Y x.xx% Cb x.xx% Cr (RA)

x.xx% Y x.xx% Cb x.xx% Cr (LB)

Enabling BDPCM on top of that is expected to bring additional gain.

No need for presentation – obsolete after decision on CE3.

[JVET-Q0463](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9289) CE3-related: Inter BDPCM with RRC for lossless video coding [G. Kulupana, S. Blasi (BBC)]

This contribution proposes to apply BDPCM on inter-predicted residuals for lossless coding. The proposed method is an extension to Regular Residual Coding (RRC) based BDPCM described in CE3-2.4 in JVET-Q0089 [1]. Identically to intra BDPCM, the proposed inter BDPCM works on quantized residuals. Therefore, the tool re-uses entirely the residual prediction operations used in the intra BDPCM pipeline. Furthermore, the proposed inter BDPCM operation is applied both for luma and chroma residuals. As with intra BDPCM, when inter BDPCM is used, residuals are not subjected to any transform operation (i.e., Transform Skip is used). When the proposed inter BDPCM is integrated into CE3-2.4, an average BD-rates of -6.97% is reported for RA with 122% encoding time and 99% decoding time with respect to lossless VTM 7.0 anchor.

Was included in the presentation of JVET-Q0460.

[JVET-Q0489](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9316) CE3-related: Modified TS residual coding [M. Karczewicz, H. Wang, M. Coban, A. Nalci (Qualcomm), C. Auyeung, X. Li, X. Zhao, S. Liu (Tencent)]

This document proposes modifications to transform skip coefficient coding to improve its coding efficiency for lossless coding. Level prediction is removed, the abs\_level\_gt2\_flag flag is moved to the 1st pass while the coeff\_sign\_flag is moved to the second pass, and the context derivation of sig\_coeff\_flag, abs\_level\_gt1\_flag and the abs\_level\_gt2\_flag flags are modified. The rice parameter value is calculated similarly as for transform coefficients with the normalization based on the number of available neighboring coefficients.

The coding results for the proposed method comparing to VTM-7.0 anchor (CTC) are summarized below:

* Natural: -0.03% (AI), -0.01% (RA), -0.06% (LB)
* Class F: 0.03% (AI), 0.02%% (RA), -0.22% (LB)
* TGM: 0.03% (AI), -0.05% (RA), -0.32% (LB)

The coding results for the proposed method comparing VTM-7.0 anchor (lossless) are summarized below:

* Natural: -6.48%, (AI), -6.08% (RA), -5.23% (LB)
* Class F: -4.37% (AI), -4.68% (RA), -4.52% (LB)
* TGM: -2.34% (AI), -3.36% (RA), -2.19% (LB)

When compared with VTM-7.0 using regular transform coefficient coding (RRC) as anchor, the lossless results are summarized below:

* Natural: -1.32% (AI), -0.54% (RA), -0.29% (LB)
* Class F: -3.00% (AI), -2.28% (RA), -2.39% (LB)
* TGM: -3.81%(AI), -3.92%(RA), -3.32%(LB)

The contribution shows that there are possibilities to make the performance of TSRC in lossless case competitive with RRC (both for natural and screen content, where it is even better for the latter). This would however have some impact on complexity and require various modifications – solution adopted from CE3 is simpler and not much worse.

[JVET-Q0551](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9397) Crosscheck of JVET-Q0489: CE3-related: Modified TS residual coding [T. Nguyen (HHI)] [late]

[JVET-Q0490](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9318) CE3-related: Simplification of rice parameter derivation [H. Wang, M. Karczewicz, M. Coban (Qualcomm)]

This document proposes rice parameter derivation methods without look-up table for regular transform residual coding (RRC) and transform-skip residual coding (TSRC). Instead of using the value locSumAbs (sum of absolute values with in the same local template) as a table index, the proposed method derives the rice parameter by performing arithmetic operations on locSumAbs.

The coding results for the proposed method comparing to VTM-7.0 anchor (CTC) are summarized below:

|  |  |  |
| --- | --- | --- |
|  | RRC change | RRC + TSRC change |
| Natural | 0.01% (AI), XX% (RA), XX% (LB) | 0.00% (AI), XX% (RA), XX% (LB) |
| Class F | 0.01% (AI), 0.00% (RA), XX% (LB) | -0.15% (AI), -0.12% (RA), XX% (LB) |
| TGM | 0.02% (AI), -0.01% (RA), XX% (LB) | -0.36% (AI), -0.18% (RA), XX% (LB) |

The coding results for the proposed method comparing VTM-7.0 anchor (lossless) are summarized below:

|  |  |  |
| --- | --- | --- |
|  | RRC change | TSRC change |
| Natural | -5.11% (AI), XX% (RA), -4.97% (LB) | -5.12% (AI), XX% (RA), -2.41% (LB) |
| Class F | -1.41% (AI), -2.42% (RA), -2.14% (LB) | -4.11% (AI), -2.91% (RA), -2.65% (LB) |
| TGM | 1.64% (AI), 0.74% (RA), 1.32% (LB) | -4.77% (AI), -6.65% (RA), -6.68% (LB) |

No need for presentation after the adoption of CE3-2.3/4

[JVET-Q0599](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9445) Crosscheck of JVET-Q0490 (CE3-related: Simplification of rice parameter derivation) [H.-J. Jhu (Kwai Inc.)] [late]

[JVET-Q0693](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9539) Crosscheck of JVET-Q0490: CE3-related: Simplification of rice parameter derivation [J. Ström (Ericsson)] [late]

[JVET-Q0498](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9326) Non-CE3: TB based Rice parameter selection for transform skip residual coding [Y.-W. Chen, T.-C. Ma, X. Xiu, H.-J. Jhu, X. Wang (Kwai Inc.)] [late]

In residual coding of a transform skip block, for each sample, the remaining absolute level “abs\_remainder” is binarized using the fixed rice parameter equal to 1. However, it is observed that using different rice parameters for different conditions (e.g. different sequences, different QPs) improves the coding efficiency especially for low QP and lossless conditions. In this proposal, it is proposed to explicitly signal the rice parameter for each TB to indicate the rice parameter for the binary codewords of abs\_remainder. Three tests are conducted including test 1: switching between rice parameters (0, 1, 2 or 3), test2: switching between rice parameters (0, 1, 2 or 4) and test 3: switching between rice parameters (0, 1, 2 or 4) with fast encoding. The results are summarized as below. The run time increase of the proposed method with fast encoding is around 105% for AI, RA and LDB cases.

The results of TB-level rice parameter compared to VTM7.0 on CTC sequences:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Rice (0,1,2,3) | | | Rice (0,1,2,4) | | | Rice (0,1,2,4) with Fast encoding | | |
|  | AI | RA | LDB | AI | RA | LDB | AI | RA | LDB |
| Standard QPs | 0.03% | 0.01% | -0.04% | 0.03% | 0.01% | -x.xx% | 0.03% | 0.01% | -0.04% |
| Low QPs | -0.04 % | -0.06% | -0.04 % | -0.04% | -x.xx% | -x.xx% | -0.03% | -x.xx% | -x.xx% |
| Lossless | -4.61% | -3.40% | -1.83% | -4.77% | -x.xx% | -1.96% | -4.15% | -x.xx% | -1.61% |

The results of TB-level rice parameter compared to VTM7.0 on Class F sequences:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Rice (0,1,2,3) | | | Rice (0,1,2,4) | | | Rice (0,1,2,4) with Fast encoding | | |
|  | AI | RA | LDB | AI | RA | LDB | AI | RA | LDB |
| Standard QPs | 0.03% | 0.05% | -0.05% | 0.00% | -0.05% | -x.xx% | 0.03% | 0.01% | -0.04% |
| Low QPs | -1.14 % | -1.20% | -0.49 % | -1.29% | -1.27% | -0.57% | -0.97% | -0.99% | -x.xx% |
| Lossless | -2.38% | -1.95% | -1.73% | -2.69% | -2.18% | -1.89% | -2.05% | -1.74% | -1.43% |

The results of TB-level rice parameter compared to VTM7.0 on TGM sequences:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Rice (0,1,2,3) | | | Rice (0,1,2,4) | | | Rice (0,1,2,4) with Fast encoding | | |
|  | AI | RA | LDB | AI | RA | LDB | AI | RA | LDB |
| Standard QPs | -0.18% | 0.00% | -0.04% | -0.23% | -0.07% | 0.00% | -0.18% | 0.00% | -0.04% |
| Low QPs | -2.43 % | -2.33% | -1.42 % | -3.16% | -2.92% | -1.70% | -2.22% | -2.06% | -0.96% |
| Lossless | -4.95% | -5.17% | -5.38% | -6.44% | -5.75% | -5.70% | -5.27% | -1.30% | -0.73% |

No need for presentation after the adoption of CE3-2.3/4

[JVET-Q0588](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9434) Crosscheck of JVET-Q0498 (Non-CE3: TB based Rice parameter selection for transform skip residual coding) [R.-L. Liao (Alibaba)] [late]

[JVET-Q0561](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9407) CE3-related: Transquant Bypass Mode for Lossless Coding [A. Nalci, M. Karczewicz, H. Wang, H. E. Egilmez, M. Coban (Qualcomm)] [late]

This document proposes to bring back HEVC like transquant bypass mode into VVC for lossless coding. Currently, lossless coding is possible via existing syntax with TS residual coding. However, TS residual coding has lesser bit-rate savings as compared to regular coefficient coding as observed in the 16th Geneva meeting. As a result, CE3 has many tests for signaling either a high-level flag or a low-level flag for switching between TS residual coding and regular residual coding. In the case of transquant bypass, transform and quantization steps are simply bypassed using a coding unit (CU) level flag. This flag does not only provide a CU level control for lossless coded blocks but is also more flexible for doing mixed lossy and lossless coding.

* The simulation results show overall bit-rate savings of -5.32% AI, -5.62% RA, and -5.00% LDB with Class F: -3.08% AI, -3.73% RA, and -3.54% LDB and Class TGM: -3.19% AI, -2.59% RA, and -2.84% LDB.
* The simulation results with Luma BDPCM enabled show overall bit-rate savings of -6.86% AI, X% RA, and -X% LDB with Class F: -6.94% AI, -5.23% RA, and X% LDB and Class TGM: -5.59% AI, -3.52% RA, and -3.09% LDB.

* The simulation results with Luma and Chroma BDPCM enabled show overall bit-rate savings of -7.79% AI, X% RA, and -X% LDB with Class F: -8.52% AI, -5.94% RA, and X% LDB and Class TGM: -8.26% AI, -4.50% RA, and -4% LDB.

Results indicate that a low-level flag switching between the two residual coding modes may have some benefit for screen content, for natural content similar to the solution adopted in CE3-2.4

No need for action

[JVET-Q0793](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9639) Crosscheck of JVET-Q0561 (CE3-related: Transquant bypass mode for lossless coding) [Z.-Y. Lin (MediaTek)]

[JVET-Q0749](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9595) CE3-related: Additional Results with Luma and Chroma BDPCM on CE3-2.5 [A. Nalci, H. E. Egilmez, M. Coban, M. Karczewicz (Qualcomm), T.-C. Ma, H.-J. Jhu, X. Xiu, Y.-W. Chen, X. Wang (Kwai Inc.)] [late]

This document provides additional results with chroma BDPCM enabled on top of CE3-2.5 sub test 2.

• The simulation results show overall bit-rate savings of -7.69% AI, -6.20% RA, and -5.83% LDB with Class F: -7.99% AI, -5.80% RA, and -5.06% LDB and Class TGM: -7.86% AI, -5.25% RA, and -4.61% LDB.

Results indicate that a low-level flag switching between the two residual coding modes may have some benefit for screen content, for natural content similar to the solution adopted in CE3-2.4

No need for action

[JVET-Q0783](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9629) Crosscheck report for JVET-Q0574 (CE3-related: Additional Results with Luma and Chroma BDPCM on CE3-2.5) [H. Jang (LGE)] [late]

[JVET-Q0785](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9631) CE3-related: Modification of chroma BDPCM [M. Karczewicz, H. Wang, A. Nalci, M. Coban (Qualcomm), T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)] [late]

TBP track B

[JVET-Q0790](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9636) Crosscheck of JVET-Q0785 (CE3-related: Modification of chroma BDPCM) [T. Poirier (InterDigital)]

[JVET-Q0792](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9638) Crosscheck of JVET-Q0785 (CE3-related: Modification of chroma BDPCM) [H.-J. Jhu (Kwai Inc.)]

Overall conclusion: CE3 does not need to be continued.

## CE4 related – Inter prediction with geometric partitioning (33)

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

[JVET-Q0761](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9607) BoG report of CE4 related contributions on inter prediction with geometric partitioning [H. Yang]

Review of this BoG report was discussed Saturday 11 Jan. 1115 in Track A (chaired by GJS).

Four sessions had been organized for the BoG meeting, 27 contributions have been reviewed. [integrate times]

* Jan. 8, 2000 to 2230, on the category of mode reduction for geometric partitioning.
* Jan. 9, 0800 to 1300, on remaining contributions.
* Jan. 9, 1430 to 1725, on remaining contributions.
* Jan. 10, 1530 to 1730, on the summary table of various proposals in the category of mode reduction for geometric partitioning.

JVET-Q0061 had been discussed in track A when the CE4 report was presented.

BoG-recommended normative changes, relative to the CE4 method:

* JVET-Q0188: change the sampling position from (4i+1.5, 4j+1.5) to (4i+2, 4j+2), for the calculation of motionIdx for the motion storage of GEO mode (method 2 of proposal).

With the proposed method, the weightIdx derived for blending matrix can be reused (if desired) for the derivation of motionIdx, and no need for separate calculation of motionIdx.

This is a small adjustment of the formula. It was commented that this might have no real reduction of complexity for most implementations (since they might not reuse the blending mask to derive the motion mask); however, it makes equations in different places consistent with each other and does not harm coding efficiency or increase complexity, and provides the opportunity fore reusing calculations in those implementations that might be able to do that.

* JVET-Q0365: Replace the LUT of GeoFilter[ ] by the proposed equation.

The proposed method is considered to be friendly for parallel processing in both hardware and software implementation, as a single equation can be used for per-sample weight calculation. (Basically no coding efficiency impact: 0.02% gain for RA, 0.06% loss for LB.)

Decision: Adopt per BoG recommendation.

BoG recommended for Track discussion:

* JVET-Q0422: Revisit aspect 2 and 3 in track A or in an HLS session on high level control of coding tools.
  + See notes for Q0482 regarding the signalling of number of merge candidates. Revisit details once we establish the level of the signalling.
* Revisit candidate proposals on reducing the number of modes of geometric partitioning, as summarized in section 3.1.1 in the BoG report document. The claimed benefit is verification/validation efforts. The number of the combinations of GEO modes and CU shapes is 64\*16 in the method previously agreed in the meeting. (The “common base” method had 82\*19 combinations.) Decision: Stay with the 64-combination method from the CE, except disable GEO for 8x64 and 64x8.

Encoder will do 60 SATD check and 8 R-D checks.

* JVET-Q0437 (disabling MTS for geometric partition mode), only partial data for the encoder only restriction had been available in the BoG. It was noted that the transform and prediction are different stages of processing. No action was taken on this.

[JVET-Q0061](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8886) CE4-related: Combined Test of CE4-1, CE4-2 and CE4-3 [H. Gao, S. Esenlik, E. Alshina, A. M. Kotra, B. Wang (Huawei), K. Reuzé, C.-C. Chen, H. Huang, W.-J. Chien, V. Seregin (Qualcomm), R.-L. Liao, J. Chen, Y. Ye, J. Luo (Alibaba), L. Xu, F. Chen, L. Wang (Hikvision), Z. Deng, L. Zhang, H. Liu, K. Zhang, Y. Wang (Bytedance), M Bläser, J. Sauer (RWTH Aachen)]

[JVET-Q0123](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8948) CE4-related: Modifications of GEO [J. Li (Panasonic)]

[JVET-Q0668](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9514) Crosscheck of JVET-Q0123 (CE4-related: Modifications of GEO) [Z. Deng (ByteDance)] [late]

[JVET-Q0127](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8952) Non-CE4: On merge list generation for geometric partitioning [Y. Kidani, K. Kawamura, K. Unno, S. Naito (KDDI)]

[JVET-Q0692](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9538) Crosscheck of JVET-Q0127: Non-CE4: On merge list generation for geometric partitioning [H. Gao (Huawei)] [late]

[JVET-Q0131](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8956) Non-CE4: GEO with mode reduction [T. Hashimoto, E. Sasaki, T. Ikai (Sharp)]

[JVET-Q0711](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9557) Crosscheck of Non-CE4: GEO with mode reduction [K. Reuzé, H. Huang, W.-J. Chen, V. Seregin, M. Karczewicz (Qualcomm)] [late]

[JVET-Q0132](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8957) Non-CE4: Separate syntax for GEO angle and distance [T. Zhou, E. Sasaki, T. Ikai (Sharp)]

[JVET-Q0667](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9513) Crosscheck of JVET-Q0132 (Non-CE4: Separate syntax for GEO angle and distance) [Z. Deng (Bytedance)] [late]

[JVET-Q0160](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8985) CE4-related: CE4-1 spec text with suggested fixes [M. Zhou (Broadcom)]

[JVET-Q0168](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8993) CE4-related: On GEO clean-ups [Y. Morigami, M. Ikeda, T. Suzuki (Sony)]

[JVET-Q0719](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9565) Crosscheck of JVET-Q0168 (CE4-related: On GEO cleanups) [A. Filippov, V. Rufitskiy (Huawei)] [late]

[JVET-Q0188](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9013) CE4-related: Simplification on geometric partitioning mode by replacing motion index calculation with subsampled weight information [Y.-L. Hsiao, C.-C. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0554](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9400) Crosscheck of JVET-Q0188: CE4-related: Simplification on geometric partitioning mode by replacing motion index calculation with subsampled weight information [H. Gao (Huawei)] [late]

[JVET-Q0189](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9014) CE4-related: Reducing GEO modes [O. Chubach, Y.-L. Hsiao, C.-Y. Chen, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0738](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9584) Cross-check result of JVET-Q0189: CE4-related: Reducing GEO modes [Z. Zhang (Ericsson)] [late]

[JVET-Q0268](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9093) CE4-related: GEO with 32 modes [K. Reuzé, H. Huang, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-Q0714](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9560) Crosscheck of JVET-Q0268 (CE4-related: GEO with 32 modes) [T. Hashimoto, T. Ikai (Sharp)] [late]

[JVET-Q0307](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9132) CE4-related: Block-dimension based GEO mode selection [Z. Deng, L. Zhang, H. Liu, K. Zhang, Y. Wang (Bytedance)]

[JVET-Q0577](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9423) Crosscheck of JVET-Q0307 (CE4-related: Block-dimension based GEO mode selection) [L. Xu, H. Dou, Y.-J. Chiu (Intel)] [late]

[JVET-Q0309](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9134) CE4-related: Further constraints on block shapes for GEO [Z. Deng, L. Zhang, H. Liu, K. Zhang, Y. Wang (Bytedance)]

[JVET-Q0528](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9358) Crosscheck of JVET-Q0309 (CE4-related: Further constraints on block shapes for GEO) [J. Li (Panasonic)] [late]

[JVET-Q0312](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9137) CE4-related: On simplification for GEO weight derivation [Y. Sun, F. Chen, L. Wang (Hikvision)]

[JVET-Q0672](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9518) Crosscheck of JVET-Q0312 (CE4-related: On simplification for GEO weight derivation) [Z. Deng (ByteDance)] [late]

[JVET-Q0575](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9421) Crosscheck of JVET-Q0338 (CE4-related: Harmonized conditions for CIIP and GEO) [N. Zhang (Bytedance)] [late]

[JVET-Q0339](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9164) CE4-related: Adjustment of the distance on the GEO mode [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-Q0677](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9523) Crosscheck of JVET-Q0339 (CE4-related: Adjustment of the distance on the GEO mode) [Y. Morigami, M. Ikeda (Sony)] [late]

[JVET-Q0348](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9173) CE4-related: Displacement Restriction on Geometric Inter Prediction [Y.-C. Yang, C.-Y. Teng (Foxconn)]

[JVET-Q0598](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9444) Crosscheck of JVET-Q0348 (CE4-related: Displacement Restriction on Geometric Inter Prediction) [H.-J. Jhu (Kwai Inc.)] [late]

[JVET-Q0541](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9387) Crosscheck of JVET-Q0364 (CE4.4-related: Combination of GEO or TPM with Weighted-Prediction) [T. Chujoh (Sharp)] [late]

[JVET-Q0365](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9190) CE4-Related: On-the-fly Weighting Index to Sample Blending Weight Conversion without Table Look-Up in GEO [L.-F. Chen, X. Li, G. Li, S. Liu (Tencent)]

[JVET-Q0564](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9410) Crosscheck of JVET-Q0365: CE4-Related: On-the-fly Weighting Index to Sample Blending Weight Conversion without Table Look-Up in GEO [H. Gao (Huawei)] [late]

[JVET-Q0388](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9213) CE4-related: GEO memory reduction in weighting masks by fixed shifting [D. Liu, C. Hollmann, R. Yu, J. Ström (Ericsson)]

[JVET-Q0670](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9516) Crosscheck of JVET-Q0388 (CE4-related: GEO memory reduction in weighting masks by fixed shifting) [Z. Deng (ByteDance)] [late]

[JVET-Q0422](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9247) CE4 related: cleanup for signalling maximum number of triangle merge candidates [L. Li, X. Li, G. Li, S. Liu (Tencent)]

[JVET-Q0429](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9254) CE4-related: Geometric partitioning signaling [T. Poirier, F. Le Léannec, F. Urban, A. Robert (InterDigital)]

[JVET-Q0728](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9574) Crosscheck of JVET-Q0429 (CE4-related: Geometric partitioning signaling) [T. Zhou, T. Ikai (Sharp)] [late]

[JVET-Q0437](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9263) Non-CE4: Disabling MTS for Geo [K. Naser, F. Le Leannec, T. Poirier, F. Galpin (InterDigital)]

[JVET-Q0681](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9527) Crosscheck of JVET-Q0437 (Non-CE4: Disabling MTS for Geo) [X. Zhao (Tencent)] [late]

[JVET-Q0440](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9266) Non-CE4: Disabling TrSkip for Geo [K. Naser, F. Le Léannec, T. Poirier (InterDigital)]

[JVET-Q0721](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9567) Crosscheck of JVET-Q0440 (Non-CE4: Disabling TrSkip for Geo) [B. Ray (Qualcomm)] [late]

[JVET-Q0456](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9282) Non-CE4: reduced LUT for GEO blending weights generation [Y.-Z. Ma, Q.-H. Ran, R.-P. Qiu, M.-L. Zhang, J.-Y. Huo, F.-Z. Yang (Xidian Univ.), S. Wan (NPU)]

[JVET-Q0642](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9488) Crosscheck of JVET-Q0456 (Non-CE4: reduced LUT for GEO blending weights generation) [R.-L. Liao (Alibaba)] [late]

[JVET-Q0458](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9284) CE4-Related: On-the-fly Weighting Index to Sample Blending Weight Conversion without Table Look-Up on Top of Combine Test in Q0061 [L.-F. Chen, X. Li, G. Li, S. Liu (Tencent)]

[JVET-Q0565](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9411) Crosscheck of JVET-Q0458: CE4-Related: On-the-fly Weighting Index to Sample Blending Weight Conversion without Table Look-Up on Top of Combined Test in Q0061 [H. Gao (Huawei)] [late]

[JVET-Q0459](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9285) CE4-Related: Look-Up Table Free Weighting Index to Sample Blending Weight Calculation By Using Piecewise Constant Function in GEO [L.-F. Chen, X. Li, G. Li, S. Liu (Tencent)]

[JVET-Q0466](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9292) CE4-Related: On-the-fly Weighting Calculation in GEO [L.-F. Chen, X. Li, G. Li, S. Liu (Tencent)]

[JVET-Q0507](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9336) CE4-related: Quality scalable GEO [J. Li, C. S. Lim (Panasonic)]

[JVET-Q0669](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9515) Crosscheck of JVET-Q0507 (CE4-related: Quality scalable GEO) [Z. Deng (ByteDance)] [late]

[JVET-Q0508](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9337) CE4-related: Combined test of JVET-Q0123 and JVET-Q0268 [K. Reuzé, H. Huang, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm), J. Li, C.S. Lim (Panasonic)] [late]

[JVET-Q0760](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9606) Crosscheck of JVET-Q0508 Test 1 (CE4-related: Combined test of JVET-Q0268 and JVET-Q0123) [R.-L. Liao (Alibaba)]

[JVET-Q0526](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9356) CE4-related: GEO support for 4xN and Nx4 CU [K. Panusopone, S. Hong, L. Wang (Nokia)] [late]

[JVET-Q0768](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9614) Crosscheck of JVET-Q0526 (CE4-related: GEO support for 4xN and Nx4 CU) [T.Zhou (Sharp)] [late]

[JVET-Q0710](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9556) Joint solution for GEO parameter adjustment (JVET-Q0168 and JVET-Q0336) [Y. Morigami, M. Ikeda, T. Suzuki (Sony), N. Park, J. Nam, H. Jang, J. Kim (LGE)] [late]

[JVET-Q0767](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9613) Crosscheck of JVET-Q0710 (Joint solution for GEO parameter adjustment (JVET-Q0168 and JVET-Q0339)) [M. G. Sarwer (Alibaba)] [late]

[JVET-Q0727](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9573) Non-CE4: simplified LUT for GEO blending weights generation [(?? (Xidian Univ.)] [late] [miss]

## CE5 related – Cross-component adaptive loop filtering (24)

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

[JVET-Q0074](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8899) CE5-related: Performance of CE5 anchor with 8-bit dynamic range for CC-ALF coefficients [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-Q0124](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8949) CE5-related: JC-CCALF with Power of 2 Weight Values [C.-W. Kuo (Panasonic)]

[JVET-Q0653](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9499) Cross-check of JVET-Q0124 (CE5-related: JC-CCALF with Power of 2 Weight Values) [Y.-W. Chen (Kwai Inc.)] [late]

[JVET-Q0125](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8950) CE5-related: JC-CCALF with Alternative Filter Weight [C.-W. Kuo (Panasonic)]

Was further reviewed in track B Monday Jan. 13, 13:30.

In this contribution, it is proposed to use individual JC-CCALF filter weight for each alternative filter. Specifically, instead of using various weight values as in JC-CCALF, only sign changes are applied for 4 alternative filters, e.g., +--+. In decoder, the current CTU selects the filter weight according to the parsed alternative filter index. Compared to the JC-CCALF in CE5-3.2, coding gain improvement and negligible runtime change are observed.

Simulation results with joint YUV performance (AHG13 8:1:1 metric) are summarized as follows.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | **Random Access** | | | | **Low Delay B** | | | |
| **Y** | **U** | **V** | **YUV** | **Y** | **U** | **V** | **YUV** | **Y** | **U** | **V** | **YUV** |
| CCALF (CE5 anchor) | 0.17% | -8.31% | -7.06% | -1.40% | 0.14% | -10.14% | -9.82% | -1.88% | 0.12% | -13.00% | -9.48% | -2.15% |
| JC-CCALF (CE5-3.2) | 0.10% | -5.84% | -4.87% | -0.99% | 0.16% | -8.63% | -8.27% | -1.56% | 0.12% | -12.71% | -9.47% | -2.12% |
| alternative filter weight | 0.10% | -6.65% | -5.56% | -1.14% | 0.15% | -9.39% | -9.16% | -1.74% | 0.11% | -13.03% | -10.11% | -2.22% |

The gain comes from two aspects: Replace weight by +/-1 (sign), the gain comes mainly from saving bits for signalling. In total, there are less options for weighting, but more options for the joint filter. The adopted option from CE5-2.1 still has more options for the filters, and the new proposal still is less performant. The complexity of the adopted proposal is not a real concern, and the approach proposed here appears to have some more irregularity.

No action.

[JVET-Q0585](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9431) CE5-related: cross-check report of JVET-Q0125 on JC-CCALF with Alternative Filter Weight [E. François (InterDigital)] [late]

[JVET-Q0165](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8990) CE5-related: On the CC-ALF filtering process [Z. Zhang, J. Ström, K. Andersson (Ericsson)]

[JVET-Q0544](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9390) Crosscheck of JVET-Q0165 Test 1 (CE5-related: On the CC-ALF filtering process) [O. Chubach (MediaTek)] [late]

[JVET-Q0607](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9453) Crosscheck of JVET-Q0165 (CE5-related: On the CC-ALF filtering process) [N. Hu (Qualcomm)] [late]

[JVET-Q0190](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9015) CE5-related: On CC-ALF modifications related to coefficients and signalling [O. Chubach, C.-Y. Chen, C.-Y. Lai, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0648](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9494) Cross-check of JVET-Q0190 (CE5-related: On CC-ALF modifications related to coefficients and signaling) [T.-C. Ma (Kwai Inc.)] [late]

[JVET-Q0251](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9076) CE5-related: Unified cross component adaptive loop filter [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-Q0736](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9582) Cross-check result of JVET-Q0251: CE5-related: Unified cross component adaptive loop filter [Z. Zhang (Ericsson)] [late]

[JVET-Q0253](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9078) CE5-related: High level syntax modifications for CCALF [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)]

[JVET-Q0296](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9121) Non-CE5: Adaptive precision for CCALF coefficients [L.-H. Xu, J. Yao, J.-Q. Zhu, K. Kazui (Fujitsu)]

[JVET-Q0803](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9649) Non-CE5: Crosscheck of JVET-Q0296 (Adaptive precision for CCALF coefficients) [T. Ji (Sharp Labs)] [late]

[JVET-Q0301](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9126) CE5-related: CCALF filter for 4:2:2 and 4:4:4 color format [J. Choi, J. Nam, J. Heo, J. Lim, S. Kim (LGE)]

[JVET-Q0660](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9506) Crosscheck of JVET-Q0301 "CE5-related: CCALF filter for 4:2:2 and 4:4:4 color format" [G. Li (Tencent)] [late]

[JVET-Q0304](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9129) Non-CE5: Non-Linear Cross Component Adaptive Loop Filter [J. Yao, L.-H. Xu, J.-Q. Zhu, K. Kazui (Fujitsu)]

[JVET-Q0804](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9650) Non-CE5: Crosscheck of JVET-Q0304 (Non-CE5: Non-Linear Cross Component Adaptive Loop Filter) [T. Ji (Sharp Labs)] [late]

[JVET-Q0310](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9135) Non-CE5: Suggested text for CC-ALF padding process with raster scan slices [Y. Wang, H. Liu, L. Zhang, K. Zhang, Y. Wang (Bytedance)]

[JVET-Q0311](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9136) Non-CE5: On CC-ALF padding for ALF virtual boundaries [Y. Wang, H. Liu, L. Zhang, K. Zhang, Z. Deng, Y. Wang (Bytedance)]

[JVET-Q0537](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9383) Crosscheck of JVET-Q0311 (Non-CE5: On CC-ALF padding for ALF virtual boundaries) [T. Ikai (Sharp)] [late]

[JVET-Q0382](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9207) CE5-related: On high level syntax of CC-ALF [F. Chen, L. Xu, L. Wang (Hikvision)]

[JVET-Q0467](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9293) CE5-related: Simplified CCALF [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

[JVET-Q0624](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9470) Crosscheck of JVET-Q0467 (CE5-related: Simplified CCALF) [J. Choi (LGE)] [late]

[JVET-Q0494](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9322) CE5-related: Joint clip operation for CCALF and chroma ALF [T.-C. Ma, X. Xiu, Y.-W. Chen, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-Q0531](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9377) Crosscheck of JVET-Q0494 (CE5-related: Joint clip operation for CCALF and chroma ALF) [O. Chubach (MediaTek)] [late]

[JVET-Q0673](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9519) Crosscheck of JVET-Q0494 (CE5-related: Joint clip operation for CCALF and chroma ALF) [J. Heo (LGE)] [late]

[JVET-Q0171](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8996) AHG9: On CC-ALF modifications related to HLS [O. Chubach, C.-Y. Chen, C.-Y. Lai, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0250](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9075) CE5-related: Removing number of filters for CC-ALF in slice and picture header [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-Q0326](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9151) CE5-related: On CC-ALF slice and picture header syntax [X. W. Meng (PKU), X. Zheng (DJI), S. S. Wang, S. W. Ma (PKU)]

[JVET-Q0580](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9426) Crosscheck report of JVET-Q0326 [X. Xu (Tencent)] [late]

[JVET-Q0520](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9349) AHG9: Cleanups on signaling for CC-ALF, BDPCM, ACT and Palette [Y. Wang, L. Zhang, K. Zhang, W. Zhu (Bytedance)]

Items 1 and 2 of this contribution belong to this category.

[JVET-Q0559](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9405) CE5-related: CCALF coefficient derivation using combined neighbors [K. Panusopone, S. Hong, L. Wang, J. Lainema (Nokia)] [late]

[JVET-Q0805](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9651) Non-CE5: Crosscheck of JVET-Q0559 (CCALF coefficient derivation using combined neighbors) [T. Ji (Sharp Labs)] [late]

[JVET-Q0782](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9628) CE5-related: High level syntax modifications for CCALF (combination of JVET-Q0253 and JVET-Q0520) [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei), Y. Wang, L. Zhang, K. Zhang, W. Zhu (Bytedance)] [late]

## Inter prediction and MV coding (33)

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

[JVET-Q0105](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8930) nonCE4: BCW SIF Derivation for Pairwise Candidate [A. Robert, T. Poirier, F. Le Léannec (InterDigital)]

[JVET-Q0558](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9404) Crosscheck of JVET-Q0105 "BCW SIF Derivation for Pairwise Candidate" [G. Li (Tencent)] [late]

[JVET-Q0128](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8953) On clarification of applicable conditions of DMVR and BDOF [T. Chujoh, T. Hashimoto, E. Sasaki, T. Ikai (Sharp)]

[JVET-Q0589](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9435) Crosscheck of JVET-Q0128 (On clarification of applicable conditions of DMVR and BDOF) [P. Bordes (InterDigital)] [late]

[JVET-Q0129](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8954) On editorial improvements for specification of explicit weighted prediction [T. Chujoh, T. Hashimoto, E. Sasaki, T. Ikai (Sharp)]

[JVET-Q0185](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9010) AHG16: On merge estimation region for VVC [Y.-L. Hsiao, C.-C. Chen, C.-W. Hsu, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek), H. Huang, W.-J. Chien, T. Hsieh, V. Seregin, C.-C. Chen, K. Reuzé, M. Karczewicz (Qualcomm)]

[JVET-Q0640](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9486) Crosscheck of JVET-P0185 (AHG16: On merge estimation region for VVC) [S. Esenlik (Huawei)] [late]

[JVET-Q0242](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9067) Cleanup for TPM, CIIP, and GEO in the colour format of 4:0:0 [L. Pham Van, G. Van der Auwera, A. K. Ramasubramonian, H. Huang, W.-J. Chien, M. Karczewicz (Qualcomm)]

In VTM and the current WD of VVC, the TPM blending process is carried out for both luma and chroma components without regard for the chroma format. In addition, in VTM7, the CIIP blending process is also performed for the chroma components in any chroma format. However, the chroma components are not existing in the 4:0:0 colour format. This contribution proposes cleanups for the TPM and CIIP modes by disabling the blending process of these modes for the chroma components in YUV 4:0:0 format. In the case of GEO (studied in CE4), it is also recommended to disable the GEO weighted blending process for the chroma components in YUV 4:0:0.

Presented in track B Monday 13 January, 2000

The contribution points out some inconsistencies in the SW only for CIIP, as well as in the spec + SW for TPM and GEO.

Decision(BF/text+SW): Adopt JVET-Q0242

Proponents are asked to communicate with the proponents of the adopted GEO version (integrated text JVET-Q0806). The suggested fixes should be included into the integrated GEO text.

[JVET-Q0770](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9616) Cross-check of JVET-Q0242 (Cleanup of TPM, CIIP and GEO for 4:0:0 format) [Y.-W. Chen (Kwai Inc.)] [late]

[JVET-Q0438](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9264) Monochrome processing [A. Browne, K. Sharman, S. Keating (Sony)]

Presented in track B Monday 13 Jan., 1955

The current profiles for VTM permit the coding of monochrome (4:0:0) video formats. However, when an attempt was made to test monochrome processing on VTM 7.0, several fixes were required both to the encoder and the decoder software.

This contribution includes both the changes made to permit monochrome processing and results comparing VTM 7.0 monochrome performance with HM 16.21.

It is proposed that monochrome testing is added to the tests completed by AHG-13, to ensure that future changes to the VTM software model that conflict with monochrome processing are identified rapidly.

The following results were achieved by comparing monochrome processing using the modified version of VTM 7.0 and monochrome processing using HM 16.21. These results were produced using CTC[2], but with ChromaFormatIDC=400 set on the command line.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **All Intra** |  |
|  |  | **Over HM16.21\_400** |  |
|  | Y | EncT | DecT |
| Class A1 | -20.87% | 2076% | 187% |
| Class A2 | -20.75% | 3053% | 204% |
| Class B | -18.35% | 3630% | 217% |
| Class C | -17.47% | 4602% | 233% |
| Class E | -23.05% | 2881% | 214% |
| **Overall** | -19.76% | 3259% | 212% |
| Class D | -13.67% | 4873% | 217% |
| Class F | -32.01% | 6049% | 213% |
| Class TGM | -56.72% | 4905% | 172% |

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Random Access** |  |
|  |  | **Over HM16.21\_400** |  |
|  | Y | EncT | DecT |
| Class A1 | -32.70% | 581% | 135% |
| Class A2 | -38.00% | 673% | 146% |
| Class B | -33.19% | 665% | 144% |
| Class C | -26.96% | 883% | 166% |
| Class E |  |  |  |
| **Overall** | -32.39% | 700% | 148% |
| Class D | -25.06% | 1001% | 200% |
| Class F | -36.72% | 526% | 126% |
| Class TGM | -56.36% | 461% | 125% |

Some bugs were found (VTM crashed),, a patch will be provided to the SW coordinatorscoordinator.

It was found that the gain of VTM versus HM is somewhat lower than in 420 case, mainly for AI. This could partially be explained by the fact that VVC has some very efficient chroma coding tools such as CCLM, which allow shifting bit rate from chroma to luma.

The run time ratios VTM vs. HM seem to be worse for AI, better for RA.

Further study of these findings in AHG13 is recommended. Generally, experts are encouraged performing more studies on non-CTC modes.

[JVET-Q0266](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9091) On TPM and GEO merge modes in presence of weighted prediction [A. Filippov, H. Chen, V. Rufitskiy, H. Yang, E. Alshina (Huawei)]

[JVET-Q0700](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9546) Cross-check of JVET-Q0266 on TPM and GEO merge modes in presence of weighted prediction [P. Onno (Canon)] [late]

[JVET-Q0748](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9594) Crosscheck of JVET-Q0266 (On TPM and GEO merge modes in presence of weighted prediction) [P. Bordes (InterDigital)] [late]

[JVET-Q0297](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9122) AHG16: Merge estimation region [H. Huang, W.-J. Chien, T. Hsieh, V. Seregin, C.-C. Chen, K. Reuze, M. Karczewicz (Qualcomm), Y.-L. Hsiao, C.-C. Chen, C.-W. Hsu, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)])] [check author list and title wrt doc and website]

[JVET-Q0654](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9500) Cross-check of JVET-Q0297 (AHG16: Merge estimation region with constrain in HMVP update) [Y.-W. Chen (Kwai Inc.)] [late]

[JVET-Q0306](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9131) Non-CE4: Removal of MVD scaling process for 4x8/8x4 blocks in MMVD [N. Zhang, H. Liu, L. Zhang, K. Zhang, Y. Wang (Bytedance)]

[JVET-Q0635](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9481) Crosscheck of JVET-Q0306 (Non-CE4: Removal of MVD scaling process for 4x8/8x4 blocks in MMVD) [N. Park (LGE)] [late]

[JVET-Q0313](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9138) Non-CE4: Constraints on block size for ATMVP [Y. Sun, F. Chen, L. Wang (Hikvision)]

[JVET-Q0532](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9378) Crosscheck of JVET-Q0313 (Non-CE4: Constraints on block size for ATMVP) [H. Chen (Huawei)] [late]

[JVET-Q0315](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9140) Non-CE4: Triangular prediction mode with motion vector difference [K. Zhang, L. Zhang, H. Liu, Z. Deng, Y. Wang (Bytedance)]

[JVET-Q0691](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9537) Crosscheck of JVET-Q0315: Non-CE4: Triangular prediction mode with motion vector difference [J. Ström (Ericsson)] [late]

[JVET-Q0324](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9149) Simplification of MV derivation for affine chroma [S. H. Wang (PKU), X. Zheng (DJI), S. S. Wang, S. W. Ma (PKU)]

[JVET-Q0659](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9505) Crosscheck of JVET-Q0324 "Simplification of MV derivation for affine chroma" [G. Li (Tencent)] [late]

[JVET-Q0327](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9152) On IBC/ATMVP candidate list construction [X. W. Meng, S. H. Wang (PKU), X. Zheng (DJI), S. S. Wang, S. W. Ma (PKU)]

[JVET-Q0612](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9458) Crosscheck of JVET-Q0327: On IBC/ATMVP candidate list construction [J. Chen (Alibaba)] [late]

[JVET-Q0337](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9162) Non-CE4: On weight values of the chroma-component for TPM mode [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-Q0540](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9386) Crosscheck of JVET-Q0337 (Non-CE4: On weight values of the chroma-component for TPM mode) [T. Chujoh (Sharp)] [late]

[JVET-Q0340](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9165) Non-CE4: Cleanup of the MMVD offset derivation [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-Q0341](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9166) Non-CE4: Range of the motion vector [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

[JVET-Q0535](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9381) Crosscheck of JVET-Q0341 (Non-CE4: Range of the motion vector) [J. Li (Panasonic)] [late]

[JVET-Q0349](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9174) Combination of TPM and Weighted-Prediction [P. Bordes, T. Poirier, F. LeLeannec (InterDigital)]

[JVET-Q0538](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9384) Crosscheck of JVET-Q0349 (Combination of TPM and Weighted-Prediction) [T. Chujoh (Sharp)] [late]

[JVET-Q0350](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9175) Non-CE: Enable CIIP for 4x8/8x4 block without SCIPU violation [H. Jang, J. Nam, N. Park, S. Kim, J. Lim (LGE)]

[JVET-Q0600](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9446) Crosscheck of JVET-Q0350 (Non-CE: Enable CIIP for 4x8/8x4 block without SCIPU violation) [K. Panusopone (Nokia)] [late]

[JVET-Q0354](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9179) Non-CE: Clean-up regarding syntaxes for prediction mode decision [H. Jang, J. Nam, N. Park, S. Kim, J. Lim (LGE)]

[JVET-Q0651](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9497) Cross-check of JVET-Q0354 (Non-CE: Clean-up regarding syntaxes for prediction mode decision) [T.-C. Ma (Kwai Inc.)] [late]

[JVET-Q0356](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9181) AHG16: Parallel Merge Estimation for VVC [S. Esenlik, H. Gao, B. Wang, A. M. Kotra, E. Alshina (Huawei), Y.-L. Hsiao, C.-C. Chen, C.-W. Hsu, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (Mediatek)]

[JVET-Q0583](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9429) Crosscheck of JVET-Q0356 (AHG16: Parallel Merge Estimation for VVC) [B. Bross (HHI)] [late]

[JVET-Q0362](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9187) Non-normative aspects for cleanup of DMVR specification and software [S. Esenlik, B. Wang, A. M. Kotra, H. Gao, E. Alshina (Huawei), J. Arumugam, S. Kotecha, S. Ramamurthy (Ittiam)]

[JVET-Q0368](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9193) On context model for mvp\_flag and ref\_idx [H. Chen, H. Yang (Huawei)]

[JVET-Q0633](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9479) Crosscheck of JVET-Q0368 (On context model for mvp\_flag and ref\_idx) [X.-W. Li, J.-Y. Huo (Xidian Univ.), S. Wan (NPU)] [late]

[JVET-Q0370](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9195) On context model for merge indices [H. Chen, H. Yang (Huawei)]

[JVET-Q0534](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9380) Crosscheck of JVET-Q0370 (On context model for merge indices) [Y. Sun, F. Chen, L. Wang (Hikvision)] [late]

[JVET-Q0389](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9214) Non-CE4: SbTMVP harmonization [D. Liu, C. Hollmann, R. Yu (Ericsson)]

[JVET-Q0562](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9408) Crosscheck of JVET-Q0389 (Non-CE4: SbTMVP harmonization) [Y. Sun, F. Chen, L. Wang (Hikvision)] [late]

[JVET-Q0390](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9215) Non-CE4: SbTMVP simplification [D. Liu, C. Hollmann, R. Yu (Ericsson)]

[JVET-Q0789](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9635) Crosscheck of JVET-Q0390 (Non-CE4: SbTMVP simplification) [A. Aminlou (Nokia)]

[JVET-Q0431](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9256) Interaction between Affine and SBT [F. Le Léannec, K. Naser, T. Poirier, P. Bordes (InterDigital)]

[JVET-Q0666](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9512) Cross-check of JVET-Q0431 (Interaction between Affine and SBT) [A. Nalci (Qualcomm)] [late]

[JVET-Q0455](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9281) On CU-level BDOF enable condition [S. Wan, Y. Xue (NPU), J.-Y. Huo, Y.-Z. Ma, F.-Z. Yang (Xidian Univ.), Y.-F. Yu, Y. Liu (OPPO)]

[JVET-Q0613](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9459) Crosscheck of JVET-O0455: On CU-level BDOF enable condition [J. Chen (Alibaba)] [late]

[JVET-Q0483](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9310) On avoiding out of range motion vectors [F. Bossen, A. Segall (Sharp)]

[JVET-Q0496](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9324) AHG16: On motion shift derivation of SbTMVP [Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

[JVET-Q0522](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9351) Non-CE4: Early termination of DMVR and study of its pixel coverage [C.-C. Chen, H. Huang, W.-J. Chien, M. Karczewicz (Qualcomm)]

[JVET-Q0705](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9551) Crosscheck of JVET-Q0522 (Non-CE4: Early termination of DMVR and study of its pixel coverage) [H.-J. Jhu (Kwai Inc.)] [late]

[JVET-Q0524](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9354) Non-CE4: DC balancing in DMVR [A. Aminlou, M. Homayouni (Nokia)] [late]

[JVET-Q0675](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9521) Crosscheck of JVET-Q0524 (Non-CE4: DC balancing in DMVR) [K. Zhang (Bytedance)] [late]

[JVET-Q0802](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9648) Crosscheck of JVET-Q0524 Non-CE4: DC balancing in DMVR [D. Liu (Ericsson)] [late]

[JVET-Q0525](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9355) Non-CE4: Support large rotation and flipping in affine and PROF [A. Aminlou, D. Naik (Nokia)] [late]

[JVET-Q0662](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9508) Cross-check of JVET-Q0525 Non-CE4: Support large rotation and flipping in affine and PROF [D. Liu (Ericsson)

[JVET-Q0338](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9163) CE4-related: Harmonized conditions for CIIP and GEO [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

TBP?

[JVET-Q0364](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9189) CE4.4-related: Combination of GEO and Weighted-Prediction [P. Bordes, T. Poirier, F. Le Léannec (InterDigital)]

TBP?

[JVET-Q0601](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9447) Non-CE4: Extension of JVET-P0325 [A. Robert, T. Poirier, F. Le Léannec (InterDigital)] [late]

TBP?

[JVET-Q0800](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9646) Crosscheck of JVET-Q0601 (Non-CE4: Extension of JVET-P0325) [[R.-L. Liao (Alibaba)](mailto:ruling.lrl@alibaba-inc.com)] [late]

[JVET-Q0798](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9644) SPS level control over the number of merge candidates [L. Li, Y.-J. Chang, S. Esenlik] [late]

TBP track B or BoG?

## Intra prediction and mode coding (24)

Contributions in this category were discussed Saturday 11 Jan. 1100–1315 (sub-sections 6.7.1 and 6.7.2), and 1445-1615 (subsection 6.7.3) in Track B (chaired by JRO).

### General intra prediction and mode coding aspects (7)

[JVET-Q0110](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8935) On Intra Prediction Mode and Chroma BDPCM [A. Nalci, L. Pham Van, H. Egilmez, G. Van der Auwera, M. Coban, M. Karczewicz (Qualcomm)]

This document proposes two aspects and fixes for chroma BDPCM. The first aspect (bug-fix) provides an alignment of the intra prediction mode for chroma blocks when chroma BDPCM (e.g. horizontal or vertical mode) is used in 444 coding. This aspect simplifies the MPM list derivations process and provides coding gains. The same alignment was already adopted for luma blocks in JVET-O0315.

The second aspect provides an additional context derivation fix for BDPCM on top of aspect #1. Currently, BDPCM is applied to luma and chroma separately. However, BDPCM contexts are shared between luma and chroma blocks. In the spec text BDPCM has separate contexts for luma and chroma unlike the VVC software. Considering that TS has separate contexts luma and chroma, it is proposed to separate BDPCM contexts for luma and chroma and align code with spec. This provides additional coding gains.

Aspect 1 provides -0.24%/-0.11% overall BD-Rate changes under AI/RA configurations versus the VTM-7.0 anchor on 4:4:4 sequences when dual-tree is off.

Aspect 1 provides -0.13%/-0.01% overall BD-Rate changes under AI/RA configurations versus the VTM-7.0 anchor on 4:4:4 sequences when dual-tree is on.

Aspect 2 provides -0.36%/-0.14% overall BD-Rate changes under AI/RA configurations versus the VTM-7.0 anchor on 4:4:4 sequences when dual-tree is off.

Aspect 2 provides -0.23%/-0.08% overall BD-Rate changes under AI/RA configurations versus the VTM-7.0 anchor on 4:4:4 sequences when dual-tree is on.

Additional Results

Aspect 1 provides -0.26%/-0.12% overall BD-Rate changes under AI/RA/LDB configurations versus the VTM-7.0 anchor on 4:4:4 sequences when dual-tree is off and palette is off.

Aspect 2 provides -0.43%/-0.21% overall BD-Rate changes under AI/RA/LDB configurations versus the VTM-7.0 anchor on 4:4:4 sequences when dual-tree is off and palette is off.

Both aspects are already in the text, but the software deviates.

Decision (SW/BF): Adopt JVET-Q0110, align software with text

[JVET-Q0597](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9443) Crosscheck of JVET-Q0110 (On Intra Prediction Mode and Chroma BDPCM) [H.-J. Jhu (Kwai Inc.)] [late]

[JVET-Q0192](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9017) Chroma wide angle intra prediction mode mapping for 4:2:2 format [C.-M. Tsai, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

This contribution proposes a bug fix for the 4:2:2 chroma intra mode mapping of wide angle intra prediction (WAIP) modes. In HEVC-RExt, 4:2:2 chroma intra mode mapping is the final step in deriving chroma intra angular prediction mode. However, in VVC Draft 7, 4:2:2 chroma intra mode mapping is not the final step in deriving chroma intra angular prediction mode. The 4:2:2 chroma intra mode mapping is applied before the WAIP mode mapping process, and therefore not every WAIP mode is mapped to the correct angular mode. In the proposed method, the 4:2:2 chroma intra mode mapping is moved after the WAIP mode mapping process, and the mapping table is also extended for supporting WAIP intra mode mapping.

Compared with VTM7.0, results of 4:2:2 test sequences using All Intra (AI) and Random Access (RA) configurations are reported as follows:

VTM7.0-AI: {Y-BD-rate = 0.00%, EncT = 99%, DecT = 96%}  
VTM7.0-RA: {Y-BD-rate = 0.00%, EncT = 99%, DecT = 100%}

It is shown that the bug causes very minor impact on BD-rates. However, it is asserted that fixing the bug is good for VVC.

The current spec is correct in so far that everything is clearly specified which intra prediction sample generation a decoder has to do. The change suggested in the contribution would only cover cornercase of extremely narrow blocks which practically don’t occur. There have been various alignments of the WAIP mapping in the past, and the best solutions (in terms of complexity and performance) were chosen.

No need for action.

[JVET-Q0604](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9450) Crosscheck of JVET-Q0192 (Chroma wide angle intra prediction mode mapping for 4:2:2 format) [B. Wang (Huawei)] [late]

[JVET-Q0275](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9100) Suggested bugfixes for CCLM filtering in the VVC specification draft [A. Filippov, V. Rufitskiy, E. Alshina (Huawei)]

This contribution proposes to fix several mismatches between the VVC specification draft and the VTM- 7.1 software. These bugs relate to CCLM filtering process and have been already reported on the VVC bug tracker as tickets #727 and #776.

Two bugs related to 4:2:2 case:

Fix #1, ticket 727: Set F[1]=0 – agreed.

Fix #2, ticket 776: filtering of block sample to be corrected, The contributors of Q0275 are the original contributors and confirm that the suggested fix is correct. - agreed

Decision (BF/text): Adopt both fixes, align text with SW.

[JVET-Q0302](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9127) Simplified contexts in intra prediction [J. Choi, J. Heo, J. Lim, S. Kim (LGE)]

Theoretically, context coded bins provides better coding performance compared to bypass coded bins because it can estimate the probability more accurately. However, it requires more computational complex and delay to estimate the probability so that the number of context coded bins determines throughput efficiency of the system. This contribution investigates justification of using context coded bins for some indications of intra prediction tools, such as cclm\_mode\_idx, intra\_luma\_ref\_idx, and intra\_subpartitions\_split\_flag. Based on the investigation, following three methods are proposed. :

* Method 1: all bins of **cclm\_mode\_idx** are coded in bypass mode.
* Method 2: second bin of **intra\_luma\_ref\_idx** is coded in bypass mode.
* Method 3: **intra\_subpartitions\_split\_flag** is coded in bypass mode.

Experimental results (BD-rate changes in AI configuration, compare to the VTM7.0 anchor) for the proposed method 1, 2 and 3 are as below:

* Method 1: Y 0.01%, Cb -0.08%, Cr -0.06%
* Method 2: Y 0.01%, Cb -0.05%. Cr 0.02%
* Method 3: Y 0.01%, Cb 0.00%. Cr 0.02%

No real benefit, in the interest of convergence of the spec, this change should not be done.

[JVET-Q0697](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9543) Crosscheck of JVET-Q0302 (Simplified contexts in intra prediction) [L. Li (Tencent)] [late]

[JVET-Q0392](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9217) On the coding of cclm\_mode\_flag [B. Ray, G. Van der Auwera, A. K. Ramasubramonian, M. Karczewicz (Qualcomm)]

It is proposed to have separate context for cclm\_mode\_flag when the co-located luma block is coded with MIP. Results on VTM-7.0, for CTC (dual-tree on) and dual-tree off cases are reported below. In version v2, the source code is attached.

Table 1: CTC results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Config. | Y | U | V | EncT | DecT |
| AI | -0.01% | -0.01% | 0.03% | 100% | 101% |
| RA | -0.02% | 0.00% | 0.06% | 99% | 99% |

Table 2: dual-tree off results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Config. | Y | U | V | EncT | DecT |
| AI | -0.06% | -0.13% | -0.05% | 100% | 102% |
| RA | -0.03% | -0.01% | 0.11% | 99% | 100% |

No real benefit, in the interest of convergence of the spec, this change should not be done.

[JVET-Q0555](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9401) Crosscheck of JVET-Q0392 (On the coding of cclm\_mode\_flag) [R. Ghaznavi-Youvalari (Nokia)] [late]

[JVET-Q0556](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9402) Aligning intra-prediction of TS blocks with BDPCM [Saverio Blasi, Gosala Kulupana (BBC)] [late]

This contribution proposes to disable PDPC (Position Dependent Prediction Combination) and reference sample filtering on intra-predicted blocks, in case the corresponding residual blocks are Transform Skipped (TS). By doing so, handling of prediction in TS blocks is aligned with BDPCM blocks. The proposed alignment brings an average luma BD-rates of -0.10% and -0.05%, for Class TGM and Class F AI respectively with no encoder or decoder run time increment. For CTC, there is no performance change. All the coding performances are measured with respect to the VTM 7.0 anchor [1].

Not obvious that this is a benefit in implementation, and compression benefit is almost zero

No action.

[JVET-Q0758](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9604) Crosscheck of JVET-Q0556 (Aligning intra-prediction of TS blocks with BDPCM) [V. Rufitskiy, A. Filippov (Huawei)]

[JVET-Q0500](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9328) AHG16: On derivation of CCLM predictors [Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

In the current CCLM design, different filters are used to generate the down-sampled luma samples depending on whether the luma samples are available or not, which is not friendly for certain parallel processing such as single instruction multiple data (SIMD) operation. In this proposal, it is proposed to perform repetitive padding for those unavailable luma samples, and apply the same 6-taps filter to generate all the down-sampled luma samples. The results show 0.00% (AI), 0.01%(RA) and 0.00%(LDB) BD-rate impact with negligible run time changes under CTC. It is also asserted that with the proposed method, the VVC spec can be reduced by around 100 lines in specifying the decoding process of CCLM mode.

Loss in chroma is slightly higher (not severe), which is obvious as CCLM is a chroma tool).

Cross-checkers express that the software still needs to check for picture border and boundary, the benefit in implementation is not really obvious, and may depend on architecture. SIMD advantage, but would only be effective at CTU boundary.

Main advantage would be the simplification of spec text. Cross-checker confirms that SW and text are matching.

Some support expressed.

Decision(cleanup): Adopt JVET-Q0500

[JVET-Q0610](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9456) Crosscheck of JVET-Q0500: AHG16: On derivation of CCLM predictors [C.-H. Hung, C.-H. Chao (Qualcomm)] [late]

### Prediction sample generation (7)

[JVET-Q0194](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9019) Cleanup for checking CTU row boundary location in CCLM [C.-M. Tsai, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

In this contribution, the condition of checking the coding tree unit (CTU) row boundary location in luma downsampling process of cross-component linear model (CCLM) modes is corrected. In VVC Draft 7, the CTU row boundary location is checked by evaluating if the top position of the current chroma transform block (TB) is a multiple of luma coding tree block (CTB) size divided by 2, which is not valid for colour formats 4:2:2 and 4:4:4. In the proposed method, the condition is modified to check if the corresponding luma top position of the current chroma TB is a multiple of luma CTB size.

Apparently, there is no problem in the current software, as the results with and without that change are identical. Obviously, the software has some mechanism to identify where the CTU boundary is in the $$$ and 422 chroma cases.

Revisit: Confirm with other experts if the suggested text change is needed. Generally it should be expected that the subheightC parameter should take care of this.

[JVET-Q0683](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9529) Crosscheck of JVET-Q0194 (Cleanup for checking CTU row boundary location in CCLM) [K. Andersson (Ericsson)] [late]

[JVET-Q0292](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9117) Cleanup of intra reference sample filter selection [J. Heo, J. Choi, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

In current VVC draft, the intra reference sample filter decision process relies on the size-dependent threshold to select intra reference sample filters, and the intra reference sample filtering process requires multiple checks because intra mode information should be considered to select intra reference sample filters. This contribution introduces two methods to simplify this intra reference sample filter decision process. In Method 1, the selection of filters for both the reference sample filter and the interpolation filter is directly derived according to the size-dependent threshold. In Method 2, the reference sample filter process is completely removed in the intra coding process and the interpolation filter is selected based on the size-dependent threshold. Method 1 provides the coding performance changes of 0.00%, 0.00%, and -0.04% BD-rate in AI, RA, and LD configuration, respectively. Method 2 provides the coding performance changes of 0.01%, 0.02%, and 0.03% BD-rate in AI, RA, and LD configuration, respectively.

The benefit is not substantial, and this would require a substantial amount of changes. In the interest of convergence of the spec, this should not be done.

[JVET-Q0650](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9496) Cross-check of JVET-Q0292 (Cleanup of intra reference sample filter selection) [T.-C. Ma (Kwai Inc.)] [late]

[JVET-Q0293](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9118) Removal of chroma Nx2 blocks in PDPC [J. Heo, H. Jang, J. Choi, J. Lim, S. Kim (LGE)]

Considering that 2xN chroma blocks were removed in chroma intra prediction, and PDPC is applied to luma block which is greater than or equal to 4x4, PDPC condition is different for Nx2 blocks according to luma and chroma intra prediction. This contribution proposes to remove chroma Nx2 blocks in PDPC. The experimental results show that the proposed method provides the coding performance changes of 0.00%, 0.01%, and -0.01% BD-rate in AI, RA, and LD configuration, respectively. Encoding and decoding run-times are not changed.

This is a straightforward alignment, and change in text is minimum

It is pointed out that the second proposed text change of the contribution

“refIdx is equal to 0 ~~or cIdx is not equal to 0”~~

shall not be adopted, as it would inhibit usage of PDPC for chroma when luma uses MRL.

Decision: Adopt JVET-Q0293, only the first suggested text change

* nTbW is greater than or equal to 4 and nTbH is greater than or equal to 4 ~~or cIdx is not equal to 0~~

[JVET-Q0698](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9544) Crosscheck of JVET-Q0293 (Removal of chroma Nx2 blocks in PDPC) [L. Li (Tencent)] [late]

[JVET-Q0366](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9191) Non-CE3: Simplification of interpolation filtering for intra prediction [G. Rath, F. Galpin, F. Urban (InterDigital)]

This document presents a simplification of the interpolation filtering for luma intra prediction. It is proposed to replace the 4-tap smoothing filter in VTM 7.0, that replaced the Gaussian filter in VTM 6.0, by linear interpolation with a prior filtering of reference samples by [1 2 1]/4 filter. It is reported that the proposed simplification yields 0.02% coding loss in AI over VTM-7.0, with 100% encoding and 96% decoding time, and that it yields 0.02% coding loss in RA over VTM-7.0, with 100% encoding and 100% decoding time.

It is commented that there is necessarily a benefit for implementation separating the filter into two stages. Out of this reason the 4-tap filter was introduced.

No action.

[JVET-Q0765](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9611) Crosscheck of JVET-Q0366 (Simplification of interpolation filtering for intra prediction) [J. Heo (LGE)] [late]

[JVET-Q0385](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9210) Simplification of intra prediction in CIIP mode [R. Ghaznavi-Youvalari, J. Lainema, K. Panusopone (Nokia)]

This contribution proposes to simplify the intra prediction part of the combined inter intra prediction (CIIP) mode by disabling or limiting the usage of the PDPC filter. Three alternatives are proposed in this contribution. The first method is to disable the PDPC filter always when the block is coded in CIIP mode. The second method enables the PDPC filter only when at least one of the neighboring blocks is coded in intra prediction mode. The third method enables the PDPC when at least one of the neighboring blocks is coded in intra mode or includes residual coding. The simulation results in VTM-7.0 are as below:

**Method 1:**

RA: 0.01%, -0.03%, 0.01%

LB: -0.01%, -0.02%, -0.05%

**Method 2:**

RA: 0.00%, -0.01%, -0.01%

LB: -0.01%, 0.03%, -0.07%

**Method 3:**

RA: 0.01%, 0.00%, 0.03%

LB: -0.03%, -0.16%, -0.04%

The proposed methods reduce the complexity of CIIP mode in terms of number of calculations with almost no impact in coding performance and execution times.

When CIIP was adopted, it was decided to keep the intra part unchanged out of good reasons. The benefit is not obvious that this is really a simplification, because the intra processing pipeline would need to be modified or duplicated for CIIP.

No action.

[JVET-Q0547](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9393) Crosscheck of JVET-Q0385 (Simplification of intra prediction in CIIP mode) [B. Ray (Qualcomm)] [late]

[JVET-Q0391](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9216) Unified PDPC for angular intra modes [B. Ray, G. Van der Auwera, M. Karczewicz (Qualcomm)]

Current VVC specification does not allow PDPC for the cases for angular modes where the secondary reference samples needed for PDPC are unavailable. This contribution proposes to perform PDPC for those cases by extending gradient based approach from horizontal/vertical modes. CTC results for AI and RA configurations, over VTM-7.0, are as follows. In version v2, the source code is attached. In version v3, the excel sheet for Table 3 is added.

Table1: CTC results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Config. | Y | U | V | EncT | DecT |
| AI | -0.09% | -0.07% | -0.02% | 100% | 101% |
| RA | -0.05% | 0.11% | 0.09% | 99% | 99% |

It is commented that this is a modification/extension of the gradient mode, rather than a unification. Another aspect may be that cascaded clipping occurs.

0.1% in intra is probably interesting, but this is not a simplification and would require various changes to PDPC.

Cross-checkers express support for adoption.

Other experts expressed their opinion that the change is too substantial to be done at this late stage, and it is not a simplification.

No action.

[JVET-Q0543](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9389) Crosscheck of JVET-Q0391 (Unified PDPC for angular intra modes) [J. Pfaff (HHI)] [late]

[JVET-Q0464](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9290) On modifications of intra prediction process [A. Filippov, V. Rufitskiy, B. Wang, S. Esenlik, A.M. Kotra, H. Gao, E. Alshina (Huawei)]

This contribution proposes to modify intra prediction process. In particular, PDPC scaling is harmonized with intra subpartitions (ISP) coding mode, so that the number of reference samples used is maximized. The simulation results for method 1 reportedly show the Y/U/V BD-rate changes of 0.00%/- 0.02%/0.00%, -0.01%/‑0.01%/0.03% and ‑0.04%/0.01%/-0.16% for AI, RA and LDB configurations, respectively. The simulation results for method 2 reportedly show the Y/U/V BD-rate changes of 0.00%/- 0.03%/0.00% and 0.00%/‑0.06%/0.07% for AI and RA configurations, respectively. More significant coding efficiency improvements (-0.12%/0.57%/-0.27% and -0.10%/-0.32%/0.24% for method 1 and method 2, respectively) are achieved for class E in LDB case.

In version 2, a symmetric intra interpolation filter selection is used, named as method 3. This method is independent from the other proposed ones. Compared to the current asymmetric interpolation filter selection approach in VTM7.0, method 3 achieves luma BD-rate changes of 0.00%/0.01%/-0.06% for AI, RA and LDB configurations, respectively. In addition, a combined test of method 1 and 3 are performed, the BD-rate changes of 0.00%/-0.01%/-0.04% for AI, RA and LDB configurations, respectively.

In version 3, a test with minimal changes to the specification (method 0) is carried out. Minor consistent improvement of coding performance on RA is observed for this method. The simulation results for method 0 reportedly show the Y/U/V BD-rate changes of 0.00%/‑0.03%/‑0.01%, -0.02%/‑0.04%/0.01% and 0.00%/-0.08%/-0.14% for AI, RA and LDB configurations, respectively.

It is not obvious that there are problems solved by the various methods. The elements of the proposal do not appear as a simplification, and the compression benefit is low. Further, at least method 3 was added only recently, which is basically disconnected from the original proposal.

No need for action.

[JVET-Q0746](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9592) Crosscheck of JVET-Q0464 (On modifications of intra prediction process) [S. De-Luxán-Hernández (HHI)] [late]

### MIP (10)

[JVET-Q0161](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8986) On constant shift and offset in MIP [K. Kondo, M. Ikeda, T. Suzuki (Sony)]

This contribution proposes to replace an adaptive shift operation and offset with constant shift and offset in a matrix-based intra prediction (MIP). In current VTM, MIP uses the shift operations that the number of shift changes depending on MIP-sizeId and MIP mode. Also MIP uses adaptive offset factor "fO" that the value changes depending on MIP-sizeId and MIP mode. To simplify, this contribution proposes to use constant those values. Two cases are tested that the table bit range are in 7 bit (test-sW5) and 8 bit (test-sW6). For the test-sW5, experimental results of 0.04% and 0.02% for AI and RA conditions, are reported. For the test-sW6, experimental results of 0.00% and 0.00% for AI and RA conditions, are reported.

See under JVET-Q0446 (joint proposal)

[JVET-Q0542](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9388) Crosscheck of JVET-Q0161 (On constant shift and offset of MIP) [J. Pfaff (HHI)] [late]

[JVET-Q0274](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9099) MIP with fixed-length mode coding and memory reduction [T. Biatek, L. Pham Van, A. K. Ramasubramonian, G. Van der Auwera, M. Karczewicz (Qualcomm)]

This contribution proposes to reduce the number of MIP matrices in order to harmonize the fixed-length coding for MIP mode signaling. In VTM-7.0, the MIP sets contain 16, 8 and 6 matrices, respectively for MipSizeId 0, 1 and 2. We propose to reduce the number of MIP matrices for MipSizeId 2 from 6 to 4. This enables to use fixed-length coding for all MipSizeId and brings the side benefit of saving some storage (18%). In addition, VTM-7.0 MIP weights are kept as we simply select a subset of existing matrices (no retraining). Coding performance interms of average (Y, U, V) Bd-rate is evaluated on CTC, Div2K and OpenImages datasets providing the following results:

* CTC: AI: (0.02%, -0.04%, -0.01%), RA: (0.02%, 0.02%, 0.06%) RA
* Div2K: AI: (0.02%, 0.03%, -0.04%)
* Ericsson: AI: (0.02%, 0.05%, -0.05%).

It is proposed to adopt this cleanup in the next VVC specification.

Question: How was it decided which matrices to remove? A: Was done by running experiments for best results.

Main benefit would be reduction in memory. There seems not to be a critical issue with the current memory, so stability of the design is more important.

No action.

[JVET-Q0774](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9620) Crosscheck of JVET-Q0274 (MIP with fixed-length mode coding and memory reduction) [M. Schäfer, J. Pfaff (HHI)] [late]

[JVET-Q0371](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9196) Unification of intra reference sample generation [D.-Y. Kim (Chips&Media), S.-C. Lim, J. Lee, J. Kang (ETRI)]

This contribution points out a mismatch between text and software in regard to intra reference sample generation for MIP. Whereas the VVC7 text generates the reference samples of above and left for MIP, the VTM7 software generates the reference samples of above, above-right, above-left, left, and left-bottom like general intra sample prediction modes. It is found that it would occur a mismatch on the reconstructed samples between text and software in case where multiple slices are used. To solve the problem, this proposal suggests to align the reference sample generation of the MIP to that of the general intra sample prediction.

The contribution points out a mismatch in a non-CTC case (TU and CTU of same size, 32 or 64). Two methods are proposed: 1. Align text with SW, i.e. use same padding as in normal intra. 2. Align SW with text (use median). Method 1 is preferred.

Decision (BF/text): Adopt JVET-Q0371 method 1.

[JVET-Q0380](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9205) LFNST restriction based on MIP [S. Shrestha, A. Kumar, B. Lee (Chosun Univ.), Y. Lee, J. Park (Humax)]

In VTM-7.0 [1], MIP [2] and LFNST [3] have been harmonized, where LFNST is allowed for the MIP blocks with width and height greater than or equal to 16. In addition, it has been decided that MIP is applied to all CU blocks without any restrictions of block sizes [5] in VTM7.0. Hence, we propose to modify the number of block sizes to apply LFNST for MIP blocks. In this contribution, we propose two sets of block sizes to apply LFNST on MIP blocks. First, where either height or width are greater than or equal to 16 or (maximum(height, width) greater than or equal to 32 && minimum(height, width) greater than or equal to 4), which includes 4×32, 4×64, 8×32, 8×64, 16×16, 16×32, 16×64, 32×4, 32×8, 32×16, 32×32, 32×64, 64×4, 64×8, 64×16, 64×32 and 64×64 block sizes. In the second test, where either height or width both are greater than or equal to 16 or (H>=4 && W>=64) and vice-versa or (H>=8 && W>=32) and vice versa, which includes all right diagonal blocks as 4×64, 8×32, 8×64, 16×16, 16×32, 16×64, 32×8, 32×16, 32×32, 32×64, 64×4, 64×8, 64×16, 64×32 and 64×64 block sizes.

Not clear that there is a problem, no complexity reduction, and this would add more condition checks.

No action.

[JVET-Q0696](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9542) Crosscheck of JVET-Q0380 (LFNST restriction based on MIP) [L. Li (Tencent)] [late]

[JVET-Q0446](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9272) MIP with constant shifts and offsets [J. Pfaff, B. Stallenberger, M. Schäfer, P. Merkle, P. Helle, T. Hinz, H. Schwarz, D. Marpe, T. Wiegand (HHI), K. Kondo, M. Ikeda (Sony), J. Huo, H. Wang, Y. Ma, F. Yang (Xidian University), S. Wan (NPU), Y. Yu (OPPO)]

In this document, it is proposed to unify the shift and the offset used in the matrix-vector multiplication of matrix based intra prediction (MIP). It is proposed to always set the right shift sW to 6 and to always set the offset fO to 32. Thus, it is proposed to remove the dependency of sW and fO on the MIP mode and the MIP-sizeId. Experimental results of 0.00% BD rate change for the AI configuration and of -0.01% BD rate change for the RA configuration are reported. The measured encoding- and decoding-times are 99% and 99% for the AI configuration and 99% and 101% for the RA configuration, respectively.

Presentation deck to be provided.

This simplification had been asked for the benefit of SIMD. So far, all solutions had been coming with loss.

Matrices were retrained, which is necessary to guarantee the bit depth of 8 with the constant-shift approach to avoid the loss.

Otherwise, the text is simplified, but it is necessary to redefine the matrices.

Decision: Adopt JVET-Q0446

It is agreed that this is the last time the matrices are changed.

[JVET-Q0726](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9572) Cross-check of JVET-Q0446 (MIP with constant shifts and offsets) [F. Bossen (Sharp)] [late]

[JVET-Q0450](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9276) On fixed sW and fO in MIP [J.-Y. Huo, H.-X. Wang, Y. Sun, Y.-Z. Ma, F.-Z. Yang (Xidian Univ.), S. Wan (NPU), Y.-F. Yu, Y. Liu (OPPO)]

In this document, it is proposed 3 MIP modifications including sign change, fixed fO and fixed sW. Specifically, sign change is to change the sign of input value p[0]; fixed fO is to remove the table of fO in VVC and use a fixed value; fixed sW is to remove the table of sW in VVC and use a fixed shift value.

Three Tests are conducted.

For test1, sign change (the input value p[0] modification), the prediction is identical with the prediction of VVC7 and the coding performance is identical with that of VTM7.0. The experimental results are as below:

For AI configuration: 0.00%, 0.00%, and 0.00%, with 100% EncT, 100% DecT;

For RA configuration: 0.00 %, 0.00%, and 0.00%, with 100% EncT, 100% DecT.

For test2, sign change and fixed fO are included, the experimental results are as below:

For AI configuration: 0.00%, 0.00%, and 0.01%, with 100% EncT, 101% DecT;

For RA configuration: 0.01 %, 0.09%, and 0.07%, with 100% EncT, 100% DecT.

For test3, sign change, fixed fO and fixed sW are all included, the experimental results are as below:

For AI configuration: 0.04%, -0.01%, and -0.01%, with 100% EncT, 100% DecT;

For RA configuration: 0.02 %, -0.01%, and 0.06%, with 100% EncT, 100% DecT.

No need for presentation – included in JVET-Q0446.

[JVET-Q0757](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9603) Crosscheck of JVET-Q0450 (On fixed sW and fO in MIP) [K. Kondo, M. Ikeda, (Sony)]

[JVET-Q0451](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9277) On mipSizeId modification for 8x8 blocks [J.-Y. Huo, H.-X. Wang, X.-W. Li, Y.-Z. Ma, F.-Z. Yang (Xidian Univ.), S. Wan (NPU), Y.-F. Yu, Y. Liu (OPPO)]

This contribution change the mipSizeId of 8 × 8 blocks from 1 to 2. For a 8 × 8 block, the predicted samples can be directly derived by matrix multiplification and no upsampling operation is need.

The experimental results are as below:

For AI configuration: -0.03%,-0.01%, and 0.03%, with 100% EncT, 100% DecT;

For RA configuration: 0.00 %, -0.03%, and 0.08%, with 100% EncT, 100% DecT.

No need for presentation – included in JVET-Q0582.

[JVET-Q0740](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9586) Crosscheck of JVET-Q0451 (On mipSizeId modification for 8x8 blocks) [J. Pfaff (HHI)] [late]

[JVET-Q0453](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9279) Modification of LFNST for MIP coded block [J.-Y. Huo, W.-H. Qiao, X.-W. Li, Y.-Z. Ma, F.-Z. Yang (Xidian Univ.), S. Wan (NPU), Y.-F. Yu, Y. Liu (OPPO)]

In VVC Draft 7, LFNST transform set 0 is always selected and LFNST transpose flag is always equal to 0 for a MIP coded block. In this contribution, it is proposed to utilize intra\_mip\_mode[ xTbY ][ yTbY ] to select LFNST transform set and utilize intra\_mip\_transposed[ xTbY ][ yTbY ] to determine LFNST transpose flag.

This contribution proposes two tests: test1) modify the LFNST transform set and LFNST transpose flag determination for MIP coded blocks, test2) based on test 1, make LFNST is enabled for all MIP coded blocks with mipSizeId equal to 2.

It is reported that test1 gives average BD-rate changes of {-0.04%, -0.04%, -0.01%} for AI, and {-0.02%, -0.02%, 0.03%} for RA.

It is reported that test2 gives average BD-rate changes of {-0.07%, -0.06%, -0.01%} for AI, and {-0.06%, -0.01%, 0.12%} for RA.

The methods introduce more condition checks, and more implicit choices of transforms.

Difference of test 2 versus test 1 would be similar to the modification in contribution JVET-Q0380.

One table is added to the spec for this purpose.

It is pointed out that the gain would still apply with the new MIP matrices of JVET-Q0446.

It is not a simplification, and the gain is relatively low.

No action.

[JVET-Q0655](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9501) Cross-check of JVET-Q0453 (Modification of LFNST for MIP coded block) [Y.-W. Chen (Kwai Inc.)] [late]

[JVET-Q0582](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9428) Harmonization of JVET-Q0451 and JVET-Q0453 for MIP & LFNST design [J.-Y. Huo (Xidian Univ.), S. Wan (NPU), X.-W. Li, H.-X. Wang, F.-Z. Yang, Y.-Z. Ma (Xidian Univ.), Y.-F. Yu, Y. Liu (OPPO)] [late]

Proposed is a harmonization of the methods proposed in JVET-Q0451 and JVET-Q0453. It is reported that, under the CTC, an average performance for {Y, U, V} is {-0.11%, -0.06%, -0.01%} for AI and {-0.07%, 0.02%, 0.10%} for RA over VTM 7.0.

This extends the combination of MIP with LFNST also to 8x8 blocks. It is however pointed out by another expert that this would increase the worst case of complexity.

No action.

[JVET-Q0725](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9571) Crosscheck of JVET-Q0582 (Harmonization of JVET-Q0451 and JVET-Q0453 for MIP & LFNST design) [H. Chen, X. Ma (Huawei)] [late]

[JVET-Q0452](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9278) Modification of up-sampling in MIP [J.-Y. Huo, X.-W. Li, Q.-H. Ran, Y.-Z. Ma, F.-Z. Yang (Xidian Univ.), S. Wan (NPU), Y.-F. Yu, Y. Liu (OPPO)]

In VVC Draft 7, a fixed up-sampling order is used to obtain the prediction signal in MIP. The up-sampling process is performed firstly in the horizontal direction and secondly in the vertical direction. In this contribution, it is proposed to perform the up-sampling process in two orders, horzontal-vertical and vertical-horizontal. Then the average of the prediction signals obtained by the two up-sampling orders is the final prediction signal of MIP. It is reported that, under the CTC, the overall performance impact for {Y, U, V} is {-0.02%, -0.04 %, -0.01 %} for AI and {-0.01 %, -0.04 %, 0.00 %} for RA over VTM 7.0. As for Class A1 sequences, the performance impact for {Y, U, V} is {-0.04%, -0.15 %, 0.13 %} for AI and {-0.02 %, -0.16 %, 0.02%} for RA over VTM 7.0. As for Class A2 sequences, the performance impact for {Y, U, V} is {-0.03%, -0.01 %, -0.11 %} for AI and {-0.04 %, 0.00%, -0.08%} for RA over VTM 7.0.

This would duplicate the complexity of upsampling. Not justified by the small compression gain.

[JVET-Q0741](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9587) Crosscheck of JVET-Q0452 (Modification of up-sampling in MIP) [J. Pfaff (HHI)] [late]

[JVET-Q0457](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9283) MIP input value calculation unification [S. Wan (NPU), H.-X. Wang, J.-Y. Huo, D.-N. Wang, Y.-Z. Ma, F.-Z. Yang (Xidian Univ.), Y.-F. Yu, Y. Liu (OPPO)]

It is proposed to unify the MIP input value calculation without dependency on the mipSizeId and sample position. The proposed modification can get a good unification to calculate MIP input value. The prediction is identical with the prediction of VVC.

The experimental results are as below:

For AI configuration: 0.00%, 0.00%, and 0.00%, with 100% EncT, 100% DecT;

For RA configuration: 0.00 %, 0.00%, and 0.00%, with 100% EncT, 100% DecT.

This would be purely editorial. There is no problem in the current spec. Left to discretion of editor if that is useful to make the spec better readable (which is likely the case because there is no difference between the two cases).

[JVET-Q0643](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9489) Crosscheck of JVET-Q0457 (MIP input value calculation unification) [R.-L. Liao (Alibaba)] [late]

## Loop filtering (11)

Contributions in this category were discussed Friday 10 Jan. 1815–2050 in Track B (chaired by JRO).

See also:

* Section 6.19.2:
  + Q0121 on deblocking control parameters
  + Q0175 on parameters override mechanism in slice header for in-loop filters
  + Q0248 on constraints for ALF APS
  + Q0254 on override for ALF related syntax elements in slice header
  + Q0352 on subpicture boundaries
  + Q0572 on ALF signalling
* Section 6.20.3:
  + Q0120 on control of loop filtering across subpicture/tile/slice boundaries
  + Q0317 which affects filtering control for subpictures
  + Q0352 on subpicture boundaries
  + Q0475 on subpicture signalling

[JVET-Q0150](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8975) Fix for ALF virtual boundary processing [K. Andersson, J. Ström, Z. Zhang, J. Enhorn (Ericsson)]

ALF virtual boundary processing avoids increasing the size of the line buffers for adaptive loop filtering. This contribution claims that this processing, in some cases, can introduce visual artifacts due to the use of extreme padding for the closest row on each side of the virtual horizontal CTU boundary without compensating the filter strength for that. In this contribution, two alternative solutions are proposed. Alternative 1 moves the virtual boundary one row upwards and reduce the amount of padding such that always at least the neighbouring rows to the center row are available. Alternative 2 reduce the filter strength by increasing the right shift for ALF filtering of the rows adjacent to the virtual horizontal CTU boundary. Alternative 1 increase the line buffers by two lines for luma and two lines for chroma. Alternative 2 has similar complexity as VTM.

The BD rate impact for luma for alternative 1:

• AI -0.01%, RA 0.01%, LDB -0.02%

The BD rate impact for luma for alternative 2:

• AI 0.00%, RA 0.00%, LDB 0.02%

Similar encoding and decoding time.

At the virtual CTU boundary, the current ALF VB processing de facto behaves like a purely horizontal filter, which has the consequence that artifacts become visible in particular in case of diagonal structures at the horizontal CTU boundaries.

A viewing session shall be organized to demonstrate the severeness of the artifacts, and the possible reduction by methods 1 and 2.

In the discussion, it is mentioned by hardware implementers that the method without additional line buffer would be preferable.

It is also mentioned that a similar method like method 2 had been investigated when the decision for the current VB solution was made, but it had not been selected as the visual test by that time showed similar quality as with the (somewhat simpler) selected solution.

Revisit

[JVET-Q0606](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9452) Crosscheck of JVET-Q0150 (Fix for ALF virtual boundary processing) [N. Hu (Qualcomm)] [late]

[JVET-Q0167](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8992) Non-CE5: Multiplication simplification for ALF and CC-ALF [J. Ström, Z. Zhang, K. Andersson (Ericsson)]

This document proposes a restriction of ALF coefficients. Instead of allowing all coefficient values from 127 to 127, only values that are pure powers of two +/-{0, 1, 2, 4, 8, …} and values that are 3 times pure powers of two +/-{3, 6, 12, 24, …} are proposed to be allowed. It is claimed that this gives a substantial complexity reduction in terms of surface area of hardware implementations of ALF since every per-sample multiplication can be then replaced by an addition and shifts. Reported BDR figures are:

Test 1: Y-BDR: 0.02% (AI), 0.02% (RA), 0.00% (LDB)

YUV-BDR: 0.01% (AI), 0.01% (RA) -0.07% (LDB)

A variant (test 2) which, in addition to allowing the values of test 1, also allows coefficient values that are 5 times a pure power of two +/-{5, 10, 20, 40, …} is also presented, and it is claimed that this can also be implemented in hardware with the same number of additions as test 1. Reported BDR figures are:

Test 2: Y-BDR: 0.00% (AI), 0.00% (RA), -0.04% (LDB)

YUV-BDR: -0.01% (AI) -0.01% (RA) -0.08% (LDB).

Combinations with CC-ALF enabled are also presented for information.

Question: Is the quantiztion considered in the encoder? Yes, similar way as currently in VTM.

Question: What would happen without change of encoding? Less than 0.1%

Would only be beneficial for hardware – software would use direct multiplication.

Benefit for hardware would probably depend on architecture.

Too many changes at this late stage. The implementation benefit is not large enough to justify this.

[JVET-Q0608](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9454) Crosscheck of JVET-Q0167 (Non-CE5: Multiplication simplification for ALF and CC-ALF) [N. Hu (Qualcomm)] [late]

[JVET-Q0249](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9074) Clipping flag clean-up for chroma adaptive loop filters [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

In VVC draft 7, one adaptation parameter set can signal up to 8 chroma filters. One clipping flag is signalled for each chroma filter to control whether clipping is applied for this filter or not. In this contribution, it is proposed to apply one clipping flag to all chroma filters in one adaptation parameter set. Under common test conditions, compared to VTM-7.0 anchor, similar overall coding efficiency and running time are observed.

Question: Why was it designed in a way that each chroma filter has its own clipping flag?

The original proponents would agree that this makes the design more consistent.

Decision (cleanup): Adopt JVET-Q0249

[JVET-Q0690](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9536) Crosscheck of JVET-Q0249: Clipping flag clean-up for chroma adaptive loop filters [J. Ström (Ericsson)] [late]

[JVET-Q0319](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9144) Non-CE5: On SEI for ALF [H.-B. Teo, H.-W. Sun, C.-S. Lim (Panasonic)]

This contribution proposes a use of ALF module. This is a further follow-up on JVET-P0179. In the case when ALF module is disabled through bitstream header, an adaptive loop filter control SEI is decoded. The proposed SEI is used to turn on the ALF module to filter the reconstructed image for output using the accompanied ALF filter flags and filter coefficients.

Using the proposed SEI, it is possible to customize the picture quality. In an example, customized sets of sharpening filter coefficients combined with low-pass filter coefficients can be used in ALF module to sharpen the output YUV to enhance the edges and smoothen the unwanted noise of an image. A use-case application is in post-processing.

Though the intent of invoking a post filter by SEI is clear (was already in AVC), several questions arise in the context of VVC:

- We know that ALF as loop filter works better than as post filter. Why would certain applications disable the loop filter and invoke the post filter?

- If the post filter has other purposes than the ALF (e.g. sharpening), would it not be better to design it specifically for that purpose?

From the presentation, it appears that the possible application cases are rather specific. Editing is mentioned, but would it then not be better to run the sharpening during editing and code again?

As an SEI message is not mandatory, there would be no guarantee that a decoder receiving it would actually apply the ALF as post filter.

More relevant evidence about possible application cases and actual benefit in terms of quality improvement would be needed.

No action at this moment.

[JVET-Q0378](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9203) Non-CE5: On the number of ALF Chroma filters [P. Onno, G. Laroche, N. Ouedraogo (Canon)]

This contribution proposes to fix the VVC Draft 7 specifications about the number of alternative ALF Chroma filter. It is asserted in the current VVC draft that the maximum number of Chroma filter for ALF related to the **alt\_ctb\_filter\_alt\_idx** is not indicated. It means that the size of the APS to store the ALF data cannot be bounded in the current VVC draft. This contribution proposes to limit the number of the ALF Chroma filters in the VVC draft.

In JVET-Q0041, the number of ALF chroma filters is limited to 8. This should just be kept.

[JVET-Q0720](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9566) Crosscheck of JVET-Q0378 (Non-CE5: On the number of ALF Chroma filters) [V. Rufitskiy, A. Filippov (Huawei)] [late]

[JVET-Q0427](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9252) AHG11: Picture/slice level deblocking control flag for IBC [X. Xu, G. Li, X. Li, S. Liu (Tencent)]

In this contribution, a picture/slice level deblocking on/off control flag is suggested for the IBC mode. The claimed benefit of this flag is to turn on/off the deblocking operation for IBC coded samples with an encoder side choice for different contents.

Also the high-level control flag would imply low-level changes of the deblocking process depending on IBC mode, which would be undesirable. The main motivation is usage of IBC for screen content, which might anyway be better encoded in lower QP to preserve the quality (which would automatically reduce the blurring of the deblocking filter).

There may be sufficient options for an encoder to control the effect of the deblocking.

More study of this is needed.

[JVET-Q0434](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9260) PRE-Sample Adaptive Offset Filter [W. Lim, C. Helmrich, J. Erfurt, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

This contribution proposes a tool referred to as Pre-Sample Adaptive Offset Filter (Pre-SAO). Pre-SAO operates jointly with the deblocking filter (DBF) process to further improve the coding efficiency of the in-loop filter. The tool is controlled by information in the bit-stream, and this information includes both (a) offset coefficients for luma and each chroma component and (b) threshold values for its classification. The offset coefficients and threshold values are both signalled at the slice level.

The proposed approach was evaluated using the CTC and reportedly results in the following average BD-rate improvement relative to VTM 7.1:

AI: −0.64% (Y), −0.81% (Cb), −0.71% (Cr) at 101% enc. and approximately 101% dec. time;  
RA: −0.43% (Y), −0.83% (Cb), −0.81% (Cr) at 100% enc. and approximately 101% dec. time;  
LB: −0.54% (Y), −0.47% (Cb), −0.42% (Cr) at 100% enc. and approximately 100% dec. time;  
LP: −0.41% (Y), −0.30% (Cb), −0.37% (Cr) at 101% enc. and approximately 99% dec. time.

In addition, results for an alternative design, signalling the offset coefficients and threshold values on the CTU level, are reported. For this version, which more closely resembles the operation of the existing SAO in-loop filter, the following average results are reported:

AI: −0.49% (Y), −0.71% (Cb), −0.63% (Cr) at 100% enc. and approximately 102% dec. time;  
RA: −0.25% (Y), −0.68% (Cb), −0.66% (Cr) at 100% enc. and approximately 98% dec. time;  
LB: −0.17% (Y), −0.14% (Cb), −0.06% (Cr) at 101% enc. and approximately 100% dec. time;  
LP: −0.15% (Y), −0.18% (Cb), 0.12% (Cr) at 101% enc. and approximately 98% dec. time.

With an updated encoder implementation, this CTU-level Pre-SAO version yields almost the same results as the slice-level Pre-SAO version above, i.e., luma BD-rate gains of –0.6% AI, –0.4% RA/LP, –0.5% LB.

Interesting new method, which would however require an amount of investigations (including exploration of subjective implication, implementation, etc.), which would make it unlikely to be included in VVC1.

[JVET-Q0682](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9528) Crosscheck of JVET-Q0434 (Pre-Sample Adaptive Offset Filter) [K. Andersson (Ericsson)] [late]

[JVET-Q0776](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9622) Crosscheck of JVET-Q0434 (Pre-Sample Adaptive Offset Filter) [A. M. Kotra, S. Ikonin (Huawei)] [late]

[JVET-Q0441](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9267) SAO Modification for 12-bit [A. Browne, K. Sharman, S. Keating (Sony)]

This document proposes a change to the formula for the offset for SAO. This offset ensures SAO is applied with the same relative magnitude for bit depths greater than 10 as it is at bit depths of 8 and 10.

The adjustment is equivalent to the one introduced in HEVC RExt.

Decision: Adopt JVET-Q0441

[JVET-Q0470](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9296) Conditional signalling of SAO [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

In this contribution, it is proposed to conditionally signal SAO in SPS depending on the ALF usage at sequence level. The proposed methods were implemented on top of VTM-7.0, and simulations were conducted with common test conditions. It is reported that compared with VTM-7.0 anchor, the proposed method has overall performance as following.

• ALF on: AI 0.00%, RA 0.08%; LB 0.09%

• ALF off: AI 0.00%, RA 0.00%, LB 0.00%

The proposal would invoke ALF and SAO alternatively.

However, SAO and ALF have different effects, and may also differently be used by other visual-quality optimized encoders than VTM (which is purely targeting PSNR vs. rate optimization).

Complexity-wise, there is no problem, as SAO has rather low complexity compared to ALF. Any encoder can disable SAO, why should that be done normatively?

No action.

[JVET-Q0797](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9643) Crosscheck of JVET-Q0470 (Conditional signaling of SAO) [A. Robert (InterDigital)] [late]

[JVET-Q0495](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9323) AHG16: Simplified clip ranges for NL-ALF [Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

TBP track B

[JVET-Q0609](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9455) Crosscheck of JVET-Q0495: AHG16: Simplified clip ranges for NL-ALF [C.-H. Hung, Y.-H. Chao (Qualcomm)] [late]

## Reference picture resampling (14)

Remaining aspects to be handled in HLS context

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

Probably more contributions currently allocated to HLS/scalability belong here

[JVET-Q0257](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9082) How to do 16:1 reference picture resampling in VVC [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

[JVET-Q0199](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9024) AHG8: Support of ROI (Region-Of-Interest) RPR [T. Lu, F. Pu, [P. Yin](mailto:pyin@dolby.com), S. McCarthy, W. Husak, T. Chen (Dolby)]

Initially discussed Saturday 11 Jan. 1815–1845 in Track B (chaired by JRO).

This contribution proposes syntax and semantics to support additional functionality and coding efficiency for reference picture resampling (RPR) in VVC. In particular, this contribution proposes a generalization of reference picture resampling (RPR) in which a region of interest (ROI) within a picture – rather than the entire picture – may be resampled to create a reference picture. The proposed syntax and semantics also support the case in which a reference picture is used to predict a region of interest within a current picture rather than the entire current picture. The coding tool proposed in this contribution may be thought of as either RPR using ROI (ROI RPR), or as reference region resampling (RRR) in which RPR is a special case. It is proposed to signal ROI RPR window offset parameters to substitute for the default RPR scaling window offset parameters when ROI RPR is enabled. The additional decoding complexity increase is minimal.

For test clips with a bitstream comprising regular frames and frames with ROI, test results indicate an average coding performance improvement of approximately 11%, compared to VTM7.0 without ROI support, for LDB and LDP test conditions. When using the ROI feature, decoder complexity relative to VTM7.0 is 102% for LDB and 100% for LDP. Encoder complexity is 105% for LDB and 104% for LDP. There is no change in performance if there is no ROI in the bitstream.

An example application is a video sequence where a part of the entire scene is switched to an ROI with larger resolution for a certain duration, and then switches back to the entire scene. It is claimed that compression benefit can be achieved at the switching points.

It is reported that approx. 11% and 10% bit rate reduction can be achieved when the scaling factor is 2x / 0.5x for the switches between entire scene and ROI (ROI then coded with full res) and back. The switch is assumed to happen every 0.5 s, which might be unrealistic. For example, if switching would happen only every 2 seconds, the bit rate saving would only be 1/4.

It would probably be necessary to impose some constraints.

Further discussion in HLS

Revisit for that.

[JVET-Q0567](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9413) Crosscheck of JVET-Q0199 AHG8: Support of ROI (Region-Of-Interest) RPR [J. Luo (Alibaba)] [late]

[JVET-Q0178](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9003) AHG9: Bitstream conformance requirement related to RPR scaling ratio [T.-D. Chuang, O. Chubach, C.-Y. Chen, C.-W. Hsu, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0179](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9004) AHG9: Bitstream conformance requirement related to RPR scaling ratio for worst case MC memory bandwidth reduction [T.-D. Chuang, O. Chubach, C.-Y. Chen, C.-W. Hsu, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0262](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9087) AHG9: On reference picture resampling enabled flag [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

This contribution was discussed Monday 13 January at 2125 (chaired by GJS).

This contribution contains a proposal for modification of the constraint associated with ref\_pic\_resampling\_enabled\_flag. It is asserted that the current constraint is unnecessarily strict and prohibits relevant coding structures that do not use Reference Picture Resampling.

The current constraint is as follows:

* When subpics\_present\_flag is equal to 1 or ref\_pic\_resampling\_enabled\_flag equal to 0, the value of pic\_width\_in\_luma\_samples shall be equal to pic\_width\_max\_in\_luma\_samples.
* When subpics\_present\_flag is equal to 1 or ref\_pic\_resampling\_enabled\_flag equal to 0, the value of pic\_height\_in\_luma\_samples shall be equal to pic\_height\_max\_in\_luma\_samples.

Decision (Ed.): The editor should consider changing the name of the flag, e.g., resolution\_change\_allowed\_flag.

[JVET-Q0290](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9115) AHG9/AHG12: Modifications related to subpicture signalling and RPR [S.-T. Hsiang, C.-Y. Chen, T.-D. Chuang, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

Item 1 of this contribution belongs to this category.

[JVET-Q0318](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9143) AHG9: Constraints on RPR [K. Zhang, L. Zhang, Y.-K. Wang, H. Liu, J. Xu, Z. Deng (Bytedance)]

[JVET-Q0331](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9156) AhG8: Constraints on the picture scaling ratios [Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Item 1 of this contribution belongs to this category.

[JVET-Q0449](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9275) On smoothing filter with RPR in VVC [B. Bross, M. Winken, Y. Sanchez, R. Skupin, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

This contribution asserts that application of the luma half-sample smoothing interpolation filter in case of RPR is undesirable, as samples of a reference block will be derived using different filter kernels thereby mixing interpolation filter kernels with smoothing and DCTIF (i.e., almost all-pass) characteristics in a reference block. This design aspect is asserted to be an oversight. The contribution proposes to change the interpolation filter selection by disabling the smoothing filter kernel for reference pictures either independently in horizontal and vertical if the scaling ratio in the respective direction is not equal to 1 (Fix A) or jointly in horizontal and vertical direction of the scaling ratio in at least one direction is not equal to 1 (Fix B). The coding efficiency results in BD-rate (Y, U, V) using the reference picture resampling CE test conditions with a scale factor of 2.0x are identical for A and B and different for different scale factors such as 2.0x in horizontal and 1.0x in vertical direction:

Hor./Ver.: 1.5x A, B:

LB 0.00%, 0.01%, 0.00% (PSNR1) 0.01%, 0.02%, 0.02% (PSNR2)

Hor./Ver.: 2.0x A, B:

LB −0.03%, 0.02%, 0.13% (PSNR1) −0.04%, 0.03%, 0.11% (PSNR2)

Hor: 2.0x / Ver: 1.0x A

LB −0.01%, −0.28%, −0.12% (PSNR1) 0.00%, −0.26%, −0.11% (PSNR2)

Hor: 2.0x / Ver: 1.0x B

LB 0.00%, −0.08%, −0.03% (PSNR1) 0.00%, −0.05%, −0.03% (PNSR2)

Version 2 of this contribution contains updated results based on a VTM fix for a mismatch reported in ticket [#787](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/787) as well as software with the proposed fix and the fix for the ticket.

Fix A would have the advantage that it would not have an exception case when scaling ratio is 1 (i.e. the normal motion comp is nicely included)

Decision (cleanup): Adopt JVET-Q0449 Fix A

[JVET-Q0756](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9602) Cross-check of JVET-Q0449 on smoothing filter with RPR [V. Seregin (Qualcomm)] [late]

[JVET-Q0486](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9313) AHG8: Constraints on Scaling Window Offset Parameters [T. Hellman, W. Wan, P. Chen, B. Heng, M. Zhou (Broadcom)]

[JVET-Q0487](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9314) AHG8: RPR Scaling Window Issues [W. Wan, T. Hellman, B. Heng, P. Chen (Broadcom)]

[JVET-Q0517](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9346) On RPR down-sampling filters for affine mode [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai)]

In VVC draft 7, for affine mode, 6-tap and 4-tap motion interpolation filters are always applied to interpolation process regardless of scaling factor between one current picture and its reference picture. Because those motion interpolation filters are not strong low-pass filters, affine prediction samples may present severe aliasing artifacts when the reference picture is of higher resolution than the current picture (i.e. down-sampling). In this contribution, down-sampling filters are proposed to replace the existing motion interpolation filters for affine mode. Similar to the derivation of luma motion interpolation filters for affine mode, the luma down-sampling filters for the affine mode are 6-tap filters and are directly derived from the existing 8-tap luma down-sampling filters used for non-affine mode. Meanwhile, for chroma components, the same 4-tap chroma down-sampling filters are used.

For common test condition (CTC) sequences, simulation results reportedly show that average luma BD-rate differences of PSNR1 are -0.19% and -0.14% for 2X and 1.5X scaling ratios, respectively. The corresponding average luma BD-rate differences of PSNR2 are -0.16% and -0.12% for 2X and 1.5X, respectively.

For affine sequences, simulation results reportedly show that average luma BD-rate differences of PSNR1 are -1.88% and -1.06 %% for 2X and 1.5X scaling ratios, respectively. The corresponding average luma BD-rate differences of PSNR2 are -1.57% and -0.84% for 2X and 1.5X, respectively.

Results are reported under RPR testing conditions (switching every 0.5 s)

In current RPR, affine mode uses same filters for up-and downsampling as for normal inter prediction (which is necessary due to memory access constraints in 4x4 blocks. Due to the fact that no good downsampling filters were available, the existing interpolation filters are re-used, which probably causes some alias.

This contribution proposes two sets of filters (one for 2x, one for 1.5x downsampling) with a length of 6 taps, which are for luma are determined from the existing 8-tap downsampling filters of non-affine mode by combining the two outermost coefficients at each end. For chroma, the existing 4-tap downsamplingv filters of non-affine RPR are used.

The results indicate improvement, which at least shows that the proposed solution is better than the one of VTM7.

Decision: Adopt JVET-Q0517.

[JVET-Q0568](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9414) Crosscheck of JVET-Q0517 On RPR down-sampling filters for affine mode [J. Luo (Alibaba)] [late]

[JVET-Q0518](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9347) Mismatch between text specification and reference software on RPR chroma down-sampling for affine mode [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai)]

Dicussed Sat 11 Jan 19:20 Track B (chaired by JRO)

Problem is resolved by adoption of JVET-Q0517

[JVET-Q0788](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9634) AHG9: A joint solution of constraints on RPR [K. Zhang, L. Zhang, Y.-K. Wang, H. Liu, J. Xu, Z. Deng (Bytedance), T.-D. Chuang, O. Chubach, C.-Y. Chen, C.-W. Hsu, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek), Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

## Quantization control (15)

Contributions in this category were discussed Saturday 11 Jan. 1925–2200 and Monday 13 Jan. 1820-1950 in Track B (chaired by JRO).

See also Q0484.

[JVET-Q0126](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8951) Initializations and propagation of Chroma QP Offset [K. Kawamura, S. Naito (KDDI)]

Chroma QP offset-scheme was introduced in the 15th JVET meeting, which was also used for the decision of chroma deblocking filter from the previous meeting. This offset is signalled in the TU level in the working draft 6.0, which means that the offset is not signalled in the non-coded block where CBF is false. In this cases, an actual chroma QP values for the deblocking filter decision is ambiguous. In this contribution, initialization processes of offset values for some block levels are introduced. The most frequently case of the initialization is the unit of chroma quantization group while the least one case is the unit of slice header. At the same time, the offset values for the non-coded unit are propagated from that of the previous coding unit.

Other related contributions: JVET-Q0267, JVET-Q0476, JVET-Q0570-

See further notes under JVET-Q0267.

[JVET-Q0148](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8973) AHG15: Additional coefficients for low frequency region of 64x64 scaling matrix [K. Abe, T. Toma (Panasonic)]

This contribution proposes to add three scaling matrix coefficients for three 4x4 regions in the lowest frequency area of 64x64 matrix. In 64x64 matrix, all scaling matrix coefficients in a 8x8 region have same value, but the majority of non-zero coefficients tend to appear in the lowest frequency 8x8 region. Therefore, the proposed modification allows controlling of 64x64 scaling matrix as same level of granularity as 32x32 scaling matrix. Two methods are proposed; Method1) Apply proposed method to 64x64 luma scaling matrices only. Method2) Enable individual matrices for 64x64 chroma, and apply proposed method to 64x64 luma and chroma scaling matrices. Simulation results reportedly show that the proposed method can achieve higher granularity of controlling quantization without any coding performance cost.

In case 64x64, each scaling coefficient applies to a group of 8x8 coefficients. It is proposed toi subdivide te lowest frequency group into 4 groups.

The opinion is expressed that the approach introduces some inconsistency into the current concept, as the sampling and mapping of the 64x64 matrix is no longer homogeneous. In an implementation this would mean that additional mechanism are necessary during the scaling to identify where the current position is (first 8x8 group or higher groups).

It is not fully clear if the finer frequency resolution is really necessary.

No action.

[JVET-Q0536](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9382) Crosscheck of JVET-Q0148 (AHG15: Additional coefficients for low frequency region of 64x64 scaling matrix) [T. Hashimoto, T. Ikai (Sharp)] [late]

[JVET-Q0209](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9034) [AHG9][AHG15]: On chroma Qp offsets [Hendry, J. Zhao, S. Kim (LGE)]

This contribution asserted that the current signalling mechanism for chroma Qp offsets and chroma Qp offset list may be improved in the following aspects:

* Consistency in the signalling related to chroma Qp offsets in transform unit and palette coding syntax table. Currently in transform unit syntax table, syntax element cu\_chroma\_qp\_offset\_idx is present only if there is more than one chroma Qp offset is present in the chroma Qp offset list signalled in PPS. This condition should be applicable as well for chroma Qp offset index signalling in palette coding syntax table.
* In the PPS, the syntax element pps\_cb\_qp\_offset, pps\_cr\_qp\_offset, and pps\_joint\_cbcr\_qp\_offset are signalled separately from the list of cb\_qp\_offset\_list[ ], cr\_qp\_offset\_list[ ], and joint\_cbcr\_qp\_offset\_list[ ]. However, when used for deriving the values of Qp′Cb and Qp′Cr, and Qp′CbCr, the values pps\_cb\_qp\_offset is always together with CuQpOffsetCb as shown in equation (8-929). Likewise for pps\_cr\_qp\_offset and pps\_joint\_cbcr\_qp\_offset. Such design is not optimal and they should be considered signalled together.

This contribution proposes the following:

1. Synchronize the signalling related to chroma Qp offset in palette coding syntax table with the same signalling in transform unit syntax table.
2. Simplify the chroma Qp offset signalling in PPS by combining the signalling of pps\_cb\_qp\_offset, pps\_cr\_qp\_offset, and pps\_joint\_cbcr\_qp\_offset with the list of cb\_qp\_offset\_list[ ], cr\_qp\_offset\_list[ ], and joint\_cbcr\_qp\_offset\_list[ ].

About a), it is pointed out by another expert that the software implements chroma QP offset in palette exactly the same way as for transform coding.

About b), it is proposed to include the global offset values as the first entry in the list, extend the list by one entry and add the global offset value to every other list entry. From the viewpoint of low level decoding description, it is considered better keeping the current design, as the usage of global offset value is common and the usage of list is special (i.e. the list will not be used by most encoders). Keeping them separate makes the semantics more clear.

Decision (BF/text) Adopt JVET-Q0209 aspect a), align chroma qp offset signalling for palette.

[JVET-Q0227](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9052) Dependent Quantization with Qp offset adaptation [P. de Lagrange, F. Hiron, F. Le Léannec, E. François (InterDigital)]

This contribution relates to Dependent Quantization (DepQ). When DepQ applies, an qP offset of +1 is added to the qP value when applying the scaling process for transform coefficients. No offset is used when DepQ is off. In this contribution, it is proposed to adapt the offset value depending on the qP value. The reported psnr-Y, U, V BD-rate variations compared to VTM7.0 are -0.07%, 0.29%, 0.28% for the AI configuration, -0.07%, -0.23%, -0.34%for the RA configuration, -0.18%, 0.08%, -0.17% for the LDB configuration.

The offset is set to +2 for QP>30, +1 for 30>=QP>23, +0 otherwise.

It is pointed out that some of the effect could be due to the change in lambda, and that basically also an encoder could just use QP control to achieve this effect. The best choice could also be sequence dependent.

The gain is relatively small.

More investigation beyond CTC might be necessary to better study the effect.

No action.

[JVET-Q0723](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9569) Crosscheck of JVET-Q0227: Dependent Quantization with Qp offset adaptation [H. Schwarz (Fraunhofer HHI)] [late]

[JVET-Q0267](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9092) On Propagation of Chroma CU QP Offsets [B. Heng, M. Zhou, W. Wan (Broadcom)]

After the adoption of JVET-P1001, the chroma QP now affects the deblocking filter process. Therefore, chroma QP values must be determined, even for non-coded TUs. In particular, this includes the CU-level chroma QP offsets introduced in JVET-O1168.

In non-coded TUs, CU-level chroma QP offsets can currently propagate across tiles boundaries and across entropy-coding sync points, because no process has been put in place to reset the CU‑level chroma offsets until the start of the next slice. It is asserted that this cross tile / entropy-sync dependency was never intended, and that this problem needs to be addressed.

This contribution proposes to solve the problem by limiting chroma QP offset propagation to within the current chroma quantization group. Specifically, it proposes resetting CuQpOffsets to 0 at the start of each new group.

This is a straightforward and simple solution to this problem. It is consistent with the handling of luma QP adaptation.

Decision(BF/text+SW): Adopt JVET-Q0267

It is noted that JVET-Q0476 is identical.

It is also noted that some other parts of local chroma QP offset in the encoder software implementation still have problems (tickets exist).

[JVET-Q0421](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9246) AHG15: Clean up for signaling quantization matrix [L. Li, H. Zhang, X. Li, S. Liu (Tencent)]

This contribution proposes a cleanup for signaling quantization matrix. When scaling list ID is equal to 0 , 2 and 8, which are the start IDs of 2x2, 4x4 and 8x8 QM, respectively, scaling list copy mode flag is not signaled.

Nothing is broken in the signalling of the quantization matrix. The benefit claimed is that the copy mode would not frequently be used for those case; however, saving bit rate for this high-level information is not really important, and it is also not an obvious simplification.

No urgent need for action. Stability of the specification has higher importance.

[JVET-Q0472](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9298) AHG15: Quantization matrix signalling [P. de Lagrange, F. Le Léannec, E. François, K. Naser (InterDigital)]

This contribution proposes two changes to quantization matrix signalling.

In a first aspect, it removes the scaling\_list\_pred\_mode\_flag syntax element, which is said to be mostly redundant.

In a second aspect, scaling\_list\_copy\_mode\_flag is replaced by a number (scaling\_list\_num\_coef), which specifies the number of delta-coefficient transmitted, possibly less than matrix size, the missing ones being inferred to zero. This is said to enable efficient QM adjustments at low bit cost.

The second aspect had already been proposed by the last meeting and not been adopted. There is no new evidence that change of quant matrices per picture would be useful, which would make such large compression necessary.

Nothing is broken in the signalling of the quantization matrix. No urgent need for action. Stability of the specification has higher importance.

[JVET-Q0474](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9300) AHG15: defining QP at TU level [P. de Lagrange, F. Le Léannec, F. Urban, K. Naser (InterDigital)]

This contribution proposes to define QP at the same level QP-delta is signaled, i.e. TU level instead of CU level. This changes the way QP is assigned to leading TUs that do not carry coded coefficients within a CU that carries a QP-delta, removing QP-delta back-propagation and aligning the process with leading CUs without coded coefficients within a QG. This is said to be a cleanup, which is mostly a semantic change, and removes the need for fixes adopted from JVET-O0046 and JVET-P0436 by solving the root cause.

The method would change the current approach, where always the same QP is used over the whole CU, by associating the QP with TU

It would keep the following concepts unchanged

* QG can not be smaller than a CU
* QP can only change once in a QG

As a consequence, Luma TBs within ISP could have different QPs

Question is raised if QPs are still stored with 4x4 for deblocking? Proponent says yes.

Not clear what the advantage is? Proponent claims that the current design requires back propagation of QP for the deblocking of TBs that belong to the same CU but have no transform coefficients. This problem was however solved in last meeting by sending delta QP up front.

Not obvious that there is a problem to be solved, and the proposal would require a substantial amount of semantics changes which would change the normative behaviour.

No interest for adoption.

[JVET-Q0476](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9303) On chroma QP offsets for zero-CBF leading chroma coding blocks [A. K. Ramasubramonian, B. Ray, G. Van der Auwera, M. Karczewicz (Qualcomm)]

Identical to JVET-Q0267

[JVET-Q0505](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9334) AHG15: Improvement for Quantization Matrix Signaling [H. Zhang, X. Li, G. Li, L. Li, S. Liu (Tencent)]

In this contribution, two improved signaling methods of user defined quantization matrices (QMs) are proposed. In VVC Draft 7, up to 28 QMs are signaled in APS even when some of them will not be used in the quantization process. This contribution suggests simple changes on top of the current design to only signal the QMs to be used. The proposed method was implemented on top of VTM7.0 with minor changes on current spec. Additionally, the experiment results reportedly show that bit-rate reduction was observed under various conditions of transform size range on a provided test set.

The basic idea of solution 2 is that quant matrices are only sent for transform sizes that are used. To avoid dependency of APS form SPS, the SPS max transform size parameters are duplicated.

It is however pointed out that unused quant matrices could just be set to default value which would only cost two bits.

Compared to the data rate increase that is caused by disabling large transforms, saving of a few bits in the signalling of APS for quant matrices is negligible.

This would also make the specification text more complicated without real need.

No need for action seems necessary on this aspect.

The requested functionality can easily be achieved with the current design

Solution 1 has two aspects:

* Not signalling chroma quant matrices for monochrome
* Not sending quant matrices for TB sizes that are not used, by using the using information about min and max TB sizes.

To achieve this, parameters from SPS are sent again in APS (to avoid the dependency, a design principle of HLS).

Basically, both aspects could be achieved again at very low cost by the same approach (signalling default matrices for those that are not used).

For cases of TB size restriction, this is an operation mode which might not commonly be used.

For case of monochrome, it might appear reasonable not being forced to signal chroma quantization matrices that are never used. On the other hand, it makes the text spec more complicated (one condition check, 1 more syntax element + associated semantics). However, the text change should be minimum.

Revisit: Proponents shall provide text with a reduced “solution 1” only for monochrome

[JVET-Q0671](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9517) Crosscheck of JVET-Q0505 (AHG15: Improvement for Quantization Matrix Signaling) [Z. Deng (ByteDance)] [late]

[JVET-Q0570](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9416) AHG15: reset chroma QP offsets when starting a CTU [P. de Lagrange (InterDigital)] [late]

This contribution, as JVET-Q0126, JVET-Q0267 and JVET-Q0476, exposes the problem #659 reported in JVET bug tracker, namely the propagation of the chroma QP offsets CuQpOffsetCr, CuQpOffsetCr and CuQpOffsetCbCr across the boundaries of regions that should be decodable independently or in parallel.

To solve the problem, this contribution proposes to reset the CuQpOffsetCx variables every CTU (or every CTU row); it states that the reset process potentially creates adverse effects (creating zero-offset “holes” in the chroma QP-offset map), and that resetting the chroma QP-offset more often than necessary is not desirable.

The proposed draft text change consists in moving a 3-lines sentence from sequence header semantics to CTU semantics.

Unlike the proposal JVET-Q0267/476, the reset is performed at the beginning of each CTU (or alternatively, CTU row), which is less frequent.

[JVET-Q0576](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9422) AHG15: History of local chroma QP offsets [P. de Lagrange (InterDigital)] [late]

TBP track B – related to JVET-Q0484 which is in HLS

## Transforms and transform signalling (28)

Contributions in this category were discussed Thursday 9 Jan. 1900–2200 and Friday 10 Jan. 1215–1315, 1430-1630 in Track B (chaired by JRO).

### MTS

[JVET-Q0055](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8880) On MTS index signalling [J. Lainema (Nokia)]

Draft VVC standard allows MTS transform coefficients only inside the lowest frequency 16x16 area of a transform block. However, signalling of the mts\_idx is conditioned to the last coefficient position which does not guarantee existence of coefficients only inside the valid area. Thus, in some cases mts\_idx is signalled even though it could be inferred to be zero. There is also a possibility for a non-conforming encoder to signal MTS transform coefficients in positions outside the 16x16 area and still indicate one of the MTS modes to be active.

It is proposed to add normative checks to the transform coefficient parsing and indicate mts\_idx only if all non-zero transform coefficients are within the valid MTS coefficient area. Bitrate and complexity impact of the proposed change is asserted to be negligible. In the case of AI, RA and LD-B the average BD-rate changes are reported to be 0.00%, 0.00 % and 0.00 %, respectively.

Related/similar/identical proposals: JVET-Q0057 (identical), JVET-Q0136, JVET-Q0196 (one aspect), JVET-Q0430, JVET-Q0448 (with 2 solutions, one identical)

It is agreed that all those proposals are solving the problem in avoiding the bitstream restriction which is not straightforward.

It is further agreed that the solution proposed in JVET-Q0055 is the most straightforward with minimum changes of the spec.

Decision (cleanup): Adopt JVET-Q0055

[JVET-Q0566](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9412) Crosscheck of JVET-Q0055 (On MTS index signalling) [S. De-Luxán-Hernández (HHI)] [late]

[JVET-Q0057](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8882) Coefficient group based restriction on MTS signaling [M. Coban, M. Karczewicz, H.E. Egilmez, V. Seregin (Qualcomm)]

This document proposes a coefficient group (CG) based restriction for signaling MTS. The proposed method replaces the bitstream restriction existing in current VVC draft with a syntax-based restriction. The proposed change can be viewed as a clean-up for the coefficient-level restriction in MTS signaling. The experimental results show that the proposed change has no impact in terms of average BD-rates.

See notes under JVET-Q0055

[JVET-Q0549](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9395) Crosscheck of JVET-Q0057 (Coefficient group based restriction on MTS signaling) [J. Lainema (Nokia)] [late]

[JVET-Q0136](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8961) Alignment of MTS index signalling condition with MTS zero-out [M. Koo, M. Salehifar, J. Lim, S. Kim (LGE)]

In the recent VVC working draft, MTS index is signalled only if last non-zero coefficient is not located outside of top-left 16x16 region in a Luma TB, which is motivated by MTS zero-out. However, this scheme cannot detect the case that last non-zero coefficient lies within the top-left 16x16 region outside of which at least one non-zero coefficient exists, as the case that MTS index does not need to be signalled. In this case, the associated MTS index could have been inferred to be zero, i.e. DCT-2 pair, which was reported via JVET bug tracker ticket #678. In the VVC WD, a constraint that MTS index must be signalled to be zero when that case occurs is described for bitstream conformance.

In this contribution, it is proposed that a variable, MtsZeroOutSigCoeffFlag should be determined by checking whether coded\_sub\_block\_flag or sig\_coeff\_flag outside of the top-left 16x16 region is zero or not, in order to indicate the existence of non-zero coefficients outside of the top-left 16x16 region. The Y/U/V BD-rate changes are 0.00%/0.00%/-0.01% (AI), 0.00%/-0.01%/0.02% (RA), and 0.00%/-0.10%/-0.03% (LD) under CTC. In overall, performance and complexity of the proposed method are almost the same as those of VTM 7.0 and design of MTS index signalling becomes more consistent with the existing MTS zeroing-out. Furthermore, the bitstream conformance constraint can be removed, which may reduce conformance testing burden.

See notes under JVET-Q0055

[JVET-Q0679](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9525) Cross-check of JVET-Q0136 (Alignment of MTS index signalling condition with MTS zero-out) [X. Zhao (Tencent)] [late]

[JVET-Q0196](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9021) MTS redundancy removal [M.-S. Chiang, C.-W. Hsu, C.-M. Tsai, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

In VVC Draft 7, when the last significant coefficient position of a luma transform block (TB) is in the multiple transform selection (MTS) zero-out region (i.e., the TB excluding the top left 16x16 region), this reveals that MTS is not selected at encoder, and therefore the MTS index is not signalled and inferred to 0 (i.e., indicating DCT-II) at decoder. However, redundant MTS index signalling is not avoided thoroughly by using this method. The MTS index is still signalled but always equal to 0 when there is any non-last significant coefficient in the MTS zero-out region. This contribution proposes a method of checking coefficient group (CG) significant flags to replace the current method of checking the last significant coefficient position. If any CG significant flag in the MTS zero-out region is true, the MTS index is not signalled and inferred to 0. With the proposed modification, the redundant MTS index signalling is totally avoided. Compared to VTM7.0 common test condition (CTC), the proposed method results in negligible BD-rate changes.

See notes under JVET-Q0055

[JVET-Q0550](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9396) Crosscheck of JVET-Q0196 (MTS redundancy removal) [J. Lainema (Nokia)] [late]

[JVET-Q0295](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9120) On residual coding for MTS [C. Rosewarne, J. Gan (Canon)]

In the VVC WD7 text mts\_idx is signalled in the CU footer, conditioned on the luma last position being within the upper-left 16×16 region of the TB. As this condition check could still allow significant coefficients outside the 16×16 region, either a conformance constraint was suggested to ensure such coefficients need to be zero when MTS is applied or additional decoder-side checks for further conditioning of mts\_idx. This contribution proposes a scan pattern such that the last position check is sufficient to ensure no significant coefficients are present outside of the 16×16 region.

No need to review, as the problem is solved via JVET-Q0055.

[JVET-Q0759](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9605) Crosscheck of JVET-Q0295 (On residual coding for MTS) [M. Koo (LGE)]

[JVET-Q0381](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9206) Block size restriction in MTS kernel for ISP and LFNST [S. Shrestha, A. Kumar, B. Lee (Chosun Univ.), Y. Lee, J. Park (Humax)]

In the 16-th JVET meeting, it has been decided that DCT-2 MTS kernel is used for the ISP block when both ISP and LFNST is ON [1] and DCT-2 or DST-7 are decided based on the block sizes when ISP is ON and LFNST is OFF. That is, DCT-2 is used for the sizes greater than 16 and less than 4, otherwise DST-7 is used in VTM7.0 [2]. In this contribution, it is proposed to use DCT-2 for blocks greater than 8 and less than 4 and DST-7 for other blocks when ISP is ON and LFNST is OFF.

There is no obvious benefit, neither on compression, nor on simplifying the design.

No action.

[JVET-Q0632](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9478) Crosscheck of JVET-Q0381 (Block size restriction in MTS kernel for ISP and LFNST) [J. Jung, D. Kim, G. Ko, J.-H. Son, J. Kwak (WILUS)] [late]

[JVET-Q0430](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9255) AHG16: Syntax based MTS zero out [F. Le Léannec)]

In VVC spec draft 7, the MTS index of a CU is signaled in case the last significant coefficient in scanning order has x- and y- coordinates lower than 16. However, it is possible to fulfill this condition and to have some non-zero transform coefficient(s) outside the top-left 16x16 TU region at the same time.

A bitstream conformance constraint imposes the MTS index to be zero in case at least one non-zero coefficient is outside the top-left 16x16 region. An AHG16 comment states a syntax-level restriction is more desirable than this conformance requirement.

This contribution proposes a syntax-level control of the existence of non-zero coefficients beyond the 16x16 top-left region, in case of non-TS residual coding. To do so, a CU-level mts\_zero\_out\_flag syntax element is introduced.

The mts\_zero\_out\_flag syntax element is then taken into account in the residual coding and in the coding of the MTS index. The BD-rate change over VTM-7.0 is reportedly equal to 0.04% and 0.03%, respectively in AI and RA configurations.

See notes under JVET-Q0055

[JVET-Q0745](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9591) Crosscheck of JVET-Q0430 (AHG16: Syntax based MTS zero out) [S. De-Luxán-Hernández (HHI)] [late]

[JVET-Q0442](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9268) Non-CE: Transform Selection for MIP in Implicit MTS [K. Naser, F. Le Léannec, T. Poirier, F. Galpin (InterDigital)]

Implicit MTS is a special configuration of transform selection where mts\_idx is not signaled and the transform pairs are implicitly selected. Unlike regular intra prediction mode, the implicit transform selection for MIP is the default DCT2 for both horizontal and vertical direction.

This contribution proposes an alternative method of selecting the transform pairs depending on block dimensions with the same condition as for regular intra prediction mode. This method achieves a luma coding gain of 0.03% and 0.02% in AI and RA configurations.

There is no obvious benefit, neither on compression, nor on simplifying the design.

No action.

[JVET-Q0739](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9585) Crosscheck of JVET-Q0442 (Non-CE: Transform Selection for MIP in Implicit MTS) [J. Pfaff (HHI)] [late]

[JVET-Q0448](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9274) MTS dependent coefficient subblock scanning for zero-out [S. De-Luxán-Hernández, T. Nguyen, B. Bross, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

This contribution proposes two fixes to replace the bitstream restriction that requires the MTS index to be equal to 0 (DCT-II in both directions) in case there are non-zero coefficients outside the 16x16 zero-out area, by a syntax change. The first fix A checks for every coefficient subblock whether there are non-zero coefficients outside the 16x16 area and does not signal the MTS index if there are any and infers it to zero instead. The second fix B avoids checking each subblock by moving the MTS index signaling before the coefficient parsing in subblocks and adapting the subblock scan to cover only the 16x16 area in case the MTS index is greater than 0. Fix A results in 0.0% BD-rate Y for AI and RA, fix B results in -0.01% BD-rate Y for AI and 0.02% for RA with no measurable change in runtimes.

See notes under JVET-Q0055

[JVET-Q0730](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9576) Cross-check of JVET-Q0448 "MTS dependent coefficient subblock scanning for zero-out" [F. Le Léannec (InterDigital)] [late]

[JVET-Q0516](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9345) MTS signaling based on last significant coefficient position [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai)]

In VVC draft 7, multiple transform selection (MTS) can be enabled when there is non-zero transform coefficient in luma transform block (TB). This is done by checking whether the luma coded-block-flag (CBF) is equal to one. In this contribution, it is proposed to replace such CBF based condition with one based on the position of last significant coefficient. More specifically, the signaling of the MTS index (i.e., mts\_idx) is conditioned on whether the position of last significant coefficient is less than one. Since the same condition is also used to determine the signaling of LFNST index lfnst\_idx, the proposed change incurs no extra complexity. Compared to VTM-7.0 anchors, the proposed change reportedly leads to BD-rate differences of -0.10% and -0.03% for AI and RA configurations, respectively, with no impacts on encoding and decoding runtimes.

Presentation deck not uploaded.

JVET-Q0685 is identical, however on top of JVET-Q0055 modification.

The benefit of harmonization is not too obvious, as it is just a part of conditions that invoke LFNST and/or MTS.

In terms of compression, the gain over CTC is relatively small and would not justify that action.

The powerpoint deck has additional non-CTC results where MTS is switched on for inter, the gain of the modification seems to be more relevant in that case. Currently, MTS is disabled for inter, as the runtime increase is not justified by the compression gain. However, those results are not complete.

Revisit: Report when results on inter MTS are complete. Different from the powerpoint deck, results for enabling inter MTS with and without that modification should be reported compared to CTC.

[JVET-Q0557](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9403) Crosscheck of JVET-Q0516: MTS signaling based on last significant coefficient position [H. Gao (Huawei)] [late]

[JVET-Q0779](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9625) Crosscheck of JVET-Q0516 "MTS signaling based on last significant coefficient position" [?? (Tencent)] [late]

[JVET-Q0529](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9359) On LFNST index and MTS index signalling [Z.-Y. Lin, M.-S. Chiang, T.-D. Chuang, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)] [late]

In VVC Draft 7, when the last significant coefficient position of a luma transform block (TB) is in the multiple transform selection (MTS) zero-out region (i.e., the TB excluding the top left 16x16 region), this reveals that MTS is not selected at encoder, so the MTS index is not parsed and inferred to 0 (i.e., indicating DCT-II) at decoder. However, redundant MTS index signalling is not avoided thoroughly by using the current design. The MTS index is still signalled but always equal to 0 when there is any non-last significant coefficient in the MTS zero-out region. This contribution proposes to parse low frequency non-separable transform (LFNST) index and MTS index right after parsing the first nonzero TB’s last significant coefficient position. If the MTS index is not equal to 0, coefficients in the MTS zero-out region will not be parsed and inferred to 0. In this way, there is no redundancy of MTS index signalling or coefficient signalling in MTS blocks. Since LFNST index is parsed in the first nonzero TB, the LFNST index parsing checks related to the last significant coefficient position are only considered for the first nonzero TB. Since both LFNST index and MTS index can be obtained right after parsing the first nonzero TB’s last significant coefficient position, the inverse transform process can be performed much earlier before parsing the entire coding unit (CU) as needed in the current VVC design. It is asserted that the proposed method can reduce the latency between inverse transform process and parsing stage and is beneficial to hardware implementation. In common test condition (CTC), the results shows 0.01%, 0.01% and 0.03% luma BD-rates under AI, RA, and LB, respectively.

The main target is reducing buffer size and latency that is existing in the current design, where the transform coefficients for luma and chroma need to be stored before MTS can be invoked. It is however somewhat dependent on specific implementation how large the benefit is, and the proposed change is relatively large. There is also some relation of the buffering problem with the problem of LFNST/TS in the next section.

Further, this contribution would make the decision on JVET-Q0055 unnecessary.

No action, problem is resolved by adoption of JVET-0106.

[JVET-Q0735](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9581) Crosscheck of JVET-Q0529 (On LFNST index and MTS index signalling) [C. Auyeung (Tencent)] [late]

[JVET-Q0685](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9531) On MTS Signaling [H.E. Egilmez, A. Nalci, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)] [late]

This document proposes to extend the DC coefficient based restriction in LFNST for MTS signaling by combining with JVET-Q0057. The proposed additional change in this document can be viewed as a unification of the coefficient-level restriction in MTS and LFNST signaling. The experimental results show that the proposed changes achieve 0.10% AI, x.xx% RA and x.xx% LDB BD-rates under CTC.

Technically same as JVET-Q0516 built on top of JVET-Q0055. Proponents claim that their spec modification is cleaner than the version of 516.

[JVET-Q0747](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9593) Crosscheck of JVET-Q0685 (On MTS Signaling) [S. De-Luxán-Hernández (HHI)] [late]

### LFNST and TS

[JVET-Q0090](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8915) On constraint on DC only flag in LFNST [Y. Fujimoto, T. Tsukuba, M. Ikeda, T. Suzuki (Sony)]

In VVC, LFNST (Low frequency non-separable transform) is not allowed to use when non-zero coefficients after quantization is DcOnly with LfnstDcOnly=1. However, in most of encoder architecture, quantization is optimized for subjective quality, after determining encoding modes including LFNST. In the current spec, LfnstDcOnly may become 1, after determining QP, while QP is derived with LfnstDcOnly = 0. In order to fix this problem, encoder needs to store status prior to LFNST. When LfnstDcOnly = 1, encoder change LFNST to OFF and need to re-quantize. This affects on the encoder optimization (coding efficiency).

This contribution proposes to include a switch (flag) to disable the constraint on LFNST when LfnstDcOnly is equal to 1. When the flag is on, the loss is about 0.14%.

The problem exists, as an encoder has decided for LFNST, quantization is applied afterwards and then it turns out that only the DC coefficient is left, for which case LFNST shall not be invoked at the decoder. It is pointed out that instead of disabling the dependency, it might be simple for an encoder just storing the DC coefficient before LFNST, and if it is found that after LFNST only the DC position would remain, replacing it by the quantized DC coefficient. Another option would be artificially taking the next highest coefficient and quantizing into non-zero. The flag may not be needed, as the loss by the mentioned simple encoder methods may even be lower.

No action.

[JVET-Q0703](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9549) Crosscheck of JVET-Q0090 (On constraint on DC only flag in LFNST) [S. Iwamura, Y. Kondo, K. Iguchi (NHK)] [late]

[JVET-Q0099](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8924) On Interaction of LFNST and Transform Skip [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

In WD/SW, lfnst\_idx signaling is dependent on usage of transform skip for luma. In case of SingleTree, LFNST for chroma is normatively restricted since lfnst\_idx signaling is skipped when transform skip for luma is used. In addition, in case of DualTreeChroma, lfnst\_idx can be signaled regardless of usage of transform skip for chroma, which is redundant signaling.

This contribution proposes two variants: proposal#1) omit lfnst\_idx signaling when transform skip is used at least for one component, and proposal#2) omit lfnst\_idx signaling when transform skip is used for all valid components.

It is reported that proposal#1 gives average BD-rate changes of (0.00 %, -0.01 %, 0.02 %) for AI, and (0.01 %, 0.06%, 0.06%) for RA.

It is reported that proposal#2 gives average BD-rate changes of (0.00%, 0.01%, 0.01%) for AI, and (0.00%, 0.00%, 0.00%) for RA.

Method 1 disables LFNST as soon as one of the three components uses TS.

Method 2 disables LFNST if all components use TS

It is noted that in principle there is no harm with the current design (decoder behaves well defined, no crash), but there may be some impact on buffer requirement (as per JVET-Q0106).

JVET-Q0106 and JVET-0193 also propose method 1. Method 2 would not resolve the buffer issue.

JVET-Q0103, JVET-Q0138, JVET-Q0328, and JVET-Q0499 also propose method 2.

[JVET-Q0701](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9547) Crosscheck of JVET-Q0099 (On Interaction of LFNST and Transform Skip) [S. Iwamura, Y. Kondo, K. Iguchi (NHK)] [late]

[JVET-Q0100](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8925) On Maximum Block Size for Chroma Transform Skip [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

In VVC WD, there is an inconsistency between maximum transform block size for chroma and transform skipped block size for chroma; Maximum transform skipped block size for chroma is always set to (1 << ( log2\_transform\_skip\_max\_size\_minus2 + 2 ) regardless of chroma format while maximum transform block size for chroma is set depending on chroma format. This contribution proposes to derive maximum block size for chroma transform skip based on log2\_transform\_skip\_max\_size\_minus2, SubWidthC, and SubHeightC.

At normal QP condition, it is reported that proposal gives average BD-rate differences of (0.00 %, -0.01 %, -0.01 %) for AI, (0.00 %, 0.02 %, 0.06 %) for RA and (0.02 %, 0.15 %, -0.06 %) for LB, respectively.

At low QP condition (QP=2, 7, 12, 17), it is reported that proposal gives average BD-rate differences of (0.00%, 0.00 %, 0.01%) for AI, (0.00%, 0.00 %, 0.00%) for RA and (0.00 %, 0.02 %, 0.00 %) for LB, respectively. Especially, for SCC sequence, it is reported that proposal provides some BD-rate saving: (-0.14%, -0.13%, -0.11%) for AI, (-0.06%, 0.24%, 0.24%) for RA and (-0.39%, -0.25%, -0.26%) for LB.

It is pointed out that the proposal, though appearing logical in terms of coupling luma and chroma sampling also in transform skip, would somehow restrict flexibility of encoder choices. It is a design intent that luma and chroma can select TS independently of each other. For example, luma could use 64x64 regular transform, and chroma 32x32 TS (which would no longer be possible if the proposal was adopted). It is also not fully clear how it would affect the dual-tree case.

No action.

[JVET-Q0663](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9509) Crosscheck of JVET-Q0100 (On Maximum Block Size for Chroma Transform Skip) [A. Nalci (Qualcomm)] [late]

[JVET-Q0101](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8926) On Transform Skip in JointCbCr mode [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

In VVC WD, transform skip for chroma can be used regardless of JointCbCr mode or not. However, in VTM, transform skip for chroma is restricted in JointCbCr mode; In JointCbCr mode, transform type equal to DCT2 is only evaluated while transform type equal to DCT2 or TS is evaluated in non-JointCbCr mode.

To solve the above miss-alignment of transform skip for chroma between in JointCbCr mode, this contribution proposes two variants: proposal#1) align SW with WD by reusing transform type in non-JointCbCr mode for JointCbCr mode (encoder-only change), and proposal#2) align WD with SW by omitting transform\_skip\_flag for chroma in JointCbCr mode (normative change).

It is reported that proposal#1 achieves average BD-rate savings of (0.00%, -0.06%, -0.04%) for AI, (0.00%, -0.06%, -0.01 %) for RA, and (-0.02 %, -0.23%, -0.32 %) for LB at normal QP; Especially, for SCC sequence, BD-rate savings of (-0.06%, -0.37%, -0.41%) for AI, (-0.06%, -0.40%, -0.34%) for RA, and (-0.04%, -0.34%, -0.36%) for LB.

It is reported that proposal#2 achieves average BD-rate savings of (0.00%, 0.01%, 0.00%) for AI, (0.00%, -0.04%, 0.03%) for RA, and (0.00%, -0.17%, -0.17%) for LB at normal QP; Especially, for SCC sequence, BD-rate savings of (-0.03%, -0.03%, -0.04%) for AI, (-0.05%, -0.08%, -0.04%) for RA, and (-0.13%, -0.23%, -0.21%) for LB.

Proposal #1 is the preferred solution, as apparently there is no bug in the spec, and the combination does not have significant impact on encoder / decoder runtime.

The proposal of enabling the combination of TS and JCbCR (which is allowed in the spec) also in the Software and CTC is identical with JVET-Q0408 an JVET-Q0514, which became a joint proposal JVET-Q0695.

Results indicate that there is minor impact on CTC, but also no harm on runtime. JVET-Q0695 gives additional results under CE2 conditions, which indicates that for screen content and 4:4:4 content there is a minor benefit, without impacting encoder runtime. See further notes there.

[JVET-Q0664](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9510) Crosscheck of JVET-Q0101 (On Transform Skip in JointCbCr mode) [A. Nalci (Qualcomm)] [late]

[JVET-Q0103](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8928) LFNST Signaling for Chroma based on Chroma Transform Skip Flags [H. E. Egilmez, A. Nalci, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)]

In VTM-7.0, the LFNST signaling for chroma blocks depends on the luma transform skip flag. This contribution document proposes to restrict chroma LFNST signaling based on the chroma transform skip flags as a cleaner design. The experimental results show that the proposed change has negligable impact in terms of average BD-rates.notes under JVET-Q0099 and JVET-Q0106

[JVET-Q0652](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9498) Cross-check of JVET-Q0103 (LFNST Signaling for Chroma based on Chroma Transform Skip Flags) [T.-C. Ma (Kwai Inc.)] [late]

[JVET-Q0104](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8929) On worst-case complexity of LFNST [H. E. Egilmez, A. Nalci, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)]

This document proposes two alternative designs for LFNST without increasing the worst-case complexity in terms of multiplications per coefficient. The first design aims to simplify the existing 8x8 LFNST design by replacing the L-shaped, 48-sample support pattern with the 8x8-square. It is experimentally shown that the proposed method lead to -0.09% AI and -0.06% RA BD-rates over VTM-7.0. The second design keeps the L-shaped, 48-sample support pattern, but reduces the number of normatively zeroed-out coefficients. The experimental results of the second design show that -0.02% AI and -0.02% RA BD-rates are achieved over VTM-7.0.

No obvious benefit – no action.

[JVET-Q0539](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9385) Crosscheck of JVET-Q0104 (On worst-case complexity of LFNST) [T. Zhou, T. Ikai (Sharp)] [late]

[JVET-Q0106](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8931) Combination of LFNST with transform skip [B. Heng, T. Hellman, M. Zhou, W. Wan (Broadcom)]

The signalling of LFNST index currently includes a condition preventing the use of LFNST when luma transform skip is enabled, but no corresponding condition was added for chroma transform skip. It is asserted that this is a design inconsistency. It may have been an unintentional oversight when chroma transform skip was added in JVET-P0058.

Given that LFNST is signalled at the very end of the CU, it is asserted that allowing mixed LFNST / transform‑skip CUs introduces a significant increase in buffering requirements. Therefore, this contribution recommends adding the corresponding conditions to prevent the use of LFNST with either luma or chroma transform skip. Experimental results reveal that the suggested changes do not impact coding efficiency.

It is agreed that method 1 could help reducing buffer in certain common pipeline architectures.

Method 1 appears beneficial for decoder implementations, and it is minimum change.

Decision: Adopt JVET-Q0106. Editor to decide if JVET-Q0193 or JVET-Q0106 text is more appropriate.

[JVET-Q0530](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9360) Crosscheck of JVET-Q0106: AHG16: Combination of LFNST with transform skip [W. Zhu (Bytedance)] [late]

[JVET-Q0133](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8958) Fix on LFNST condition [T. Hashimoto, T. Chujoh, E. Sasaki, T. Ikai (Sharp)]

This contribution proposes a fix related to LFNST condition. In the current specification, LFNST index and transform unit size are checked to decide if LFNST is applied or not to guarantee small TUs (i.e. chroma 2xN, Nx2 TUs) is not applied. However, in scaling list and implicit MTS process, transform unit size condition is missing (not checked). This contribution proposes a fix on WD and software. Specifically, the proposed WD uses the following variable lfnstEnabledFlag in whole WD to avoid mistakes and confusions

The variable lfnstEnabledFlag is set equal to lfnst\_idx && nTbW >= 4 && nTbH >= 4 ? 1 : 0

The problem points out as a bug that the case may happen that LFNST is not applied to a chroma, and scaling matrix is disabled for LFNST, and due to that the chroma block is not using the scaling matrix even though it is not using LFNSTThis is in both text and software.

It is not a bug in the sense that there is no undefined decoder behaviour. It might also not have much impact on quality. However several experts suggested that it would be more consistent to enable the scaling matrix for such cases of chroma blocks, and it was the original intent.

Decision (BF/text&SW): Adopt JVET-Q0133. The editiorial aspect (lfnst flag usage in 8.7.4.1) left to the editor.

[JVET-Q0611](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9457) Crosscheck of JVET-Q0133 (Fix on LFNST condition) [K. Abe (Panasonic)] [late]

[JVET-Q0138](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8963) Separate transform skip checking of Luma and Chroma for LFNST index signalling [M. Koo, M. Salehifar, J. Lim, S. Kim (LGE)]

In the current VVC working draft, LFNST index signaling for both Luma and Chroma only depends on Luma transform skip flag. However, in the 16th JVET meeting, transform skip flag signaling of each color component was adopted so that the current dependency on Luma transform skip flag for Chroma components does not seem to be desirable considering separate tree structure. Furthermore, in VTM 7.0, it is controlled by each transform skip flag whether LFNST computation for each color component is performed or not. Therefore, LFNST index signalling condition should be modified according to separate transform skip flag for each color component, and the associated SW implementation should be aligned accordingly. In this contribution, two methods where Luma and Chroma depend only on their own transform skip flags in separate tree case are proposed. In the first method (Method 1), transform skip flag checking is absorbed in a variable, LfnstDcOnly, where,

1. A Luma LFNST index can be signalled when Luma transform skip flag is equal to zero in Luma separate tree.

2. A Chroma LFNST index can be signalled when any of Cb/Cr transform skip flags is equal to zero in Chroma separate tree.

3. One LFNST index can be signalled when any of Y/Cb/Cr transform skip flags is equal to zero in single tree.

The second method (Method 2) employs different signaling for single tree in a way that LFNST index can be signalled when Luma transform skip flag is equal to zero, which is the same as in VTM 7.0, of which LFNST index signaling for separate tree is the same as that of Method 1.

The BD-rate/EncT/DecT changes for Method 1 are reportedly observed, which are 0.00%/100%/100% (AI), and 0.00%/100%/99% (RA), respectively.

The BD-rate/EncT/DecT changes for Method 2 are reportedly observed, which are 0.00%/101%/102% (AI), and 0.00%/100%/100% (RA), respectively.

See notes under JVET-Q0099 and JVET-Q0106

[JVET-Q0729](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9575) Cross-check of JVET-Q0138 (Separate transform skip checking of Luma and Chroma for LFNST index signalling [C.)] [late]

[JVET-Q0183](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9008) AHG9: High-level syntax related to transform skip mode [S.-T. Hsiang, Y.-W. Huang, S.-M. Lei (MediaTek)]

This contribution proposes three high-level syntax modifications related to transform skip mode, summarized as follows:

1. Skip coding min\_qp\_prime\_ts\_minus4 when sps\_transform\_skip\_enabled\_flag and sps\_palette\_enabled\_flag are both equal to 0;

2. Add a separate SPS syntax flag sps\_transform\_skip\_chroma\_enabled\_flag to control whether to enable or disable transform skip mode for chroma;

3. Move log2\_transform\_skip\_max\_size\_minus2 from the PPS to the SPS.

In Version 2, it is modified that signalling min\_qp\_prime\_ts\_minus4 is further conditioned on the value of sps\_palette\_enabled\_flag (as proposed in JVET-Q0374).

Item 1 would follow a general rule that syntax elements that would never be used are not sent – agreed.

Item 2: There is no agreement on this item. It is argued that there are separate flags for luma and chroma for BDPCM in SPS, but not for TS. This was however done with the intent to enable chroma BDPCM only for 444. As it is anticipated that as a result from this meeting, BDPCM would also be enabled for chroma in 4:2:0 case, this should be re-considered, i.e. provided that this decision would be taken, only one flag should be used for BDPCM controlling both luma and chroma. Revisit (convert into decision: If it is agreed that we decide for chroma BDPCM also 420, use only one flag, if not, keep as is)

Item 3: Seems more consistent to have max TS size in same parameter set (SPS) as the max transform size – agreed.

Decision: Adopt JVET-Q0183 Items 1 and 3

[JVET-Q0193](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9018) LFNST signalling cleanup with TS checking [M.-S. Chiang, C.-W. Hsu, C.-M. Tsai, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

In VVC Draft 7, combination of transform skip (TS) and low frequency non-separable secondary transform (LFNST) is not allowed, so if the TS flag for Y is true, the LFNST index is inferred to 0. However, TS was extended to Cb and Cr according to the adoption of JVET-P0058, so the TS flags are signalled for Y, Cb, and Cr, separately. Therefore, only checking the TS flag for Y is not enough for single tree and does not make sense for chroma dual tree. In this contribution, three methods are proposed. In Method 1, if any component’s TS flag in a coding unit (CU) of a coding tree is equal to 0, the LFNST index of the CU can be signalled. In Method 2, if every component’s TS flag in a CU of a coding tree is equal to 0, the LFNST index of the CU can be signalled. In Method 3, for any CU of single tree, if TS flag for Y is equal to 0, the LFNST index of the CU can be signalled; for any CU of dual tree, no additional check is added. With the proposed Method 1 and Method 2, LFNST is more properly used by considering the chroma TS settings. As for Method 3, it is a simple way to correct the wrong interaction between TS and LFNST, and it has no BD-rate impact to VTM7.0. Compared to VTM7.0 common test condition (CTC), the BD-rate and runtime changes of Method 1 and Method 2 are negligible.

See notes under JVET-Q0099 and JVET-Q0106

Method 2 is the same as JVET-Q0106.

[JVET-Q0689](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9535) Crosscheck of JVET-Q0193 (LFNST signalling cleanup with TS checking) [Kuo, Lin (ITRI)] [late]

[JVET-Q0195](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9020) Maximum TS size considering chroma sampling ratio [M.-S. Chiang, C.-W. Hsu, C.-M. Tsai, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

In VVC Draft 7, the maximum block size for transform skip (TS) is the same for luma and chroma transform blocks (TBs). However, according to the meeting notes, the maximum TS size should depend on chroma sampling ratio. This contribution proposes to decide the maximum block size for TS with chroma sampling ratio. With this modification, the maximum block sizes for transform and TS are aligned. The proposed method causes very minor BD-rate changes compared to VTM7.0.Same as JVET-Q0100 – no action.

[JVET-Q0623](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9469) Crosscheck of JVET-Q0195 (Maximum TS size considering chroma sampling ratio) [J. Choi (LGE)] [late]

[JVET-Q0303](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9128) LFNST signaling simplification [J. Yao, J.-Q. Zhu, K. Kazui (Fujitsu)]

In current VVC, LFNST signaling constraint on LfnstDcOnly is ISP mode condition dependent. This contribution proposes to remove the ISP mode condition check for LFNST signaling so that making LFNST signaling consistent and simpler. The results reportedly show that the proposed method has negligable impact on coding efficiency and complexity.

The results reportedly show the average BDR gains are respectively 0.00% -0.03% 0.01% for All Intra configuration, and 0.00% 0.00% 0.02% for Random Access configuration over VTM-7.0.No obvious benefit of simplification. No action.

[JVET-Q0578](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9424) Crosscheck of JVET-Q0303 (LFNST signaling simplification) [S. De-Luxán-Hernández (HHI)] [late]

[JVET-Q0314](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9139) Non-CE: Retrained LFNST Matrices [K. Fan, L. Zhang, K. Zhang, Y. Wang (Bytedance)]

In this contribution, a different set of LFNST matrices are proposed to replace existing matrices. It is asserted that the complexity is kept unchanged while coding performance improvements could be achieved. Experimental results reportedly show that the proposed matrices provide -0.14% and -0.09% BD-rate under AI and RA configurations, respectively.Matrices trained from non-CTC images

The aspect of re-training matrices had been dicussed in previous meetings. In the previous meeting, it was concluded that the matrices shall be frozen in the interest of a stability of the standard development.

There is no consensus to change the matrices. The additional benefit is relatively small.

No action.

[JVET-Q0744](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9590) Crosscheck of JVET-Q0314 (Non-CE: Retrained LFNST Matrices) [S. De-Luxán-Hernández (HHI)] [late]

[JVET-Q0763](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9609) Crosscheck of JVET-Q0314 (Non-CE: Retrained LFNST Matrices) [X. Z. Zheng (DJI)]

[JVET-Q0328](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9153) On LFNST signalling and transform skip [C. Rosewarne, J. Gan (Canon)]

The VVC WD7 text includes conditioning of the LFNST index, which applies across all colour channels of a CU, on the luma transform skip flag indicating application of a transform. This contribution proposes to extend the conditioning to the chroma transform skip flags, including in chroma branch of dual-tree coding trees.

See notes under JVET-Q0099 and JVET-Q0106

[JVET-Q0499](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9327) On LFNST signaling with Transform-skip mode [T.-C. Ma, X. Xiu, Y.-W. Chen, H.-J. Jhu, X. Wang (Kwai Inc.)]

In current VVC [1], LFNST index is not signaled if luma CU is Transform-Skip mode. Two issues are addressed in this contribution. First, in dual tree case, even chroma CU is TS mode, LFNST index for chroma CU is still signaled if its corresponding luma CU is non-TS mode. Second, in single tree case, LFNST can not be applied with chroma once its luma block is TS mode.

In this contribution, it is proposed to modify LFNST signaling with TS mode. First, in dual tree case, chroma LFNST index is not signaled if it is applied with chroma TS mode. Second, in single tree case, LFNST index is not signaled if all Y/Cb/Cr blocks are TS mode.

Simulation results show that the proposed changes result in a BD-rate change (YUV) of 0.00%, 0.00%, 0.00% for AI, XXX%, XXX%, XXX% for RA, XXX%, XXX%, XXX% for LDB.

See notes under JVET-Q0099 and JVET-Q0106

[JVET-Q0687](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9533) Crosscheck of JVET-Q0499 (On LFNST signaling with Transform-skip mode) [H.E. Egilmez (Qualcomm)] [late]

[JVET-Q0686](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9532) Chroma LFNST Simplification and Signaling [H.E. Egilmez, A. Nalci, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)] [late]

In VTM-7.0, the LFNST signaling for chroma blocks depends on the luma transform skip flag. This document proposes to remove this dependency by restricting chroma LFNST signaling based on chroma transform skip without any changes in luma LFNST signaling. It is also proposed to remove chroma LFNST when single-tree partition mode is used in order to reduce the worst-case latency without a significant coding loss. The experimental results show that the proposed change has negligible impact in terms of average BD-rates.It is agreed that this is a desirable simplification, as it was analysed before that various issues occur with chroma LFNST in single tree case, in particular latency, and the loss in performance is negligible.

Decision: Adopt JVET-Q0686, disable chroma LFNST for single tree

Revisit: It is requested to align the spec text with JVET-Q0106, and check how the bug fix of JVET-Q0133 is related. It must be taken care that the scaling matrices would always apply for chroma even if the luma block uses LFNST and the lfnst\_scal\_matrix\_disabling is invoked.

[JVET-Q0731](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9577) Cross-check of JVET-Q0686 "Chroma LFNST Simplification and Signaling" [F. Le Léannec (InterDigital)] [late]

[JVET-Q0784](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9630) Combination of JVET-Q0106, JVET-0686 and JVET-Q0133 for LFNST Signaling, Latency Reduction and Scaling Process [H.E. Egilmez, A. Nalci, A.K. Ramasubramonian, M. Coban, V. Seregin, M. Karczewicz (Qualcomm), T. Hashimoto, T. Chujoh, E. Sasaki, T. Ikai (Sharp)] [late]

TBP track B

## Residual coding (7)

Contributions in this category were discussed Thursday 9 Jan. 1800–1900 in Track B (chaired by JRO).

[JVET-Q0146](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8971) Simplified bypass coding of transform regular residual [Y. Kato, K. Abe, T. Toma (Panasonic)]

This contribution proposes a simplified bypass coding of transform residual coding. Update of QState in bypass coding is removed and derivation of ZeroPos[n] is changed not to use QState. Two methods are proposed.

* Method 1: ZeroPos[n] is defined to (1 << rice).
* Method 2: On top of Method 1, ZeroPos[n] is changed depending on inter block or not.

Method 1 reportedly provides 0.01%, 0.01%, and 0.01% luma BD-rates for the AI, RA, and LB settings, respectively, over the VTM-7.0 anchor under CTC, and Method 2 reportedly provides 0.00%, 0.00%, and -0.01% luma BD-rates for the AI, RA, and LB settings, respectively.

It is commented that Qstate would still be needed for CABAC, so it cannot be entirely removed. It is not obvious that the proposed method is really solving a critical complexity problem, and it introduces some loss in particular in the low QP range.

No action.

[JVET-Q0617](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9463) Crosscheck of JVET-Q0146 (Simplified bypass coding of transform regular residual) [T. Tsukuba (Sony)] [late]

[JVET-Q0243](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9068) Additional support of dependent quantization with 8 states [H. Schwarz, S. Schmidt, P. Haase, T. Nguyen, D. Marpe, T. Wiegand (Fraunhofer HHI)]

This contribution proposes to support dependent quantization with 8 quantization states in addition to the current variant of dependent quantization with 4 quantization states. It is asserted that the implementation complexity for the decoder is virtually not increased. Reportedly, both variants of dependent quantization (4 and 8 states) can be implemented using a single unified decoding process; only the state transition table used depends on the variant chosen. Alternatively, both variants of dependent quantization could be implemented using a single state transition table of 12 states, in which case only the initial state for a transform block depends on the variant of dependent quantization selected.

The following average results are reported for dependent quantization with 8 states relative to VTM-7 (dependent quantization with 4 states) under common test conditions:

AI: –0.43%, 0.07%, 0.14% (Y, Cb, Cr) at 111% encoding time and 99% decoding time;  
 RA: –0.34%, 0.05%, 0.25% (Y, Cb, Cr) at 106% encoding time and 98% decoding time;  
 LB: –0.40%, 0.21%, 0.13% (Y, Cb, Cr) at 104% encoding time and 100% decoding time;  
 LP: –0.37%, 0.16%, –0.02% (Y, Cb, Cr) at 106% encoding time and 95% decoding time.

For the low QP test conditions (QPs 2, 7, 12, 17), the following results are reported:

AI: –0.38%, –0.34%, –0.35% (Y, Cb, Cr) at 120% encoding time and 97% decoding time;  
 RA: –0.72%, –0.96%, –1.30% (Y, Cb, Cr) at 115% encoding time and 97% decoding time;  
 LB: –0.78%, –0.30%, –0.22% (Y, Cb, Cr) at 115% encoding time and 95% decoding time;  
 LP: –0.70%, –0.23%, –0.18% (Y, Cb, Cr) at 117% encoding time and 96% decoding time.

The gain is 0.3-0.4%, but the encoder runtime also increases by 10% and more. It is obvious that the trellis search is duplicating in complexity. This is clearly a worse performance/complexity tradeoff compared to the 4-state version of DQ.

The changes in specification are not large, when some state numbering is modified.

Several experts expressed concern that the complexity/performance tradeoff is not attractive enough.

No action.

[JVET-Q0626](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9472) Cross-check report of JVET-Q0243 on Dependent Quantization with 8 states [E. François (InterDigital)] [late]

[JVET-Q0708](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9554) Crosscheck of JVET-Q0243 (Additional support of dependent quantization with 8 states) [M. Coban (Qualcomm)] [late]

[JVET-Q0627](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9473) On Dependent Quantization: combination of JVET-Q0243 and JVET-Q0227 [P. Le Léannec, E. François (InterDigital)] [late]

This contribution relates to Dependent Quantization and combines the proposals from JVET-Q0243 on using 8 quantization states instead of 4 states in the current VTM, and JVET-Q0227 on using an qP-dependent offset when applying the scaling process for transform coefficients.

The reported psnr-Y, U, V BD-rate variations compared to VTM7.0 when using 8 quantization states are:

AI: –0.47%, 0.42%, 0.43% (Y, Cb, Cr) at 109% encoding time and 100% decoding time  
 RA: –0.38%, –0.05%, –0.12% (Y, Cb, Cr) at 106% encoding time and 101% decoding time  
 LB: –0.58%, 0.18%, 0.36% (Y, Cb, Cr) at 106% encoding time and 101% decoding time

No need for presentation.

[JVET-Q0724](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9570) Crosscheck of JVET-Q0627: On Dependent Quantization: combination of JVET-Q0243 and JVET-Q0227 [H. Schwarz (Fraunhofer HHI)] [late]

[JVET-Q0298](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9123) Reports on level mapping off versus level mapping on [J. Choi, S. Yoo, J. Heo, J. Lim, S. Kim (LGE)]

This contribution investigates coding performance impact from the usage of level mapping. According to simulation results, disabling level mapping does not cause any coding loss for camera-captured contents, but some coding loss to sequences from Class F and TGM. In addition, when level mapping is disabled for the chroma blocks some coding gains are observed to sequences except TGM. This contribution proposes four methods regarding how to handle level mapping as follow.

- Method 1: disabling level mapping for all blocks

- Method 2: disabling level mapping for chroma blocks

- Method 3/4: SPS flag to indicate level mapping usage for all blocks/chroma blocks

Disabling level mapping:

Overall: 0.00% / -0.01% / 0.00% (AI), -0.02% / 0.00% / -0.04% (RA), -0.02% / -0.10% / -0.06% (LD)

Class F: 0.37% / 0.35% / 0.53% (AI), 0.24% / 0.43% / 0.32% (RA), -0.02% / 0.14% / 0.37% (LD)

TGM: 0.78% / 0.93% / 0.87% (AI), 0.51% / 0.66% / 0.68% (RA), 0.37% / 0.43% / 0.40% (LD)

Disabling level mapping (Low QP):

Overall: -0.03% / -0.05% / -0.06% (AI), -0.02% / -0.02% / -0.02% (RA), -0.01% / -0.01% / -0.01% (LD)

Class F: 0.11% / 0.17% / 0.18% (AI), 0.06% / 0.11% / 0.03% (RA), -0.06% / 0.06% / 0.05% (LD)

TGM: 1.48% / 1.26% / 1.34% (AI), 1.15% / 1.14% / 1.13% (RA), 0.93% / 1.01% / 1.02% (LD)

Disabling level mapping for chroma blocks:

Overall: 0.00% / -0.01% / 0.00% (AI), 0.00% / 0.03% / 0.01% (RA), -0.01% / -0.16% / -0.04% (LD)

Class F: 0.00% / 0.04% / 0.05% (AI), -0.04% / 0.02% / 0.03% (RA), -0.01% / -0.87% / 0.36% (LD)

TGM: 0.09% / 0.12% / 0.12% (AI), 0.03% / -0.01% / 0.05% (RA), -0.01% / -0.11% / -0.09% (LD)

Disabling level mapping for chroma blocks (Low QP):

Overall: -0.01% / -0.02% / -0.03% (AI), 0.00% / -0.01% / -0.02% (RA), 0.00% / -0.01% / 0.04% (LD)

Class F: 0.00% / -0.05% / -0.03% (AI), -0.05% / -0.01% / 0.03% (RA), 0.09% / 0.10% / -0.08% (LD)

TGM: 0.46% / 0.39% / 0.46% (AI), 0.22% / 0.26% / 0.33% (RA), 0.10% / 0.17% / 0.13% (LD)

No need for consideration after CE3 decision

[JVET-Q0546](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9392) Crosscheck of JVET-Q0298 (Reports on level mapping off versus level mapping on) [Z.-Y. Lin (MediaTek)] [late]

[JVET-Q0299](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9124) Residual coding simplification [J. Choi, S. Yoo, J. Heo, J. Lim, S. Kim (LGE)]

In current VVC draft, Rice parameter for transform skip is derived from the predetermined equation. However, a look-up table of 32 entries is still used to derive Rice parameter in regular residual coding. This contribution proposes a few candidate equations to derive the Rice parameter without the look-up table. The proposed equations require shift and additions, and it generates the exactly same or almost same Rice parameters as the look-up table. The coding performance of each proposed method is shown below:

Method 1:

Exactly same with the VTM-7.0 anchor

Method 2:

CTC QPs: 0.00% (AI), 0.00% (RA), -0.03% (LD)

Low QPs: -0.02% (AI), 0.08% (RA), 0.06% (LD)

Method 3:

CTC QPs: 0.00% (AI), 0.01% (RA), 0.02% (LD)

Low QPs: 0.00% (AI), 0.00% (RA), -0.01% (LD)

No need for consideration after CE3 decision

[JVET-Q0639](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9485) Crosscheck of JVET-Q0299 (Residual coding simplification) [M. G. Sarwer (Alibaba)] [late]

[JVET-Q0300](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9125) Unification of bypass coding between TSRC and RRC [J. Choi, S. Yoo, J. Heo, J. Lim, S. Kim (LGE)]

In the current transform skip residual coding, bypass coded bins are coded with the interleaved manner (residual sample by residual sample) after context-coded bin count reaches the maximally allowed number. This contribution proposes to change the coding order of bypass coded bins/syntaxes in transform skip residual coding so that bypass bins are coded together as regular residual coding. The proposed method has no coding efficiency change.

It is suggested to align the coding order of TSRC with RRC (i.e. group remainder and sign bits together). As sign bits are partially context in TSRC, the unification is not fully possible, in hardware and software these would anyway be implemented in separate processing structures. The benefit of the unification is not clear.

No support expressed, no action.

[JVET-Q0552](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9398) Crosscheck of JVET-Q0300: Unification of bypass coding between TSRC and RRC [T. Nguyen (HHI)] [late]

[JVET-Q0363](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9188) On transform skip residual coding [J. Gan, C. Rosewarne (Canon)]

This contribution proposes removing the second pass of context-coded syntax elements from TSRC. The remaining four context-coded syntax elements are decoded in a single pass, requiring only one CABAC budget check per coefficient. It is asserted that the proposed simplification aligns the CABAC utilisation of RRC and TSRC. Losses relative to VTM-7.0 are 0.01% luma in CTC RA, and 0.37% luma in Class F RA.

The proposal intends to make TSRC more similar to RRC in various aspects. However, a complete unification is not possible, e.g. in terms of scanning order, method of sign coding, etc., such that hardware implementations would likely use separate processing stages anyway. The method particularly loses compression performance in screen content, which is the area where TSRC has most benefit.

No action.

[JVET-Q0680](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9526) Crosscheck of JVET-Q0363 (On transform skip residual coding) [X. Zhao (Tencent)] [late]

[JVET-Q0497](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9325) Simplification of Rice parameter derivation for RRC [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

In residual coding of a transform block, for each coefficient, the remaining absolute level is binarized using Golomb-Rice code whose rice parameter is adaptively derived depending on the neighbour coefficient levels and a lookup table. This contribution proposes two methods for deriving the rice parameters without using lookup table. The proposed method 1 reportedly provides 0.01%, 0.00%, and 0.00% luma BD-rate impact for the AI, RA, and LB settings respectively versus the VTM-7.0 anchor under the common test condition (CTC), and proposed method 2 reportedly provides 0.01%, -0.01%, and 0.01% luma BD-rate impact for the AI, RA, and LB settings respectively versus the VTM-7.0 anchor under the common test condition (CTC).

Very similar to JVET-Q0490 and JVET-Q0263.

No obvious benefit of such change.

[JVET-Q0688](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9534) Crosscheck of JVET-Q0497 (Simplification of Rice parameter derivation for RRC) [H. Wang (Qualcomm)] [late]

## Entropy coding (3)

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

[JVET-Q0149](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8974) AHG14: Report of CABAC skip mode results on VTM-7.0 [K. Abe, T. Toma, [V. Drugeon (Panasonic)](mailto:virginie.drugeon@eu.panasonic.com)]

This contribution is an information contribution which reports the coding results of CABAC skip mode on VTM-7.0. CABAC skip mode was proposed by JVET-M0089, JVET-N0207, and JVET-O0308. It directly outputs binarized bins as a bitstream without CABAC processing, and can avoid CABAC throughput issue without any additional building blocks. Simulation results reportedly show that the CABAC skip mode can guarantee the fixed processing delay with the cost of 16%, 19%, and 24% bits increasing for AI, RA, and LDB on VTM-7.0, and 11%, 10%, and 11% bits increasing for AI, RA, and LDB on VTM-7.0-lossless.

Update on previous proposal with VTM7 and lossless results. No detailed presentation necessary.

[JVET-Q0436](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9262) CABAC zero word threshold [A. Browne, K. Sharman, S. Keating (Sony)]

This document presents an analysis of the need for padding with cabac\_zero\_word. Following on from JVET-P0395, where CTU-level statistics were analysed, in this contribution statistics are provided for tiles of CTUs, to examine the impact of averaging. It is concluded that padding is required on tiles for some sequences within both “High” and “Main” tiers of the current specification. In addition, figures are given which indicate that these results are not “averaged out” as tiles become larger. Two possible changes to the cabac\_zero\_word threshold are proposed if the impact of padding is to be reduced.

The analysis shows that the usage of CABAC zero word becomes less when the formula in terms of slope (beta) is changed. The same formula had been used since AVC, but may in particular not be as appropriate for high tier bitrate limits.

Decision: Adopt JVET-Q0436, only for high tier, “candidate 1”, change beta from 4/3 to 3/2.

[JVET-Q0461](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9287) QP-independent and slice type-independent initialization of context models for the high throughput CABAC mode of JVET-P0300 [H. Kirchhoffer, B. Bross, T. Nguyen, D. Marpe, H. Schwarz, T. Wiegand (HHI)]

A QP-independent and slice type-independent initialization method is proposed for the high throughput CABAC mode of JVET-P0300. This opens up the possibility for simplifications in a hardware or software implementation. For example, instead of deriving a context model index (for a certain bin), the context model state (which corresponds to a probability value) can directly be derived. For QPs 2-17, the BD-rates are 4.96% for AI, x.xx% for RA, 5.37% for LB, and 5.72% for LP. For the lossless setup, the bit rates increase by 7.78% for AI, 7.34% for RA, and 6.78% for LB.

Further study and better understanding of the problem is needed before considering specific technology. See notes under JVET-Q0387.

[JVET-Q0641](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9487) Crosscheck of JVET-P0461 (QP-independent and slice type-independent initialization of context models for the high throughput CABAC mode of JVET-P0300) [S. Esenlik (Huawei)] [late]

## Partitioning (7)

Contributions in this category were discussed Sunday 12 Jan. 1330–1550 in Track B (chaired by JRO).

[JVET-Q0174](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8999) AHG9: Fix on high-level syntax related to coding tree constraints [S.-T. Hsiang, C.-Y. Lai, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

In VVC Draft 7, when the specified maximum multi-type tree (MTT) depth is equal to 0, a partial CU across the right or bottom boundary of the current picture may be inferred to be further split while having all split types disabled, as reported by Ticket #584. In this contribution, it is proposed that the specified maximum MTT depth shall be greater than 0 when the specified minimum QT size is greater than the specified minimum coding block size. When the specified maximum MTT depth is equal to 0 (MTT split is disabled), the minimum QT size is inferred to be equal to the specified minimum coding block size, reportedly corresponding to the CU partitioning structure in HEVC.

Version 2 further proposes an alternative solution that allows the specified minimum QT size to be greater than the specified minimum coding block size when MTT split is not enabled. In the alternative method, when the specified maximum hierarchy depth for multi-type tree (MTT) split is equal to 0 and the current CU is across the right or bottom picture boundary, quadtree split is always allowed for partitioning the current CU (disregarding the specified minimum QT size).

“Version 2” refers to an update of the document which proposes a similar solution as JVET-Q0330. The original proposal is a syntax modification which enforces min QT size equal to min CB size when mtt depth is equal to zero. This however would only solve the second problem mentioned under JVET-Q0330, and be more restrictive in non-boundary split cases.

The proponents of JVET-Q0174 support JVET-Q0330.

[JVET-Q0226](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9051) AHG9: High-level syntax for signalling maximum TT size [S.-T. Hsiang, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

This contribution proposes to modify the valid value range for the allowed maximum ternary tree size maxTtSize signalled in the SPS and the picture header. The proposed modifications can reportedly support additional options for CU partitioning structures and simplify the allowed ternary split process. The proposed modifications are summarized as follows:

1. Specifies maxTtSize with respect to the minimum coding block size and limits the minimum value of maxTtSize to be equal to the minimum coding block size.
2. Limits the maximum value of maxTtSize to be equal to Min( 64, CTBSizeY ) in accordance with the VPDU constraints.

The first proposed change allows more options of splitting with TT and BT up to minimum CB size. This had been discussed before, and it was previously agreed that it is not needed.

The second proposed change is restricting maxTtSize to 64 instead of 128, which would never be used in the bitstream due to VPDU constraints. As a side effect, this allows a slight simplification of decoder check in split decision, but keeps the option of splits equal.

There is no real problem related to the second proposed change. It is however supported as a cleanup.

The semantics text for “pic\_log2\_diff\_max\_tt..” in SPS and PH (2 places) should be changed to

“shall be in the range of 0 to Min( 6, CtbLog2SizeY ) − MinQtLog2SizeInterY, inclusive”

Decision(cleanup/text): Adopt JVET-Q0226, only aspect about max tt size.

Revisit – was later withdrawn – revert decision

[JVET-Q0330](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9155) On block partitioning at picture boundary [R.-L. Liao, J. Chen, Y. Ye, J. Luo (Alibaba), S.-T. Hsiang, C.-Y. Lai, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

In VVC draft 7, a block that exceed the picture boundary is forced to be split until all the samples are located inside the picture boundary. However, none of splitting methods is allowed to split the block in the following two cases:

1. A CTU block exceeds picture boundary and both the CTU size and min QT size are set to 128;
2. A block exceeds picture boundary and its size is not larger than min QT size, and min QT size is larger than the min CU size and the max BT/TT depth is equal to 0.

In this contribution, it is proposed to use QT splitting in these two conditions.

Both are cornercases not exercised in CTC which would typically not be used, but there is obviously a bug in the spec. Another option could be to impose a bitstream constraint saying that if these settings are used, the picture size should be a multiple of CTU size. This would however be too much of a constraint, and it is not clear if the two cases above are the only cornercases that might exist.

Decision(BF/text&SW): Adopt JVET-Q0330 bug fix in implicit split at boundary.

[JVET-Q0432](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9257) On TT or BT split modes disabling [F. Le Léannec, T. Poirier, F. Urban (InterDigital)]

This contribution deals with deactivating the use of the TT or BT split modes. The simplest way to deactivate the use of the TT split mode in VVC 7 is to set the maximum TT size parameter to its minimum values, i.e. 0. Then, TT is automatically set to off except for coding units that correspond to the quad-tree leaves with a size equal to the minimum QT size.

This contribution proposes to change the specification of the maximum BT and TT size, in a way that allows selectively deactivating the use of the TT or BT split modes for any coding tree node, allowing to infer some split mode (e.g. TT) to off whatever the quad-tree depth of the considered node.

The motivation behind the proposal is that an encoder might not want to test all possible BT/TT combinations. The proponents intend then e.g. to infer the TT modes as disallowed at the block level, for which there is no semantics description provided with the proposal. Furthermore, as this would be a coding efficiency proposal for a certain encoder operation mode, no results for such a case are provided.

No action on this.

[JVET-Q0468](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9294) Constraint on minimum CU size [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

It is proposed to allow minimum CU size setting in VTM software. It is further proposed to set the range of minimum CU size value in the range of {4, 8, 16} in luma samples, according to the investigation of the performance impact of applying minimum coding unit sizes on VTM-7.0. It is reported that compared with VTM-7.0 anchor with minimum CU size of 4, the following minimum CU size settings have performance impact (BD-rate Y/Enc Time/Dec Time) as following.

* Min CU size 8: AI: 2.66% / 54% / 95%; RA: 2.26% / 78% / 104%; LB: 1.96% / 80% / 104; LP 2.61% / 78% / 103%.
* Min CU size 16: AI: 10.36% / 18% / 85%; RA: 12.04% / 54% / 102%; LB 11.79%% / 59% / 103%; LP 13.43% / 55% / 101%;
* Min CU size 32: AI: 23.75% / 7% / 78%; RA: 35.60% / 29% / 95%; LB 40.10% / 33% / 97%; LP 43.59% / 30% / 95%;

It is agreed that the current value range of min CU size up to 128 is obsolete, as from a decision of last meeting it was clipped to min (64, ctusize) for the VPDU.

In the future, there might be applications which would like to use such sizes.

Decision(ed./text): (different than proposed in JVET-Q0468) Limit the range of min CU size in SPS to 4,8,16,32,64. This is an editorial cleanup of semantics. The subsequent clipping operation min (64, ctusize) shall be kept.

Decision(SW): Adopt the software implementation of JVET-Q0468 (non CTC option).

[JVET-Q0674](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9520) Crosscheck of JVET-Q0468 (Constraint on minimum CU size) [K. Zhang (Bytedance)] [late]

[JVET-Q0469](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9295) On minimum chroma QT size derivation [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

This contribution proposes a bug fix of deriving the minimum size of the chroma quadtree nodes in VTM software. The proposed method doesn’t have impact on common test condition. It reportedly fixes a signaling issue when the minimum luma coding block size is larger than 4.

Decision(BF/SW): Align the SW with spec text on this issue (does not affect CTC)

[JVET-Q0471](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9297) On chroma QT split [G. Li, X. Li, X. Xu, S. Liu (Tencent)]

This contribution firstly reports a VTM-7.0 bug with which luma block size is used when checking chroma QT split condition. Coding loss is reported for 4:2:2 sequences after fixing the bug. It is further proposed to use block height as a condition in QT split checking to compensate the loss. The proposed method doesn’t have impact on common test condition. It reportedly improves the coding performance when 4:2:2 color format is used and minimum chroma QT size is set to large values. On 4:2:2 test sequences, it was observed that when min chroma QT size is set to 32, the proposed method has BD-rate gain of -0.28% / -6.09% / -8.07% on AI, -0.60% / -4.21% / -5.07% on RA, and -0.03% / -2.42% / -3.29% on LB.

First aspect: It is agreed that the bug exists in both text and software. Editors may need to further check if MinQtSizeC is expressed per luma samples or per chroma samples (if per luma samples, the suggested text should be the correct solution).

The second aspect applies to dual tree chroma, when chroma sampling is 4:2:2. Whereas the limits of luma block sizes are always referring square blocks, the corresponding chroma would be rectangular (larger in height than in width). The proposed solution is to scale the limit check by multiplying the subsampling ratio factor. This is agreed as a straightforward solution to this case.

Decision(BF/text&SW): Adopt JVET-Q0471, both aspects.

[JVET-Q0753](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9599) Crosscheck of JVET-Q0471 (On chroma QT split) [S. H. Wang (PKU)] [late]

## Chroma formats and chroma related coding tools (26)

Contributions in this category were discussed Sunday 12 Jan. 1615–1810 and Monday 13 Jan. 1350-1820 in Track B (chaired by JRO).

### ACT related (16)

After initial presentation of contributions related to ACT, the following list of issues was set up, and initial observations/conclusions formulated as follows on Monday 12 Jan.

* There is a bug with possible QP outside valid range after ACT QP adjustment, in this context several solutions: JVET-Q0098, JVET-Q0142, JVET-Q0166, JVET-Q0241, JVET-Q0425, JVET-Q0510/JVET-Q0511. It would be desirable if the solution
  + has no effect on chroma QP used in deblocking (note it is assumed that the ACT specific QP offset should not have impact on deblocking, as deblocking is done after inverse ACT in RGB domain. Even though ACT is same as in in HEVC this problem does not exist there, as HEVC has no chroma QP adaptivity in deblocking).
  + does take QpPrimeTsMin into consideration
  + does not influence the case ACT off
* There is a bug with text spec on QP offsets (JVET-Q0241 aspect 1)
* Several proposals for signaling/adapting ACT QP offsets. Global offsets should be included. Local chroma QP offset should also be applied to ACT coded blocks, but not defining a separate list of offsets for ACT
* Current ACT design should not be modified
* Clipping at input of inverse ACT is necessary.
* Disable ACT for max transform size 64
* BoG on ACT alignments (L. Zhang, X. Xiu) to work on selecting the best approaches of resolving the issues above, suggest a combined solution and coordinate the drafting of a combined spec text.

[JVET-Q0098](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8923) On QP Adjustment for Adaptive Color Transform [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

In VTM-7.1, after applying QP adjustment (-5, -5, -3) for ACT, the quantization parameter qP for TS can be less than QpPrimeTsMin, and the qP for non-TS can be less than 0. To keep the qP in the valid range, this contribution proposes to a) apply the QP adjustment for ACT before clipping the qP for TS to QpPrimeTsMin, and b) clip the qP for non-TS to 0 after the QP adjustment for ACT.

For DualITreeOff at low QP condition (QP=2, 7, 12, 17), it is reported that BDrate-differences of (G, B, R) are (-0.17%, -0.38%, -0.33%) for AI, (-0.09%, -0.25%, -0.27%) for RA and (-0.11%, -0.34%, -0.31%) for LB; BDrate-differences of (Y, U, V) are (0.00%, 0.00%, 0.00%) for AI, (0.00%, 0.00%, -0.01%) for RA and (-0.02%, 0.01%, -0.01%) for LB

For DualITreeOn at low QP condition, it is reported that BDrate-differences of (G, B, R) are (0.00%, 0.00%, 0.00%) for AI, (-0.06%, -0.25%, -0.29%) for RA and (-0.09%, -0.29%, -0.27%) for LB; BDrate-differences of (Y, U, V) are (0.00%, 0.00%, 0.00%) for AI, (0.00%, -0.05%, -0.07%) for RA and (-0.05%, -0.19%, -0.13%) for LB.

It is further pointed out by the proposnents that current VTM SW crashes when internal bit depth = 8. This however only happens when QP was out of range – not relevant after bug fix.

The proposal should resolve the issue without taking influence on deblocking in terms of the spec text. Cross-checkers however point out that the SW implementation seems to change deblocking via modified QP’.

Related:

JVET-Q0142 (same solution for non-TS)

JVET-Q0166 (somewhat different)

JVET-Q0241 (same solution, but different results)

JVET-Q0510/JVET-Q0511 (similar solution, but more elements such as signalling)

[JVET-Q0647](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9493) Cross-check of JVET-Q0098 (On QP Adjustment for Adaptive Color Transform) [T.-C. Ma (Kwai Inc.)] [late]

[JVET-Q0142](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8967) Clipping of minimum QP prime value [K. Unno, K. Kawamura, S. Naito (KDDI)]

In this contribution, it is proposed that the minimum value of Qp′ is clipped with 0 for non transform skip case and with 4 for transform skip case. The proposed clipping is applied to Qp′ after compensation depending on whether adaptive colour transform is applied.

Difference from JVET-Q0098: For TS blocks, clipping of QP’ is performed to minimum of 4 instead of QpPrimeTSMin. It is however raised that clipping to 4 would only be correct for the case of bit depth equal 10.

It is mentioned that also the case of ACT disabled should be considered, so the clipping should only be applied when ACT is on.

It is mentioned that there should be no difference to results of JVET-0098. However, the difference is observed, which may be due to the fact that handling of deblocking is wrong in the implementation of 0098.

[JVET-Q0162](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8987) A memory issue on adaptive color transform [K. Kondo, M. Ikeda, T. Suzuki (Sony)]

In this contribution, it is proposed to restrict the large transform such 64-points when an adaptive color transform (ACT) is used. Also, it is introduced that ACT needs large buffering because the inverse-ACT needs three color components after inverse transform. To reduce maximum buffer size, it is proposed that **sps\_act\_enabled\_flag** is implicitly set equal to zero when **sps\_max\_luma\_transform\_size\_64\_flag** is true. The test is carried out and report the impact for coding efficiency. Based on the same test as JVET-P0517, simulation results reportedly show that when the separate-tree partition is off, the average {G, B, R} BD-rate losses {0.3%, 0.1%, 0.2%}, {0.4%, 0.1%, 0.3%} and { 0.5%, 0.2%, 0.3%} for AI, RA and LD configurations, respectively.

It is agreed that the issue raised here is valid, and that the loss observed by disabling 64-point transform when ACT is enabled is acceptable (considering the gain that ACT gives for RGB coding). It is pointed out that other solutions could be possible:

* Formulate as bitstream restriction at SPS
* Implicit split to 32x32 when ACT is enabled
* Disable ACT for CU sizes >1024 samples (proponents say they studied this approach, but loss was larger)

Decision: Adopt JVET-Q0162, disable ACT when max transform size is 64 (CTC for 444 RGB shall use 32 max transform and ACT)

[JVET-Q0631](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9477) Crosscheck of JVET-Q0162 (A memory issue on adaptive color transform) [J. Jung, D. Kim, G. Ko, J.-H. Son, J. Kwak (WILUS)]

[JVET-Q0166](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8991) On the adaptive color transform [H. Huang, A. K. Ramasubramonian, C.-C. Chen, V. Seregin, T. Hsieh, Y.-H. Chao, W.-J. Chien, G. Van der Auwera, M. Karczewicz (Qualcomm)]

In the 16th JVET meeting, the adaptive colour transform (ACT) for 444 video coding was adopted in VVC. It is asserted that the following issues are present in the current ACT design:

1. The quantization parameter (QP) after adding ACT offset may be out of QP range.
2. The chroma ACT QP offset may be added together with regular chroma QP offset.
3. The chroma QP used in deblocking may be different from quantization stage due to the ACT offset, which violates the adoption of JVET-P1001.
4. The inverse ACT increases the dynamic range of reconstructed residual that may exceed 16 bits. And the input of ACT may exceed 16 bits when the JCCR mode is 2 (i.e., Cr = -Cb).
5. The ACT QP offsets are fixed instead of signalled in high level syntax as in HEVC.
6. The Cb or Cr ACT QP offset may be applied in JointCbCr modes.

It’s proposed to address the above issues by the following:1) add ACT QP offset before clipping of QP; 2) CU-level switching of QP offset values for reconstructing residuals according to the ACT CU-level flag as in HEVC; 3) align the chroma QP at the deblocking stage to that at the dequantization stage as in adopted JVET-P1001; 4) clip the input and output of inverse ACT to 16 bits dynamic range. 5) signal ACT QP offsets as in HEVC; 6) use a separate chroma ACT QP offset for JointCbCr mode 2 to align with chroma QP offset in non-ACT mode.

Item 1: As a solution to the invalid range (which is targeting the same issue as 0098etc), it is suggested to apply the ACT offset before the original clipping. This however also would use the modified chroma QP value for deblocking. The proposal does this by purpose, but this may not be the right way to do

Item 4: Clipping not that relevant – JVET-Q0513 has better solution

[JVET-Q0241](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9066) On QP adjustment in adaptive color transform [J. Jung, D. Kim, G. Ko, J.-H. Son, J. Kwak (WILUS)]

This contribution presents bug fixes on QP derivation when ACT (Adaptive Colour Transform) is applied. In the current VVC design, QP is adjusted by negative integer offset to compensate dynamic range change of residual signal. It is reported that there are two bugs on QP derivation when ACT is applied.

* First, QP offsets in the current draft text are not aligned with JVET-P0517, the adopted version of ACT and VTM-7.1 software.
* Second, after adjusting QP by the offset, the modified QP can be a negative value. Also, when transform skip mode is applied, the modified QP can exceed the minimum allowed QP for transform skip mode, specified as QpPrimeTsMin.

For the first issue, it is proposed to align the draft text with VTM-7.1.the second issue, it is proposed to clip the modified QP to QpPrimeTsMin when transform skip mode is applied and to 0 when transform is applied.

It is reported that BD-rate changes of {G/Y, B/U, R/V} over VTM-7.1 are as follows.

* RGB sequences: {-0.26%, -0.18%, -0.17%} for AI, {-0.11%, -0.05%, -0.02%} for RA, and {-0.04%, -0.03%, -0.03%} for LDB
* YUV sequences: {0.00%, 0.00%, 0.00%} for AI, {0.00%, 0.00%, 0.00%} for RA, and {-0.02%, 0.00%, 0.00%} for LDB
* Average: {-0.13%, -0.09%, -0.08%} for AI, {-0.05% , -0.03%, -0.01%} for RA, and {-0.03%, -0.02%, -0.01%} for LDB

Aspect 2: Unlike JVET-Q0098, the modification of QP clip is applied in the scaling process, deblocking is not influenced.

Aspect 1: It is also pointed out that the offset values are not correctly specified in the draft text. Software is correct.

[JVET-Q0618](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9464) Crosscheck of JVET-Q0241 (On QP adjustment in adaptive color transform) [T. Tsukuba (Sony)] [late]

[JVET-Q0305](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9130) Disallowing JCCR mode for ACT coded CUs [H. Dou, L. Xu, Y.-J. Chiu (Intel)]

In 4:4:4 mode of Work Draft 7 (VTM7.1), ACT could convert a CU’s luma and chroma channel residuals into YCgCo color space and then encode on the converted residual in YCgCo space. Followed by ACT on a CU, JCCR could be further applied to jointly encode the two converted chroma channel residuals in YCgCo color space. The combination of enabling both ACT and JCCR within a CU increases undesirably the length of residual construction pipe at video decoder side. This contribution proposes not to enable JCCR for the ACT coded CUs to improve the worst-case residual reconstruction pipe delay at decoder side along with the benefit to reduce the RDO checks at encoder side. With HEVC SCC test clips, the experiments report the BD rate of the proposal has a very small impact in RGB test clips, and a very small improvement in YUV test clips (in LDB case).

* When dual-tree is off
  + For RGB test clips, the average {G, B, R} BD-rates are {0.15%, 0.16%, 0.10%}, {0.25%, 0.20%, 0.09%} and {0.11%, 0.26%, -0.13%} for AI, RA and LDB, respectively
  + For YUV test clips, the average {Y, U, V} BD-rates are {0.00%, 0.01%, 0.00%}, {0.02%, 0.02%, 0.03%} and {-0.02%, -0.03%, -0.04%} for AI, RA and LDB, respectively
* When dual-tree is on
  + For RGB test clips, the average {G, B, R} BD-rates are {0.14%, 0.11%, 0.01%} and {0.02%, 0.25%, -0.09%} for RA and LDB, respectively
  + For YUV test clips, the average {Y, U, V} BD-rates are {0.00%, 0.01%, -0.01%} and {0.00%, -0.11%, -0.10%} for RA and LDB, respectively

It is observed that for camera captured content in RA JCCR still seems to work with ACT YCoCg (loss is 0.4% when disabled. The proposal suggests a block-level change.

JVET-Q0506 proposes exactly the same, but provides additional data which show that the loss is much larger when JCCR is disabled at high level when ACT is used.

The complexity is not very detailed and does not provide enough evidence that a block level change is needed here. Furthermore, the loss of 0.4% in camera captured content (which is more critical to encode than screen content) is undesirable.

Further study of complexity criticality is suggested.

No action.

[JVET-Q0569](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9415) Crosscheck of JVET-Q0305: Disallowing JCCR mode for ACT coded CUs [W. Zhu (Bytedance)] [late]

[JVET-Q0353](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9178) Non-CE: Harmonization adaptive color transform with BDPCM chroma [H. Jang, J. Nam, N. Park, S. Kim, J. Lim (LGE)]

The Adaptive color transform and BDPCM chroma were adopted in VVC draft version 7 simultaneously without considering interaction between them. In current VVC draft, chroma intra prediction mode is implicitly determined to DM when the ACT is enabled (i.e., ACT flag is equal to 1). However, in SW, BDPCM chroma flag is still signaled when ACT is enabled. In this contribution, the mismatch is fixed and report the result. Furtherly, this contribution suggests to inherit BDPCM chroma from the corresponding luma when ACT is enabled for CU. The experimental result shows 0.24% and 0.15% BD-rate saving for 4:4:4 RGB contents with AI and RA respectively.

In the revision1, the experimental result are updated

In the revision2, the only fixing mismatch result are updated

The DM inheritance was carried over from HEVC.

First aspect: Align text with software, i.e. don’t signal BDPCM chroma flag when ACT is used. That gives 0.04% gain in AI, and 0% in RA.

Second aspect: Inherit chroma BDPCM flag (and the direction from DM) from corresponding luma when ACT is used. This gives the gain indicated in the abstract.

To resolve the issue with BDPCM: Leaving the specification text unchanged and just fix the software is the simplest solution, without need of additional low level or high level changes.

Decision(BF/SW): Adopt JVET-Q0353 method 1.

[JVET-Q0367](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9192) Cleanup on the adaptive color transform [W.-T. Cai, J.-Q. Zhu, K. Kazui (Fujitsu)]

This contribution proposes two fixes to make the specification text related to ACT more logical: a) change the inferred value of intra\_chroma\_pred\_mode from 0 to 4 when it is not present, thus the derived chroma mode is inferred to be DM which is aligned with that of an intra CU with ACT applied; b) disable ACT when the three colour components of the 4:4:4 chroma format are coded separately as monochrome sampled pictures.

From the discussion, it is concluded that the two suggested changes are not critical issues:

* The DM mapping is clearly specified, and there is no real inconsistency, no simplification, no technical problem
* Due to mechanisms in HLS, as the three colour planes are handled as monochrome, ACT would never be used for them separately.

[JVET-Q0369](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9194) Restricting MIP for ACT coded CUs [W.-T. Cai, J.-Q. Zhu, K. Kazui (Fujitsu)]

This document proposes two modifications to improve the performance of ACT:

Aspect 1: fix a bug by skipping BDPCM signaling for Chroma when ACT is used in the software to align the VTM-7.1 with VVC Draft 7

Aspect 2: disallow MIP when ACT is used for an intra CU to enhance the throughput.

Based on the same test sequences used for HEVC SCC, simulation results for the single-tree partition on top of VTM-7.1 reportedly show that Aspect 1 provides average {G, B, R} BD-rate changes {-0.03%, -0.02%, -0.03%}, {-0.01%, -0.01%, 0.00%} and average {Y, U, V} BD-rate changes {0.00%, 0.00%, 0.01%}, {0.00%, 0.00%, 0.00%} in AI and RA configurations, respectively; Aspect 2 combined with Aspect 1 provides average {G, B, R} BD-rate changes {-0.04%, -0.02%, 0.00%}, {0.02%, 0.00 %, 0.01 %} and average {Y, U, V} BD-rate changes {0.02%, -0.01%, 0.00%}, {0.01%, 0.03%, 0.02%} in AI and RA configurations.

Aspect 1 is fixing of the software mismatch also reported in JVET-Q0353.

Aspect 2: Combination of MIP and ACT is complexity-wise not critical at the decoder. A smart encoder may not check it at all. There my also be optimized encoder which could take compression benefit. This would introduce another low-level change of specific syntax which is undesrirable.

Non action.

[JVET-Q0704](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9550) Crosscheck of JVET-Q0369 (Restricting MIP for ACT coded CUs) [S. Iwamura, Y. Kondo, K. Iguchi (NHK)] [late]

[JVET-Q0423](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9248) Interaction between ACT and BDPCM chroma [L. Li, X. Li, S. Liu (Tencent)]

This contribution proposes to signal ACT flag first and turn off BDPCM chroma when ACT flag is turned on in SPS level. The experiment results reportedly show overall -0.2%, 0.1%, 0.1% and -0.1%, 0.1%, 0.1% bit rate changes for Y, U, V in AI, RA, respectively with RGB and YUV 444 test sequences. In addition, the encoding runtime overall is reduced to 97% and 99% in AI and RA.

Targets the same issue as JVET-Q0353, but fixes the software bug at high level, as the useless BDPCM chroma flag is not sent when BDPCM is disabled.

Question: Why is there a compression benefit for YUV? As ACT should not often be used there, this could only be explained that BDPCM causes loss? Is this the case?

[JVET-Q0425](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9250) AHG15: QP offsets for adaptive colour transform [R. Sjöberg, M. Pettersson, M. Damghanian, D. Saffar (Ericsson)]

This contribution proposes to add four new QP offset syntax elements to the PPS in VVC that are applied for coding units that use the adaptive colour transform (ACT). The proposed new syntax element names are pps\_act\_y\_qp\_offset\_plus5, pps\_act\_cb\_qp\_offset\_plus5, pps\_act\_cr\_qp\_offset\_plus3 and pps\_act\_cbcr\_qp\_offset\_plus5. A gating flag, pps\_act\_qp\_offsets\_present\_flag, is also proposed.

This contribution also proposes to modify the clipping that affect the range of the variable qP.

The contribution claims that additional flexibility and improved visual quality in some use cases can be achieved through the introduction of four new QP offset syntax elements for ACT in the PPS similar to corresponding support in HEVC. HEVC additionally supports ACT offsets in the slice header but that is not included in this contribution.

The contribution further claims that the current VVC draft applies normalization compensation offsets for the derivation of the quantization value qP such that it can exceed the range of 0 to 63+QpBdOffsetY. This contribution proposes to add clipping to ensure that qP stays within this range also when ACT is enabled.

Proposed specification text on top of JVET-Q0041-v2\_DraftText.docx is attached with the contribution.

In a version 2 of the contribution, clipping is done during derivation of the quantization parameter qP for all of Y, Cb, Cr and CbCr since the proponents understanding of the current ACT design is that the quantization values used in the deblocking process shall not include normalization terms. The authors of this contribution propose that the new proposed PPS syntax element values are handled as offset values to the normalization values in the quantization derivation process.

Almost identical with 510/511. No need for presentation.

[JVET-Q0506](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9335) Interaction between ACT and cross-component coding tools [H. Zhang, X. Li, L. Li, G. Li, S. Liu (Tencent)]

This contribution reports the interactions between the Adaptive Color Transform (ACT) and JCCR. Specifically, there is an overlap between JCCR and ACT in terms of reducing the inter-component dependency among residuals. It is proposed to disable JCCR when the ACT is applied at CU/SPS level. Experimental results reportedly show that on 4:4:4 YUV and RGB sequences the BD-rate changes are as follows:

* YUV: AI (0.00%/0.01%/0.00%), RA (0.03%/0.03%/0.02%) for Y/Cb/Cr, respectively;
* RGB: AI (0.11%0.15%/0.08%), RA (0.19%/0.18%/0.04%) for G/B/R, respectively.

In addition, the encoder and decoder complexity reduction on RGB is also reported as 6%/2%, 5%/1% for encoding/decoding time under AI and RA configurations, respectively.

The second version of this document updated the quality data of sequence “Kimono1\_1920x1080\_24\_10bit\_444” that 600 frames have been encoded (instead of 300 frames in the data in first version) and increased the precision of encoding and decoding time.

See notes under JVET-Q0305

[JVET-Q0645](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9491) Crosscheck of JVET-Q0506: Interaction between ACT and cross-component coding tools [W. Zhu (Bytedance)] [late]

[JVET-Q0510](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9339) ACT color conversion for both lossless and lossy coding [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai), J. Zhao, Hendry, S. Paluri, S.-H. Kim (LGE), W. Zhu, J. Xu, L. Zhang (Bytedance)]

Adaptive colour transform (ACT) in the VVC draft 7 is not reversible so that it does not support lossless coding. This contribution proposes to enable the ACT mode in lossless coding by using reversible YCgCo colour transform (also known as YCgCo-R). To achieve one unified design, it is also proposed to use the YCgCo-R transform for lossy coding. Finally, instead of using fixed offset values, it is proposed to signal ACT QP offsets in bitstream. Additionally, the QP values of ACT coding blocks are clipped to the valid QP range. The proposed method provides coding performance improvement for lossless coding while maintaining similar results for CTC QP.

For lossless coding, comparing to the VTM-7.1 lossless anchors, the proposed scheme provides bitrate differences of -2.35% for AI, -4.86% for RA, and -6.04% for LD for RGB test sequences, average encoding and decoding runtime impacts are 102% and 100%.

A side benefit of enabling the ACT lossless coding is that transform skip (TS) mode is enabled for coding chroma components for the ACT. Comparing to VTM-7.1 lossy anchors, using YCgCo-R transform and enabling chroma TS together provides {G/Y, B/Cb, R/Cr} BD-rate differences of {-0.16%, -0.08%, -0.10%} for AI, {-0.02%, 0.01%, -0.09%} for RA, and {-0.29%,0.01%, -0.31%} for LD for RGB test sequences. Impacts on encoding and decoding runtime are negligible.

Without chroma TS, using YCgCo-R transform alone has almost no impact on coding performance in lossy coding. Specifically, comparing to VTM-7.1 lossy anchors, the coding performance impacts on RGB test sequences is {-0.01%, 0.03%, 0.00%} for AI, {0.05%, 0.06%, -0.06%} for RA and {0.01%%, 0.18%, -0.10%} for LD. Impacts on encoding and decoding runtime are negligible.

One aspect of the proposal is a modified ACT which would have benefit only for lossless RGB coding. The additional gain by invoking this ACT is 2.35% for AI, 4.86% for RA, 6% for LB. Looking only at camera captured content, the gain is lower, 0.56% for AI, 1.07% for RA/LB.

Are there relevant applications for RGB lossless of VVC? Not obvious.

No primary importance at this meeting. No interest by other experts except proponents (which are three companies).

For the other aspect, adaptive QP offsets for ACT, other proposals request for that:

* JVET-Q0166
* JVET-Q0425

[JVET-Q0699](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9545) Crosscheck of JVET-Q0510 (ACT color conversion for both lossless and lossy coding) [L. Li (Tencent)] [late]

[JVET-Q0737](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9583) Crosscheck of JVET-Q0510 (ACT color conversion for both lossless and lossy coding) [H. Huang (Qualcomm)] [late]

[JVET-Q0511](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9340) On ACT QP clipping [J. Zhao, Hendry, S.-H. Kim (LGE), X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai), W. Zhu, J. Xu, L. Zhang (Bytedance)]

In VVC draft 7, Adaptive Colour Transform (ACT) is used to reduce statistical redundancy among different colour components. Since ACT forward transform is not normalized, predefined ACT QP offsets are applied to compensate the dynamic range change between colour components. However, in the existing ACT design, the values of the modified QPs may go beyond the range of the allowed QP values.

To resolve such QP value overflow problem, this contribution proposes to clip the QP values that are applied to ACT coding units (CUs) to valid QP range. At low QPs, the proposed method reportedly provides {G, B, R} BD-rate differences of {-0.32%, -0.22%,-0.21%} in AI, {-0.1%,-0.03%,-0.02%} in RA and {-0.07%, -0.05%, -0.05%} in LDB, respectively, for RGB test sequences.

Contribution 0510 proposes signalling the ACT QP offset (as is the case in HEVC), and therefore it is suggested to also clip at the high end of QP (63)

[JVET-Q0620](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9466) Crosscheck of JVET-Q0511 (On ACT QP clipping) [T. Tsukuba (Sony)] [late]

[JVET-Q0512](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9341) Enabling transform skip and BDPCM for chroma in ACT [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai)]

At the 16th JVET meeting, adaptive color transform (ACT) was adopted into VVC draft 7 for removing the redundancy between three color components in 444 videos. At the same meeting, transform skip (TS) and block differential pulse coded modulation (BDPCM) were extended to coding chroma residuals. Due to separate adoptions, in VVC draft 7 and VTM-7.1 software, the interactions of the three tools are not properly handled. Specifically, though chroma TS mode is supported for the ACT mode in VVC draft 7, it is not checked for the ACT mode at VTM-7.1 encoder. Additionally, when the ACT is applied to one intra coding unit (CU), the BDPCM mode is always disabled for chroma components in both VVC draft 7 and VTM-7.1.

In this contribution, to improve the coding efficiency of 444 videos, changes are proposed to enable the TS and BDPCM modes for the chroma residual coding of the ACT mode. The simulations were conducted for RGB and YCbCr444 videos with CTC QPs and lower QPs. Compared to the VTM-7.1 ACT anchors, the average BD-rate impacts of the proposed changes are summarized as

With proposed encoder modification of enabling chroma TS for the ACT:

* Average {G, B, R} BD-rate differences {-0.13%, -0.11%, -0.07%}, {-0.06%, -0.11%, -0.06%} and {-0.34%, -0.17%, -0.15%} for AI, RA and LD, respectively, for RGB sequences.

With the method one of normatively enabling chroma BDPCM for the ACT:

* Average {G, B, R} BD-rate differences {-0.21%, -0.13%, -0.13%}, {-0.10%, -0.08%, -0.08%} and {-0.35%, -0.19%, -0.21%} for AI, RA and LD, respectively, for RGB sequences.

With the method two of normatively enabling chroma BDPCM for the ACT:

* Average {G, B, R} BD-rate differences {-0.25%, -0.21%, -0.20%}, {-0.14%, -0.10%, -0.09%} and {-0.38%, -0.17%, -0.24%} for AI, RA and LD, respectively, for RGB sequences.

Two variants are proposed:

* Method 1 is allowing chroma BDPCM for ACT blocks, and signalling it independently
* Method 2 is signalling chroma BDPCM in ACT blocks only if luma uses BDPCM

The dependency introduced in method 2 does not seem to have much benefit.

Method 1 seems to be slightly worse than method 2 of JVET-Q0353 (which inherits the BDPCM usage in chroma for luma in the ACT case)

Overall, all methods seem to give only small gain on screen content, not worthwhile to introduce much changes.

There are additional low QP results in the contribution with slightly better performance.

The contribution also shows that by an encoder modification (enabling TS with ACT blocks, but not enabling BDPCM) gives almost the same gain without increasing encoder runtime.

Decision(SW): Adopt JVET-Q0512, enable TS for ACT blocks by encoder decision (also CTC for 444)

[JVET-Q0661](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9507) Cross-check of JVET-Q0512: Enabling transform skip and BDPCM for chroma in ACT [J. Zhao (LGE)] [late]

[JVET-Q0513](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9342) AHG16: Clipping residual samples for ACT [X. Wang (Kwai)]

This contribution proposes to add one clipping to the input residual samples to inverse adaptive color transform (IACT) module at decoder such that the reconstructed residuals along the VVC decoding path do not exceed the dynamic range of 16-bit sign integers. Simulation results reportedly show that the proposed clipping operation has minor performance impact under common test condition (CTC).

Agreed that this is necessary

Decision(BF/text&SW): Adopt JVET-Q0513

[JVET-Q0796](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9642) Crosscheck of JVET-Q0513 (AHG16: Clipping residual samples for ACT) [T. Tsukuba (Sony)] [late]

[JVET-Q0521](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9350) Alignment of BDPCM for ACT [W. Zhu, L. Zhang, J. Xu (Bytedance), X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai), H. Jang, J. Nam, S.-H. Kim, J. Lim (LGE)]

The design of ACT assumes that the prediction of three-colour components follows the same process, which is not the case for BDPCM. This contribution proposes to align prediction process for BDPCM among three colour components for an ACT coded block. Simulation results are summarized as follows.

Overall bitrate saving on top of JVET-Q0510 under lossless test condition:

RGB: AI: -2.14%, RA: -1.18%, LDB: -1.12%

YUV: AI: 0.00%, RA: 0.00%, LDB: 0.00%

Overall BD bitrate on top of JVET-Q0510 saving under lossy test condition:

RGB: AI: -0.21%, RA: -0.15%, LDB: -0.10%

YUV: AI: 0.00%, RA:0.02%, LDB: -0.02%

This is proposing the method 2 of JVET-Q0353 as a joint company contribution.

[JVET-Q0584](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9430) Crosscheck of JVET-Q0521 (Alignment of BDPCM for ACT) [H. Dou, L. Xu, Y.-J. Chiu (Intel)] [late]

### Other chroma topics (10)

[JVET-Q0140](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8965) On chroma processing simplification [A. Filippov, V. Rufitskiy, E. Alshina (Huawei)]

This contribution proposes to simplify chroma processing in intra prediction by disabling padding. This proposal targets to improve implementation freedom of intra prediction process. As compared to the VTM- 7.0 software, the simulation results for this method reportedly show no BD-rate changes for AI, RA and LB configurations.

According to contributors, this is purely editorial and does not need presentation – up to editor to integrate in text

[JVET-Q0676](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9522) Crosscheck of JVET-Q0140 (On chroma processing simplification for intra prediction) [M. Ikeda (Sony)] [late]

[JVET-Q0351](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9176) Non-CE: Report on experimental result for fixing BDPCM Chroma mismatch [H. Jang, J. Nam, N. Park, S. Kim, J. Lim (LGE)]

This contribution reports the mismatch issues on BDPCM chroma and also inform the test result after aligning SW with the specification. The abovementioned mismatch issues on BDPCM chroma is occurred according to syntax signaling position and context. The test result shows 0.25%, 0.07 and 0.11% BD-rate saving for 4:4:4 contents in AI, RA and LDB respectively after aligning SW with VVC draft.

In the revision1, the LDB experimental result tables are updated.

The software mismatch in context part was already resolved by adoption of JVET-Q0110. There is another issue with syntax ordering reported in 0351 that is not covered in 0110.

Revisit: Proponents of 0110 and 0315 to confirm which is the better solution and who delivers the corrected software.

[JVET-Q0777](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9623) Crosscheck of JVET-Q0351 (Non-CE: Report on experimental result for fixing BDPCM Chroma mismatch) [J. Gan, C. Rosewarne (Canon)] [late]

[JVET-Q0361](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9186) Cleanup of chroma BDPCM constraint [W.-T. Cai, J.-Q. Zhu, K. Kazui (Fujitsu)]

This contribution proposes to use the chroma scaling factors (SubWidthC and SubHeightC) in the chroma BDPCM constraint check instead of just using the luma size as in the current Draft 7 in order to make it aligned with that performed on Palette. It is claimed that chroma BDPCM and PLT are only enabled for sequences in the 4:4:4 format and (SubWidthC, SubHeightC) equals (1, 1) in this case. Thus, it has no impact on coding gain.

Decision(BF/text): Adopt JVET-Q0361. It should be checked if that is already included in JVET-Q0504, and JVET-Q0089.

It is further noted that different from the proposed syntax in JVET-Q0361, the scaling by subwidth might not be applied in 7.3.9.5 when checking against MaxTSsize (as otherwise the maximum chroma transform size in 420 would be 64, which breaks the VPDU concept). Clarify offline – revisit.

[JVET-Q0408](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9233) On the combination of JCCR and TS [B. Ray, G. Van der Auwera, M. Karczewicz (Qualcomm)]

Current VTM software (VTM-7.0) does not perform encoder search of JCCR in combination with ChromaTS, as only DCT2 combination is checked for JCCR, although VVC WD allows this combination. This contribution proposes two ways to fix this: 1. enabling encoder search of JCCR in combination with ChromaTS (non-normative) 2. Disabling chromaTS and JCCR combination (normative). CTC results on YUV420 and YUV444 content, for both proposals, over VTM-7.0, are as follows. In version v2, the source code is attached.

Table1.a: CTC results (YUV420) – Proposal 1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Config. | Y | U | V | EncT | DecT |
| AI | 0.00% | -0.04% | -0.03% | 99% | 98% |
| RA | 0.00% | -0.05% | 0.02% | 99% | 98% |
| LD | -0.02% | -0.07% | -0.14% | 98% | 97% |

Table1.b: CTC results (YUV444) – Proposal 1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Config. | Y | U | V | EncT | DecT |
| AI | -0.11% | -0.17% | -0.19% | 100% | 101% |
| RA | -0.06% | -0.21% | -0.20% | 100% | 99% |
| LD | -0.13% | -0.27% | -0.20% | 99% | 99% |

Table2.a: CTC results (YUV420) – Proposal 2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Config. | Y | U | V | EncT | DecT |
| AI | 0.00% | 0.01% | 0.00% | 100% | 100% |
| RA | 0.00% | -0.04% | 0.03% | 100% | 101% |
| LD |  |  |  |  |  |

Table2.b: CTC results (YUV444) – Proposal 2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Config. | Y | U | V | EncT | DecT |
| AI | -0.01% | -0.01% | 0.00% | 100% | 100% |
| RA | -0.01% | 0.00% | 0.01% | 101% | 99% |
| LD | -0.07% | -0.18% | -0.04% | 100% | 101% |

Included in JVET-Q0695 – no need to discuss.

[JVET-Q0473](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9299) AHG15: Demultiplexing joint CbCr before dequantization [P. de Lagrange, F. Le Léannec, E. François, P. Bordes (InterDigital)]

It is proposed to move joint CbCr demultiplexing from after inverse transform to before dequantization, applying regular quantization control to each reconstructed chroma channel, so that most quantization control parameters specific to joint CbCr can be removed. This is said to simplify draft text and improve design consistency. BDRate difference using the CTCs in AI and RA is reported to be 0.00% and +0.01% respectively.

Question: Why is it a difference at all? Probably due to some rounding/clipping in dequant. Further, some optimizing encoders might want using separate quantization control to JCCR.

One drawback is that now two transforms need to be done all time.

Further study could potentially be interesting on solutions which provide an exact same result, regardless if the sign is applied before or after dequant.

No action at this point.

[JVET-Q0514](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9343) Encoder improvements on JCCR with chroma transform skip [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai)]

At the 16th JVET meeting, transform skip (TS) mode was extended to coding chroma residuals. In VVC draft 7, the syntax design allows the chroma TS mode to be jointly applied with the joint coding of chroma residuals (JCCR) mode. However, the rate-distortion (R-D) checking of the TS mode in VTM-7.0 is never performed when the chroma residuals of one coding unit (CU) are coded by the JCCR mode. In this contribution, one encoder implementation is provided to properly enable the chroma TS mode for the chroma residual coding of the JCCR mode in VTM-7.0. The simulations were conducted on YCbCr444 videos with CTC QPs and lower QPs. Compared to the VTM-7.0 anchors, the performance of the proposed encoder improvement is summarized as follows:

For the CTC QPs:

* Average {Y, Cb, Cr} BD-rate differences {-0.13%, -0.09%, -0.18%%}, {-0.11%, -0.09%, -0.13%} and {-0.10%, 0.00%, 0.09%%} for AI, RA and LDB, respectively.

For the lower QPs:

* Average {Y, Cb, Cr} BD-rate differences {-0.15%, -0.01%, -0.01%%}, {-0.41%, -0.23%, -0.23%} and {-0.36%, -0.22%, -0.21%%} for AI, RA and LDB, respectively.

In all the tests, the impacts of the proposed encoder modifications on both encoding and decoding time are negligible.

Included in JVET-Q0695 – no need to discuss.

[JVET-Q0581](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9427) Crosscheck report of JVET-Q0514 (AHG11: Encoder improvements for chroma transform skip mode) [X. Xu (Tencent)] [late]

[JVET-Q0515](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9344) Disabling chroma transform skip mode for ISP [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai)]

It is reported that with the adoption of chroma transform skip mode in VVC draft 7, the transform skip mode is treated differently for luma and chroma components in the intra sub-partition (ISP) mode. Specifically, for the ISP mode, the transform skip mode is always disabled for luma component but allowed for chroma components. In the current VVC, this is also the only prediction mode under which transform skip is enabled differently for different video components.

To make the design more consistent, this contribution proposes to disable the transform skip for both luma and chroma components when the ISP mode is applied. Simulation results reportedly show that for YCbCr444 videos, the proposed method has average {Y, Cb, Cr} BD-rate differences of {0.00%, 0.03%, 0.01%} and {-0.05%, -0.02%, 0.02%} for RA and LD configurations, when dual-tree is enabled. When dual-tree is disabled, the corresponding average {Y, Cb, Cr} BD-rate differences are {0.00%, 0.02%, 0.02%}, {-0.02%, 0.01%, 0.06%} and {-0.05%, 0.07%, 0.09%} for AI, RA and LD configurations, respectively.

Consistency my not be a strong argument, as ISP is not applied for chroma.

No obvious benefit – no action.

[JVET-Q0644](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9490) Crosscheck of JVET-Q0515: Disabling chroma transform skip mode for ISP [W. Zhu (Bytedance)] [late]

[JVET-Q0523](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9352) Redistribution of chroma information for improved HDR color representation [M. Azimi (U of Cambridge), M. T. Pourazad (TELUS), P. Nasiopoulos (UBC)]

We propose a chroma processing method that adds to the existing NCL YCbCr 4:2:0 and ICtCp color encoding to reduce their visible color errors for encoding HDR color pixels. We identify the colors that are represented with visible color shifts using 10-bit YCbCr 4:2:0 and ICtCp 4:2:0 in terms of CIE DE2000 and DEITP. We then redistribute code-words for their chroma channels using a non-linear function such that those colors that bear larger color differences due to bit-depth quantization are given more code-words. The quantized new YCb\*Cr\* and ICt\*Cp\* (the star script to differentiate them from their originals) signals are then compressed with VTM xxx to evaluate the compression efficiency of the proposed method.

Contribution for information

The proposed mapping function is optimized for DE2000, could perhaps be approximated with existing piecewise linear mapping functions

BD gain based on DE2000 is in the range of 60-70% average; on the other hand, other metrics like luma PSNR suggest losses, which is probably due to the fact that more bit rate is spent for chroma.

No action – for further study.

[JVET-Q0695](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9541) Combined encoder improvements of JVET-Q0101/JVET-Q0408/JVET-Q0514 on JCCR with chroma transform skip [X. Ma, H.-J. Jhu, X. Wang (Kwai), B.Karczewicz (Qualcomm), [T. Tsukuba](mailto:Takeshi.Tsukuba@sony.com), M. Ikeda, Y. Suzuki (Sony)] [late]

Was presented in context of transform proposals Fri 10 Jan 1250.

In VVC draft 7, the syntax design allows the chroma transform skip (TS) mode to be jointly applied with the joint coding of chroma residuals (JCCR) mode. However, in VTM-7.0, the rate-distortion (R-D) checking of the TS mode is not performed when the chroma residuals are coded with the JCCR mode. In this contribution, one encoder implementation is provided to properly enable the JCCR mode in combination with the chroma TS, based on the encoder speed-up logics that were independently proposed in JVET-Q0101, JVET-Q0408 and JVET-Q0514.

Compared to the VTM-7.0 anchors of YCbCr444 videos, the proposed encoder improvement provides average {Y, Cb, Cr} BD-rate differences {x.xx%, x.xx%, x.xx %}, { -0.14%, -0.19%, -0.23%} and { x.xx%, x.xx%, x.xx%} for AI, RA and LDB, respectively. The impacts of the proposed encoder modifications on both encoding and decoding time are negligible.

Decision(SW): Adopt the software to VTM8 SW, also CTC.

[JVET-Q0750](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9596) Crosscheck of JVET-Q0695 (Combined encoder improvements of JVET-Q0101/JVET-Q0408/JVET-Q0514 on JCCR with chroma transform skip) [C. Helmrich, H. Schwarz (HHI)] [late]

[JVET-Q0771](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9617) Crosscheck of JVET-Q0695 (Combined encoder improvements of JVET-Q0101/JVET-Q0408/JVET-Q0514 on JCCR with chroma transform skip): YUV444 DualTree ON [J. Zhao (LGE)] [late]

## Lossless and near lossless coding (2)

Contributions in this category were discussed Thursday 9 Jan. 1630–XXXX in Track B (chaired by JRO). Merge this with 6.13 which is somehow related.

[JVET-Q0387](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9212) AHG14: Throughput and coding efficiency report of JVET-P0300 on VTM-7.0 [H. Kirchhoffer, B. Bross, T. Nguyen, D. Marpe, H. Schwarz, T. Wiegand (HHI)]

This contribution evaluates the throughput and coding efficiency of the high throughput CABAC mode proposed in JVET-P0300 based on VTM-7.0. The method was implemented into the throughput evaluation testbed of JVET-L1025 (CE5 subtest 2) in order to evaluate the coding engine outside of VTM-7.0. In this testbed, the coding engine of JVET-P0300 increases the throughput by approximately 70 to 100% compared to the VTM-7.0 engine. For three generalized bypass probability values (1/4, 1/8, and 1/16) and QPs 2-17, the BD-rates of the VTM-7.0-based implementation are 4.55% for AI, 5.22% for RA, 4.53% for LB, and 4.66% for LP. The corresponding throughput of the decoder (in mbit per second) is increased by 20% for AI, 18% for RA, 16% for LB, and 18% for LP.

Throughput of CABAC engine in current VVC is worse than HEVC, due to the modified CABAC engine.

It has also to be considered that the rate increases by the high-throughput method, which makes the throughput lower again.

It is further mentioned that throughput is not only dependent on the core engine, but also the context derivation has to be taken into account.

Also, it is mentioned that the gain of VVC over HEVC is significantly lower in the low QP range – so a loss of 5% may already be very significant there.

Questions raised:

- would a second entropy coding be desirable?

- if yes, what should be the advantage in terms of throughput?

- could some of these problems be resolved by parallelism, e.g. tiles?

- what are the use cases, and would VVC be competitive with HEVC at all for these cases?

Throughput is also highly dependent on hardware architecture.

Further study – requirements need to be clarified. Probably nothing for V1.

[JVET-Q0347](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9172) CE3 related: Fixed Rice parameters in transform residual coding [Y. Chen, F. Le Léannec, F. Galpin, T. Poirier (InterDigital)]

This contribution proposes to replace per-sample adaptive codeword derivation based on the levels of the bottom and right neighboring residual samples with a fixed codeword in transform residual coding. It is proposed to use a fixed rice parameter=0 for the syntax element abs\_remainder, and a fixed rice parameter=1 for the syntax element dec\_abs\_level.

The results of using fixed rice parameters show BD-rate change of 0.07% AI, 0.06% RA and 0.00% LB over VTM-7.0 for common test conditions.

No need for action for VVC1. In particular at low QP, the loss by using fixed Rice parameter is too large, it would probably for lossless coding revert some of the gain achieved in CE3.

More study is necessary, a) where are throughput problems in VCC, b) which are the applications that require high throughput, and c) is VVC or an extension of it attractive for such applications (in particular, in comparison against HEVC).

[JVET-Q0752](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9598) Crosscheck of JVET-Q0347 (CE3-related: Fixed rice parameters in transform residual coding) [H. Kirchhoffer (HHI)] [late]

## Screen content coding tools (4)

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

[JVET-Q0571](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9417) IBC-Mirror mode for screen content coding [J. Cao, Z. Qiu, J. Wang, F. Liang (SYSU), Y. Yu, Y. Liu (OPPO)] [late]

[JVET-Q0573](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9419) Intra-Affine mode for screen content coding [J. Cao, H. Wang, J. Wang, F. Liang (SYSU), Y. Yu, Y. Liu (OPPO)] [late]

## 360 degree video (0)

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

## AHG9: General high-level syntax (135)

### Combinations of features (21) - BoG

#### Combination of RPR and subpictures (7)

[JVET-Q0594](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9440) AHG9: A summary of proposals on combination of RPR and subpictures [Y.-K. Wang (Bytedance)] [late]

[JVET-Q0043](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8868) AHG9: Constraint about usage of reference picture resampling and subpictures [T. Nishi, K. Abe, V. Drugeon (Panasonic)]

[JVET-Q0232](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9057) AHG8/AHG12 Subpicture-based reference picture resampling signalling [M. Hirabayashi, M. Katsumata, T. Suzuki (Sony)]

[JVET-Q0236](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9061) AHG8/AHG12: Subpicture-specific RPR [M. M. Hannuksela, A. Aminlou, R. Ghaznavi-Youvalari, K. Kammachi-Sreedhar (Nokia)]

[JVET-Q0290](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9115) AHG9/AHG12: Modifications related to subpicture signalling and RPR [S.-T. Hsiang, C.-Y. Chen, T.-D. Chuang, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

Item 2 of this contribution belongs to this category.

[JVET-Q0331](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9156) AhG8: Constraints on the picture scaling ratios [Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Item 2 of this contribution belongs to this category.

[JVET-Q0333](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9158) AhG12: On the subpicture scaling ratios [Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-Q0334](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9159) AhG8/AhG12: On the reference picture resampling for the subpictures [Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

#### Combination of RPR and reference wraparound (8)

[JVET-Q0595](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9441) AHG9: A summary of proposals on combination of RPR and reference wraparound [Y.-K. Wang (Bytedance)] [late]

[JVET-Q0134](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8959) AHG8: Disabling reference wraparound for reference picture resampling [B. Heng, P. Chen, T. Hellman, W. Wan, M. Zhou (Broadcom)]

[JVET-Q0184](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9009) AHG9: On signalling of wrap-around motion compensation [C.-Y. Chiu, C.-C. Chen, C.-W. Hsu, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0238](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9063) AHG8/AHG9: On reference picture wraparound [M. M. Hannuksela (Nokia)]

[JVET-Q0316](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9141) AHG9: On signaling of the wraparound offset [K. Zhang, L. Zhang, Y.-K. Wang, H. Liu, J. Xu, Z. Deng (Bytedance)]

[JVET-Q0287](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9112) AHG9: On wrap-around motion compensation [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-Q0335](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9160) AhG9: On the wraparound offsets [Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Items 1 and 2 of this contribution belong to this category.

[JVET-Q0416](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9241) AHG8/AHG9: On horizontal wrap-around motion compensation [J. Chen, Y. Ye, R.-L Liao, J. Luo (Alibaba)]

Item 2 of this contribution belongs to this category.

[JVET-Q0764](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9610) AHG9: Text for combination of wrap around offset and RPR [B. Choi, S. Wenger, S. Liu (Tencent), B. Heng, P. Chen, T. Hellman, W. Wan, M. Zhou (Broadcom), M. M. Hannuksela (Nokia), Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)] [late]

#### Combination of subpictures and reference wraparound (4)

[JVET-Q0212](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9037) [AHG9/AHG12] On sub-picture wrap around signaling [Y. He, A. Hamza (InterDigital), B. Choi, S. Wenger (Tencent)]

[JVET-Q0335](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9160) AhG9: On the wraparound offsets [Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Item 3 of this contribution belongs to this category.

[JVET-Q0344](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9169) AHG6/AHG9: Signalling wrap-around for subpictures [Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek)]

[JVET-Q0403](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9228) AHG12: On subpicture specific MV wraparound [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

#### Combination of subpictures and scalability (3)

[JVET-Q0279](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9104) AHG8/AHG9: On alignment across layers [B. Choi, S. Wenger, S. Liu (Tencent)]

Item 4 of this contribution belongs to this category.

[JVET-Q0402](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9227) AHG12: On subpicture and scalability [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

[JVET-Q0405](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9230) AHG12: On subpicture and OLS [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

### High level tool control (12) - BoG

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

Note: Probably more contributions belong here which are allocated to AHGs 8/9/12.

Add mention in relevant other agenda categories.

[JVET-Q0121](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8946) AHG9: On deblocking control parameters [J. Xu, Y.-K. Wang, L. Zhang, W. Zhu, K. Zhang, H. Liu (Bytedance)]

The aspect of section 2.3 of the document (beta and tc offset) was discussed in track B Fri 10 Jan, 1200. The following was agreed: The abs range of the two parameters should be extended from 6 to 12, whereever they are.

Decision: Adopt this aspect of JVET-Q0121: Extend abs range of beta offset and tc offset from 6 to 12, PPS and SH as proposed, but also in PH.

Other low level changes suggested in this proposal shall not be considered.

Revisit: Proponents shall provide a specification text.

[JVET-Q0175](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9000) AHG9: On parameters override mechanism in slice header for in-loop filters [C.-M. Tsai, C.-W. Hsu, C.-Y. Lai, O. Chubach, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0248](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9073) AHG9: On constraints for ALF APS [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-Q0254](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9079) [AHG9]: Override mechanism for ALF related syntax elements in slice header [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)]

[JVET-Q0352](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9177) AHG9/AHG12: On subpicture boundary [H. Jang, J. Nam, N. Park, S. Kim, J. Lim (LGE)]

Items 2 and 3 of this contribution belongs to this category.

[JVET-Q0336](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9161) AhG9: Cleanup in high level syntax [Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[Move to 6.19.5] Which features are affected by this?

[JVET-Q0346](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9171) AHG9: On slice header control for LMCS and scaling lists [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

[JVET-Q0360](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9185) AHG9: Slice level control of coding tools for DMVR, BDOF and PROF [S. Esenlik, A. M. Kotra, H. Gao, B. Wang, A. Filippov, V. Rufitskiy, E. Alshina (Huawei)]

[JVET-Q0444](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9270) Non-CE: Clean-up of High-Level Syntax Related to AMVR [K. Naser, M. Kerdranvat, T. Poirier, A. Robert, F. Galpin, F. Le Léannec (InterDigital)]

[JVET-Q0484](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9311) AHG9: HLS control of chroma QP offset [W. Wan, B. Heng, P. Chen, T. Hellman, M. Zhou (Broadcom)]

[JVET-Q0572](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9418) AHG9: On ALF Signalling [K. Misra, S. Deshpande, A. Segall (Sharp)] [late]

[JVET-Q0766](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9612) [AHG9]: Override mechanism for SAO and ALF syntax elements (Combination of JVET-Q0175 and JVET-Q0254) [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei), C.-M. Tsai, C.-W. Hsu, C.-Y. Lai, O. Chubach, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)] [late]

### Misc. general HLS topics (7)

Friday 10 Jan 2010 (GJS)

[JVET-Q0113](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8938) AHG9/AHG8/AHG12: Some general HLS syntax clean-ups [Y.-K. Wang (Bytedance)]

Item 1 of this contribution belongs to this category.

Currently the variable NoIncorrectPicOutputFlag is sometimes used as associated with an AU and sometimes as associated with a picture.

It is proposed to consistently specify and use NoIncorrectPicOutputFlag as associated with a picture.

This seemed to basically be an editorial bug fix without change of technical intent.

It was commented that Q0278 is a slightly different approach to resolve the same issue. The contributor of Q0278 was satisfied by the approach taken in Q0113. The editors can consider how best to express the concepts in the text.

It was commented that the name of the flag may not be the best choice.

Decision (Ed.): Adopt as input to the editors. The editors should also consider renaming the flag. (Editor has discretion over the precise outcome.)

[JVET-Q0278](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9103) AHG9/AHG8: On random access related flags [B. Choi, S. Wenger, S. Liu (Tencent)]

See the notes for Q0113.

[JVET-Q0114](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8939) AHG9: A few more general constraints flags [Y.-K. Wang (Bytedance)]

This contribution proposes the following regarding general constraint flags:

* Remove frame\_only\_constraint\_flag, which is redundant to general\_frame\_only\_constraint\_flag.
* Add a general constraint on no tile partitioning (i.e., one tile only for each picture).
* Add a general constraint on no slice partitioning (i.e., one slice only for each picture).
* Add a general constraint on no subpicture partitioning (i.e., one subpicture only for each picture).
* Add a general constraint on no reference picture resampling.
* Add general\_non\_projected\_constraint\_flag, the value equal to 1 specifies that there is no omnidirectional projection SEI messages, and change the semantics of general\_non\_packed\_constraint\_flag to cover only frame packing, as frame packing and no omnidirectional projection can be independently applied.

It was asked whether constraints should be on the result expressed by syntax (e.g., one tile) or on the way that result is expressed in the syntax (e.g., there are several different ways that the syntax may result in only having one tile). That can be a matter for further study.

Decision (cleanup): Adopt. Text in contribution. Proponent resp. for software.

[JVET-Q0256](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9081) AHG9: Temporal sublayer level indication and conformance [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

This contribution contains a proposal regarding support for decoding temporal subsets in VVC decoders. The contribution also contains a proposal for a new NAL unit type used to indicate the highest temporal layer that is present in the CLVS. It is asserted that mandating presence of the proposed NAL unit in the first access unit of the CLVS would make it clear for a decoder to up front determine if it is capable of decoding a bitstream or not.

Considering sublayer representations,

* Shall a level 5.1 decoder be required to be able to extract and decode a level 5.1 sublayer representation from a level 5.2. bitstream?
* If a level 5.1 sublayer representation has been extracted from level 5.2 bitstream, shall a level 5.1 decoder be required to be able to decode it (even though general\_level\_idc indicates level 5.2)?

It was commented that the idea of profile/level expression in terms of sublayer representation could imply a need for the decoder to have an interface that is capable of determining which sublayer representation to decode.

The contribution proposed to define a temporal sublayer indication NAL unit type that would indicate the highest temporal ID in the bitstream.

A decoder could alternatively have some application interface through which to get an indication of what is the highest temporal ID.

It was agreed that extraction from a larger bitstream should not be a required functionality of a decoder. The extract process conceptually occurs before the bitstream is input to the decoder.

It was discussed whether rewriting of the general\_level\_idc might be necessary before feeding the bitstream to the decoder.

It was commented that the profile-tier-level information is really not necessary to the decoding process and perhaps shouldn’t even be in the bitstream.

Decision (Ed. BF): It was agreed that the language “sublayer representation” should be removed from the language as proposed. Also “identified by a specific value of general\_level\_idc” (and similar tier language) should be removed from the description of a decoder.

A suggestion was to have some optional capability described, in the spirit of INBLD.

[Stopped here 2145 Friday.]

Further discussed 0800 Saturday

One possible wording was suggested as follows:

Decoders conforming to the Main 10 profile at a specific level (~~identified by a specific value of general\_level\_idc~~) of a specific tier (~~identified by a specific value of general\_tier\_flag~~) shall be capable of decoding all bitstreams ~~and sublayer representations~~ for which all of the following conditions apply:

* The bitstream is indicated to conform to the Main 10 profile.
* The bitstream ~~or sublayer representation~~ is indicated by the value of Min( general\_level\_idc, sublayer\_level\_idc[ Htid ] ) to conform to a level that is not level 8.5 and is lower than or equal to the specified level.

Note that last two paragraphs of clause 8.1.1 are as follows (in the existing draft text):

The variables TargetOlsIdx, which identifies the OLS index of the target OLS to be decoded, and the variable Htid, which identifies the highest temporal sublayer to be decoded, are set by some external means not specified in this Specification. The bitstream BitstreamToDecode does not contain any other layers than those included in the target OLS and does not include any NAL unit with TemporalId greater than Htid.

Clause 8.1.2 is repeatedly invoked for each coded picture in BitstreamToDecode in decoding order.

Suggestion: State that:

* Decoders are not required to extract a subset of the bitstream; any such extraction process that may be a part of the system is considered to be outside of the scope of the decoding process.
* The profile of the bitstream is indicated by general\_profile\_idc
* The level of the bitstream is indicated by Min( general\_level\_idc, sublayer\_level\_idc[ Htid ].
* The values of Htid and sublayer\_level\_idc[ Htid ] are not necessary for the operation of the decoding process, and if it is desirable for the decoder to check the conformance of the bitstream, these may be provided by external means.

Decision (Ed.): Add these statements.

The prosed additional NAL units were discussed, including how many of these would need to be in the bitstream and where they would need to be found and what an extractor/rewriter would need to do with thim. Their presence is proposed to be mandatory at the start of each CVS. They would need to be present for every sublayer. In the discussion, it was suggested to consider making them optional or making a provision for the information to alternatively be provided by external means.

One participant expressed interest in this idea. Another participant pointed out that this is not needed by the decoder and said it seems too complicated to introduce, especially at this stage. No action was taken on this.

Revisit after additional offline study for discussion of related issues.

[JVET-Q0276](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9101) AHG9: On EOB NAL unit out of band [S. Wenger, B. Choi (Tencent)]

Discussed Sat 0900 GJS

The contribution proposes a) the option to receive the End of Bitstream (EOB-) NAL unit out of band, b) when receiving the EOB NAL unit out of band to cease decoding (by ignoring incoming NAL units) and start decoding only with a well-formed new bitstream. It is argued that such language is required for certain application scenarios.

The contribution proposes to add a statement that says “If an end of bitstream NAL unit becomes available, the decoder shall ignore all future NAL units up to the beginning of a new video bitstream.”

It was commented that the spec is written such that anything in a channel after the EOB is outside the scope of our standard; such data is part of a system rather than part of our bitstream. The bitstream has ended and there is no additional data, as far as our standard is concerned. There are no future NAL units in the bitstream.

It was further commented that multibitstream handling may be a practical need of system design but is outside the “spec domain” of the video coding standard.

No action was taken on this.

[JVET-Q0282](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9107) AHG9: On temporal sublayer switching [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

Discussed Track A Sat 0930 GJS

To guarantee the presence of the referenced PPS/APS NAL unit with TemporalId greater than 0 in the bitstream after temporal up-switching, the following constraint is proposed:

When a non-VCL NAL unit with nal\_unit\_type equal to PPS\_NUT, PREFIX\_APS\_NUT, or SUFFIX\_APS\_NUT and TemporalId equal to k (k is greater than 0) referred to by a VCL NAL unit with TemporalId equal to k is included in an AU, the non-VCL NAL unit shall be included in an AU with TemporalId equal to k between the nearest STSA prior to the VCL NAL unit in decoding order and the VCL NAL unit referring to the non-VCL NAL unit inclusive, or included in an AU with TemporalId less than k prior to the VCL NAL unit in decoding order.

It was commented that JVET-P0359 of the previous meeting was similar and that there is an SEI message (the referenced parameter sets SEI message) that is sufficient to indicate that such constraints are applied.

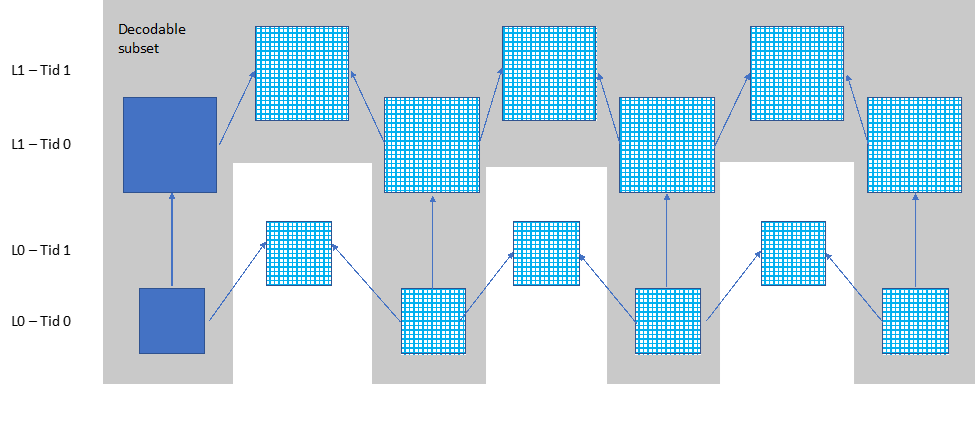
It was further commented that there are quite a few other aspects of random access that are not guaranteed – e.g., PSs are not even required at IDR pictures of the base layer (unless indicated by an SEI message or required by some systems specification); such constraints may be imposed elsewhere. No action was thus taken.

[JVET-Q0398](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9223) AHG9: Sublayer wise dependency in multi-layer [Y. Sanchez, R. Skupin, K. Sühring, T. Schierl (HHI)]

Discussed Track A Sat 0940 GJS

The layer dependency signalling in VVC cannot express coding structures with independent sublayers in higher layer, albeit such coding structures can be beneficial to lower level requirements. Some example operation points are described.

The contribution proposes to extend the dependency signalling with a sublayer specific indication that allows to identify the independent sublayers. Modifications to OLS and extraction process are proposed to benefit from the lower codec level requirements by dropping the lower layer sublayer pictures that are not used for reference and not output.



Example of a bitstream with two layers with the highest sub-layer in layer 1 being independent of layer 0

The proposal is to add some syntax elements to the VPS, to indicate layer dependency at sublayer granularity.

|  |  |
| --- | --- |
| […] |  |
| **vps\_independent\_layer\_flag**[ i ] | u(1) |
| if( !vps\_independent\_layer\_flag[ i ] ) |  |
| for( j = 0; j < i; j++ ) |  |
| **vps\_direct\_ref\_layer\_flag**[ i ][ j ] | u(1) |
| **vps\_sublayer\_dependency\_info\_present\_flag**[ i ] | u(1) |
| if( vps\_sublayer\_dependency\_info\_present\_flag[ i ] ) |  |
| for( j = 0; j <= max\_sublayers\_minus1; j++ ) |  |
| **vps\_sublayer\_independent\_flag**[ i ][ j ] | u(1) |
| } |  |
| } |  |
| […] |  |

This affects the extraction process.

It was commented that there was something in HEVC called max\_tid\_il\_ref\_pics\_plus1 that is similar. That one included an ability to indicate an IRAP-only dependency. It was said that HEVC does not take this into account during the extraction process. Unlike in HEVC, the PTL information in VVC is for the entire OLS.

Support was expressed for the concept, but to also account for the special case of IRAP-only dependency by using the max\_tid\_il\_ref\_pics\_plus1 syntax approach.

Decision (cleanup): Adopt, using the max\_tid\_il\_ref\_pics\_plus1 syntax approach. Revisit for text review.

### Parameter sets cleanups (20) - BoG

[JVET-Q0593](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9439) AHG9: A summary of proposals on parameter sets cleanups [Y.-K. Wang (Bytedance)] [late]

[JVET-Q0045](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8870) AHG9: On DPS identifier [V. Drugeon (Panasonic)]

[JVET-Q0117](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8942) AHG9: Cleanups on parameter sets [Y.-K. Wang, J. Xu (Bytedance)]

[JVET-Q0280](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9105) AHG8/AHG9: On video parameter set ID [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-Q0355](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9180) AHG8/AHG9: Cleanup on multi-layer coding [X. Ma, H. Yang (Huawei)]

Item 3 of this contribution belongs to this category.

[JVET-Q0357](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9182) AHG9: On clarification of DPS [X. Ma, H. Yang (Huawei)]

[JVET-Q0147](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8972) AHG9: On JCCR signaling [K. Abe, T. Toma (Panasonic)]

[JVET-Q0152](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8977) AHG9/AHG12: Miscellaneous HLS topics [M. Coban, V. Seregin, Y.-J. Chang, M. Karczewicz (Qualcomm)]

Item 2 of this contribution belongs to this category.

[JVET-Q0155](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8980) AHG9: On separate colour plane coding [V. Seregin, B. Ray, A. K. Ramasubramonian, Y.-J. Chang, M. Coban, G. Van der Auwera, M. Karczewicz (Qualcomm)]

Item 2 of this contribution belongs to this category.

[JVET-Q0265](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9090) Modifications to VVC Draft 7 [C. Auyeung, X. Li, X. Zhao, S. Liu (Tencent)]

[JVET-Q0329](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9154) AHG9: Syntax cleanup of chroma coding tools in 444 color format [R.-L. Liao, J. Chen, Y. Ye, J. Luo (Alibaba)]

[JVET-Q0520](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9349) AHG9: Cleanups on signalling for CC-ALF, BDPCM, ACT and Palette [Y. Wang, L. Zhang, K. Zhang, W. Zhu (Bytedance)]

Item 3 of this contribution belongs to this category.

[JVET-Q0173](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8998) AHG9: On signalling the DPB parameters with delta values [C.-Y. Lai, C.-M. Tsai, T.-D. Chuang, O. Chubach, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0176](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9001) AHG9: Overhead reduction for picture header [S.-T. Hsiang, Y.-W. Huang, S.-M. Lei (MediaTek)]

Item 2 of this contribution belongs to this category.

[JVET-Q0210](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9035) [AHG9]: Miscellaneous HLS clean-ups [Hendry, S. Paluri (LGE)]

Items 8 and 9 of this contribution belong to this category.

[JVET-Q0285](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9110) AHG9: On adaptation parameter set ID [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

Item 2 of this contribution belongs to this category.

[JVET-Q0374](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9199) AHG9: Cleanups on redundant signalling in HLS [D. Kim, G. Ko, J. Jung, J. Son, J. Kwak (WILUS)]

[JVET-Q0399](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9224) AHG8: On conformance window and scaling window [Y. Sanchez, R. Skupin, K. Sühring, T. Schierl (HHI)]

[JVET-Q0416](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9241) AHG8/AHG9: On horizontal wrap-around motion compensation [J. Chen, Y. Ye, R.-L Liao, J. Luo (Alibaba)]

Item 1 of this contribution belongs to this category.

[JVET-Q0420](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9245) AHG12: Signaling of chroma presence in PPS and APS [L. Li, X. Li, C. Auyeung, B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-Q0481](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9308) AHG9: Ordering of partition constraints syntax elements in the sequence parameter set and picture header [W. Wan, B. Heng (Broadcom)]

The SPS aspect of this contribution belongs to this category.

### Constant slice header parameters signalling (4)

Contributions in this category were discussed in Track A Friday 10 January 2020 at 1800 (chaired by GJS).

[JVET-Q0482](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9309) AHG9: Signalling of constant parameter values [W. Wan, P. Chen, [B. Heng](mailto:brian.heng@broadcom.com), [T. Hellman](mailto:tim.hellman@broadcom.com), [M. Zhou (Broadcom)](mailto:minhua.zhou@broadcom.com)]

This contribution contends that, with the adoption of the picture header structure at the October 2019 meeting in Geneva, the need for signalling constant parameter values in the PPS should be revisited. The original motivation behind the adoption of this concept was to avoid sending redundant slice header parameters that stay constant for one or more complete pictures. This concept was reported to be especially bandwidth efficient for configurations with many slices, with one example bein a 24 slice OMAF example. This contribution asserts that, since parameters can now be signalled in the picture header, the overhead and benefit of signalling fixed values in the PPS would be minimal even for configurations with a large number of slices.

Decision (PH cleanup): Adopt (merged with other decisions for the individual controlled syntax elements).

Q0259 aspect 5 affects the details of collocated picture signalling.

Revisit for plenary Noticed off-topic syntax bugs/inconsistencies:

* It was noted that dependent quantization can only be switched off at the PH level, whereas most coding tools can be disabled at a higher level. Suggestion:
  + Have an SPS enable flag for dependent quantization; if disabled, no presence of control flag at PH level. The general constraint flag should constrain the SPS-level flag.
  + And do the same thing for sign data hiding.
* It was asked why the number of merge candidates isn’t indicated at a higher level (SPS). This involves four syntax elements – one for regular mode and one for triangle (geometry), one for IBC and one for subblock. They should be handled consistently, at the same syntax level. It was agreed (Saturday in Track A CE4 related discussion) that as far as the triangle/geometry control perspective is concerned, SPS level control over the number of merge candidates seemed sufficient. As far as Track A was concerned, establishing the max number of merge candidates for all of these at the SPS level without lower-level control seemed sufficient.

[JVET-Q0153](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8978) AHG9: On picture header [M. Coban, V. Seregin, Y.-J. Chang, M. Karczewicz (Qualcomm)]

Item 3 of this contribution belongs to this category.

This item proposes to remove pps\_collocated\_from\_l0\_idc syntax element from constant\_slice\_header\_params signalling in PPS.

Resolved by actions taken on Q0259 and Q0482.

[JVET-Q0419](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9244) AHG 9: On picture header [L. Li, B. Choi, X. Xu, X. Li, S. Wenger, S. Liu (Tencent)]

Item 3 of this contribution belongs to this category.

Resolved by actions taken on Q0259 and Q0482.

[JVET-Q0240](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9065) AHG9: Additional constant slice header parameters [M. M. Hannuksela (Nokia)]

This contribution proposes signalling of patterns of reference picture list indices and slice QP delta values in the constant slice header parameters of PPS

It is observed that the common test conditions result into the use of periodic patterns for reference picture list indices and slice QP delta values. It is therefore proposed to include the signalling of reference picture list indices and slice QP delta values in the constant slice header parameters of PPS. A pattern of reference picture list indices and slice QP delta values is included in the PPS. The correct entry within the pattern is selected for decoding based on the POC correspondence between an entry in the pattern and the current picture.

The table below provides an *estimated* rate-distortion performance for the random access common test conditions:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Random access | | |
|  | Over VTM-7.0 | | |
|  | Y | U | V |
| Class A1 | -0.06 % | -0.06 % | -0.06 % |
| Class A2 | -0.05 % | -0.05 % | -0.05 % |
| Class B | -0.25 % | -0.26 % | -0.26 % |
| Class C | -0.56 % | -0.56 % | -0.55 % |
| Class E |  |  |  |
| Overall | -0.26 % | -0.26 % | -0.25 % |
| Class D | -1.60 % | -1.60 % | -1.61 % |
| Class F | -0.94 % | -0.94 % | -0.94 % |

A substantial amount of syntax and semantics is proposed to be added to specify patterns that would be selected by the decoding process.

It was remarked that QP pattern signalling aspect may not apply to real-world encoders. It was remarked that roughly 60% of the estimated gain comes from that.

Some participants commented that the results seemed questionable, based on personal experience with how much data is ordinarily sent for the RPL syntax. The results were estimates, and not cross-verified.

It was remarked that this seems too immature and too complicated to try to bring into the design at this point in the process, even if the results might end up being confirmed. No action was therefore taken on this.

### Picture header, slice header, and AUD (28)

[JVET-Q0684](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9530) AHG9: A summary of HLS contributions on picture header, slice header, and access unit delimiter [Hendry (LGE)] [late]

3pm thurs 9 Jan (GJS)

*On PH properties*

1. Do we allow PH repetition?
   1. No. Keep the current design that does not allow PH repetition within a picture

JVET-Q0115 aspect 1 & 2: No PH repetition within a picture; consequently remove AUD.

* 1. Yes. Allow PH repetition (JVET-Q0177):
* Signal POC LSB in PH to identify it in temporal domain. – deferred to discussion below.
* Differentiate PH that is repeated. To do this, the following flags may be present: sps\_ph\_repetition\_enabled\_flag in SPS; ph\_repetition\_present\_flag in PH.

AUD is currently optional, and PH is required. If there are multiple layers in an AU, detection of the AU boundary may involve checking the layer ID.

It was discussed whether we care about PH for the purpose of loss resilience.

It was commented that the PH was created for bit efficiency reasons, while the AUD is for AU boundary detection. They appear at different locations in the NAL unit stream – e.g., a common sequence of NAL units would be AUD, SPS, PPS, SEI, APS, PH, Slice, … Since AUD is optional anyway, we don’t have a clear need to remove it.

It was asked, if we allow PH repetition, why we wouldn’t just have a flag in the PH that identifies whether the current PH is a repeated one or is the first one?

PH repetition could also be inside an SEI message. Such an SEI message would not need to be defined in v1 of the standard.

The motivation for PH repetition would be partial-picture decoding when there are lost NAL units in a picture.

No action was taken on the repetition question, so repetition remains prohibited.

1. Where to signal PH. Currently PH is signalled in a NAL unit, 1 PH NAL unit is mandatory for a coded picture. Is it allowed that PH syntax structure is contained in a slice VCL NAL unit (JVET-Q0255, JVET-Q0419, JVET-Q0426)?
   1. If Yes, how the VCL NAL unit carry the PH syntax structure?

* Option 1 (JVET-Q0255): Specify a new NAL unit type Coded Picture. Coded Picture NAL unit contains a syntax element pic\_type, a PH syntax structure, an SH syntax structure, and a slice data syntax.
* Option 2 (JVET-Q0419 aspect #1): In slice layer RBSP, signal ph\_present\_flag. If this flag is equal to 1, signal PH syntax structure in the slice VCL NAL unit.
* Option 3 (JVET-Q0426): The following is proposed:
* Signal sps\_picture\_header\_enabled\_flag. When this flag is equal to 0, PH is not in PH NAL unit; syntax elements in PH are present in SH (which can be put in separate common syntax structure).
* When sps\_picture\_header\_enabled\_flag is equal to 0, signal first\_vcl\_nal\_unit\_in\_picture\_flag in SH. It is recommended that sps\_picture\_header\_enabled\_flag is equal to 1 for bitstream that may be extracted / merged.

JVET-Q0426 was revised; in the new version, there would always be a flag in the SH for whether a PH NAL unit present for the picture or not. If not, that syntax is in the SH (of every slice in the picture). There might be a restriction that this could only happen when there is only one slice in the picture.

Option 1 would change the function of the NAL unit type, such that properties such as IRAP indication would not be indicated by the NAL unit type.

Options 2 and 3 are rather similar in concept.

It was commented that when we measure CTC results, the BD rates include start code overhead.

It was commented that for the LB case, with one of the 720p test sequences in the CTC (“Johnny”), this could have a BD impact of 1.4%.

We can’t remove the whole idea of allowing a PH to be a separate NAL unit, since that is needed for BEAM.

A suggested minimum approach:

* There was discussion of limiting the combined slice header to a special case for when there is only one slice per picture without subpicture support.
  + There could be an SPS flag indicating that the whole CLVS always has one slice per picture. This might or might not be necessary
* At a minimum, a flag would need to be added to the header of every slice (regardless of whether is being used or not) that would indicate whether the PH data are in the SH or not.
  + There should be a constraint that this flag must be 0 for the entire CLVS or 1 for the entire CLVS.
  + The flag would be required to be 0 unless there is only one slice per picture and no subpicutures.
* The POC LSBs would be in the PH, regardless of wether that is in a separate NAL unit or not.
* The presence of the four flags that control whether something is in the PH or SH could be conditioned on the that added flag. These flags could be grouped together.

Revisit after side activity to draft proposed text.

On PH / SH override mechanism

1. Change the current PH / SH override mechanism as follow (JVET-Q0200, JVET-Q0259):
   1. The flags that specify whether a syntax element of a related coding tool is present in PH or in SH (but not both) are proposed to be moved from the PH to the PPS.
   2. This mechanism may be applied for signalling of syntax element related to the following tools:

* reference picture lists, SAO, ALF (JVET-Q0200 & JVET-Q0259)
* deblocking (JVET-Q0200).

It was commented that since the PPS ID can change on every picture anyway, moving the control from the PH to the PPS doesn’t make much of a difference unless this is motivated by a desire for coding efficiency by saving bits in the PH. So this is a matter of saving bits in the PH.

It was commented that this makes particular sense if we allow the PH to be combined into the SH, because in that case we could require a particular location by requiring a value for these flags.

It was commented that it is a question of usage of these tools – whether it is envisioned that there should be a switching of the decision from picture to picture (with other aspects of the PPS staying constant) for whether the controlled syntax is in the PH or SH.

Decision (cleanup): Adopt. Text in Q0200, Hendry resp. for software.

1. JVET-Q0270 aspect 3, 4, and 5:
   1. Replace pic\_deblocking\_filter\_override\_present\_flag and pic\_deblocking\_filter\_override\_flag with a pic\_deblocking\_filter\_override\_idc syntax element specifying whether deblocking filter parameters are not overridden in picture header or slice header, deblocking filter parameters may be overridden in picture header or deblocking filter parameters may be overridden in slice header.
   2. Replace pic\_sao\_enabled\_present\_flag and pic\_sao\_luma\_enabled\_flag with a pic\_sao\_enabled\_idc syntax element specifying whether SAO is disabled for the whole picture, SAO is enabled for the whole picture or SAO may be enabled per slice. Similar way is proposed for ALF aspect.

This is no longer relevant due to the action on Q0200.

*On specific coding tool related signalling in PH / SH*

1. JVET-Q0182: allow scaling list and LMCS to be signalled at slice level, instead of at picture level only. The asserted benefit is for the case of hybrid picture where a picture is a composition of different scenes (e.g., in a video conf showing multiple people and a PC screen).

Two options how to do this:

* Option 1: SL/LMCS syntax elements are signalled either at PH or slice header (SH) level. If SL/LMCS syntax elements are signalled in a PH, they cannot be signalled in any SH of the coded picture associated with the PH.
* Option 2: overriding the PH SL/LMCS settings at SH level is allowed. If overriding is enabled by an overriding flag, additional SL/LMCS information is signalled in the SH; otherwise, the PH SL/LMCS settings are used for the current slice.

This was addressed in a BoG; see Q0625.

1. On signalling of TMVP collocated ref pic.
2. Move signalling of TMVP collocated ref pic from SH to PH

* JVET-Q0207 option 1: when TMVP is enabled for picture associated with the PH, identify the collocated reference picture using its delta POC relative to the current picture’s POC.
* JVET-Q0259 aspect 5: indicate information about collocated picture in picture header when RPL information is signalled in the picture header.

Decision (cleanup): Adopt Q0259 aspect 5; proponent resp. for SW.

1. Keep the signalling of TMVP reference picture in SH and change the signalling for the case when there is only one reference picture in the DPB with the same spatial resolution as the current picture (JVET-Q0207 option 2).

It was commented that this conditions the parsing on a complicated condition, and thus should not be done.

1. JVET-Q0207 aspect 1: Update the constraint for the value of pic\_temporal\_mvp\_enabled\_flag when there is no reference picture in the DPB with the same spatial resolution with the current picture. Rather than considering all reference pictures in the DPB, the constraint should be expressed more precisely by considering only the active reference picture(s) of the picture.

It was commented that this change is not necessary and that the constraint expression may not even be needed; no action unless not resolved offline.

1. JVET-Q0130: Modify semantics of collocated\_ref\_idx.

The contribution expressed a concern over the possibility that a non-conforming could be created that would actually be decodable. The contribution proposes that the decoder override the indicated use of temporal MVP if certain conditions are violated (instead of requiring the encoder to not indicate the use of temporal MVP under those conditions).

The group did not like that this would add extra processing to the decoder and would allow the encoder to provide a misleading indication of what the decoder would be doing. No action was thus taken on the proposal.

1. It is proposed to disallow weighted prediction with customized weights at the slice level and to move the signalling of the prediction weight table from SH to PH (JVET-Q0247). The proposed aspects include:
2. Combine pps\_weighted\_pred\_flag (which) and pps\_weighted\_bipred\_flag in PPS into one flag to specify whether weighted prediction may be applied to pictures referring to the PPS.
3. When weighted prediction is enabled, a flag in picture header (i.e., pic\_weighted\_pred\_present\_flag) would be present to specify whether weighted prediction is applied to the picture or not. When pic\_weighted\_pred\_present\_flag is equal to 1, prediction weight table is present in the picture header.
4. When weighted prediction is enabled for a picture, all slices of the picture would be required to have the same reference picture lists. (And it would be required to send the RPL at the picture level.)
5. In the prediction weight table signalling, explicitly signal the number of reference pictures to be weighted for L0 and L1. This is designed to remove dependency of the prediction weight table signalling to the number of active reference pictures that may be present in slice header.

This proposes the removal of a coding tool functionality and it was agreed we should not do that without careful study, which there probably isn’t time to do.

It does seem strange that the weight table cannot be shared by all slices of the same picture. Decision (cleanup): Make the prediction weight table a fifth type of data that can be signalled either in the PH or SH (like ALF, deblocking, RPL, and SAO). Text to be included in the text being prepared for the other four. Hendry resp. for SW.

*On changes for signalling of syntax elements in PH / SH and additional features*

1. Condition the presence of inter-/intra- related syntax elements.
   1. Using a flag to condition the presence of some syntax elements in PH

JVET-Q0116 aspect 1:

* A new syntax element ph\_all\_intra\_slices\_flag is proposed to be signalled in PH, and all the inter-related syntax elements in PH that are not needed for intra slices are conditioned on ph\_all\_intra\_slices\_flag not equal to 1.
* The slice\_type in slice header (SH) is inferred to be equal to 2 (i.e., intra slice) when the ph\_all\_intra\_slices\_flag is equal to 1.
* This flag (ph\_all\_intra\_slices\_flag) is asserted to be useful not only for reducing PH size but also may be used by system for some features (e.g., trick mode).
  1. Using two flags (or 2 syntax elements) and use them to condition the presence of some syntax elements in PH
* JVET-Q0153 aspect 2 & JVET-Q0428 option 3: Have 2 flags such to specify whether intra related syntax element is present and whether inter related syntax elements are present.
* JVET-Q0245: In addition to JVET-Q0153, define some constraints for the values of the two flags and to anticipate bitstream extration and merging cases.
* JVET-Q0176 aspect 1: Signal new syntax element mixed\_slice\_types\_in\_pic\_flag in PPS. If this flag is equal to 0, signal slice type (i.e., B / P / I) in PH.
* JVET-Q0259 aspect 1: Signal two separate flags for indication of partition constraint override.
* JVET-Q0376 aspect 2: change override flag for partitioning parameters from 1 flag to 2 flags (one of inter and one for intra).
* JVET-Q0428 has 2 options for the definition the the 2 flags (the presence of the second flag is condition upon the value of the first flag):
  + Option 1: pic\_single\_coding\_type\_flag and pic\_intra\_picture\_pred\_only\_flag.
  + Option 2: pic\_inter\_slice\_only\_flag and pic\_intra\_slice\_only\_flag
  1. Allowing dependent PH

JVET-Q0198: A dependent PH skips the signalling of some syntax elements which are inferred from the preceeding PH. A flag pps\_dependent\_pic\_header\_enabled\_flag is proposed in PPS and dependent\_pic\_header\_flag is proposed in PH.

It was agreed to have a two-flag approach. One flag that indicates the presence of intra parameters and one that indicates the presence of inter parameters. When the first flag is 0, no inter slices can be present. When the second flag is 0, no intra slices can be present. If the first flag is 0, the second flag is not present and inferred to be equal to 1. When the first flag is 0, the SH would not contain a slice\_type. This is very close to Q0428 option 2. Text will be developed and provided in a revision of Q0428. Revisit for review of that approach.

Hypothetically, a third flag could distinguish B-only and P-only from a mixture when I slices are indicated not to be present. Hypothetically, slice\_type could become a flag or be absent under relevant conditions.

JVET-Q0176 has a somewhat different proposal that enables sending slice\_type in the PH when the PPS indicates that there is only one slice type in the picture. (As originally proposed, it would not allow skipping when intra syntax elements when the picture contains a mixture of P and B slices.) Interest was not expressed by others in this sort of PPS special casing.

[Track A stopped here Thurs pm.]

1115 Fri 10 Jan (GJS)

1. Rearranging the ordering of syntax elements in PH (also possibly other parameter set as well)
   1. JVET-Q0481: Reordering syntax elements in PH and SPS related to intra and inter coded picture. Also, group the partition constraint syntax elements by type (intra, inter, dual-tree chroma).

Resolved as noted by BoG and other Track A outcomes.

1. Allowing signalling of extra bits in PH.
   1. JVET-Q0400: Add reserved extra bits to the picture header similar to extra slice header bits in HEVC. It is asserted that the proposal, however, differs from the HEVC design in that the presence of the flags in the picture header is controlled by the sequence parameter set.

It was commented that it would be desirable to have the ability to control such extra bits for both the PH and SH. The contribution also has a proposed way to indicate the meaning of such extra bits (using presence flags) and some proposed specific meanings: global and layer-wise non-reference and sublayer non-reference.

The basic idea was supported (for both the PH and SH, each separately controllable). There was discussion of whether the proposed aspects that differ from HEVC’s method are desirable. Revisit after offline discussion.

1. On the GDR picture indication in PH.
   1. JVET-Q0270 aspect 1 & JVET-Q0414 Option 1: Condition gdr\_pic\_flag in picture header on gdr\_enabled\_flag in SPS such that gdr\_pic\_flag is not present and inferred to 0 when gdr\_enabled\_flag is equal to 0.
   2. JVET-Q0414 Option 2: Imposing a constraint on the value of gdr\_pic\_flag
   3. JVET-Q0154 aspect 1: Have an IRAP or GDR picture indicator at the beginning of PH.

* Option 1: irap\_or\_gdr\_pic\_flag in the beginning of PH and use it to condition the presence of gdr\_pic\_flag in the PH.
* Option 2: irap\_or\_gdr\_pic\_idc in the beginning of PH. 1 means the pic associated with the PH is IDR pic, 2 means CRA, and 3 means GDR picture. Remove gdr\_pic\_flag and condition the presence of recovery\_poc\_cnt only when irap\_gdr\_idc is equal to 3.

JVET-Q0270 aspect 1 had a parsing problem and was withdrawn. It was also commented that it would be desirable to be able to use the flag without needing to identify and parse the applicable SPS, so no action on this method.

Decision (Ed.): Clarify as necessary per item b. The constraint is already expressed, but would benefit from clarification in the semantic of the gdr\_pic\_flag flag.

Decision (PH cleanup): Adopt Q0154 option 1. The semantics should be a “one way” indication, not a guarantee that the picture is not an IRAP or GDR. Proponent resp. for text and SW.

YKW to coordinate preparation of syntax document reflecting the combined recorded agreements for review.

1. JVET-Q0154 aspect 3: Signalling slice layer NUTs as PH\_NUTs at picture header. Slice layer NUTs are replaced by SLICE\_NUT. For this piece, the following changes is proposed:
   1. If mixed\_nalu\_types\_in\_pic\_flag is equal to 1, signal irap\_gdr\_idc in PH
   2. Semantics of irap\_gdr\_idc is as follows: 0 indicates IDR\_W\_RADL picture. 1 indicates IDR\_N\_LP picture. 2 indicates CRA picture. 3 indicates GDR picture.

Addressed by action recorded above.

1. JVET-Q0154 aspect 4: Recovery picture POC count (currently in the PH) signalling for mixed nal unit type pictures. Signal the recovery\_poc\_cnt at subpicture/slice level or change the definition of the gdr\_pic\_flag to include mixed nal unit type in picture that has GDR slices.

It was commented that we don’t know of a use case for mixing GDR with non-GDR.

Currently, GDR can only be mixed with IRAP. Other mixing is already prohibited. No clear need was also mentioned for the mixing of GDR with IRAP. Decision (BF): Disallow mixing of GDR and IRAP (Disallow mixing of GDR with any non-GDR).

1. On POC LSB signalling
   1. Move POC LSB signalling from SH to PH (JVET-Q0115 aspect 3, JVET-Q0153 aspect 1)
   2. Add POC LSB signalling in PH (JVET-Q0177 aspect 2). This is asserted to be useful to identify whether the PH is a repeated PH.

There was discussion of whether it is necessary to have POC LSB to enable detection of whether slices are from the same picture or not if a PH can be lost. It was agreed that relevant systems provide other indications, such as timestamps, to resolve such detection needs.

Decision (PH cleanup): Move POC LSB signalling from SH to PH.

1. JVET-Q0116 aspect 2: Change PH extension mechanism to be like the mechanism for extension of parameter sets. Note that currently it is like SH extension mechanism.

The rationale was said to be that slices have slice data that follows the SH data. Parameter sets do not – they only contain header data. Revisit after determining whether PH can be combined in the same NAL unit.

1. JVET-Q0155 aspect 1: move colour\_plane\_id to SH. Also specify that slice address values are unique within each colour plane (rather than unique within each picture) when separate colour plane coding is used. (Although all of this is somewhat hypothetical, per below.)

Decision (BF): Adopt.

It was asked whether separate colour plane mode is allowed in the 4:4:4 profile or not. In the current draft, it is not forbidden. This mode has been specified also in AVC and HEVC syntax but has been disallowed in all of their profile specifications. Decision (BF): Disallow separate colour plane mode in the 4:4:4 profile(s).

1. JVET-Q0270 aspect 2: signal an se(v) pic\_qp\_delta syntax element in the picture header and derive SliceQpY = 26 + init\_qp\_minus26 + pic\_qp\_delta + slice\_qp\_delta. The presence of pic\_qp\_delta is gated by a sps\_pic\_qp\_delta\_present\_flag syntax element signalled in SPS.

Decision (PH cleanup): Add a PPS flag to determine whether qp delta is sent in the PH or SH, like other things (e.g., ALF, deblocking, SAO).

1. JVET-Q0358: add a TemporalId constraint between the ALF\_APS NAL unit and the picture associated with PH.

Decision (BF): Adopt.

1. JVET-Q0376 aspect 1: parameters related to delta QP signalling for Inter and Intra are merged into single parameters.

It was commented that since inter slices may have very large regions relative to intra slices, it may be desirable to keep the ability for the level control of QP as different. No action was taken.

1. JVET-Q0379: move the syntax elements related to the APS ID at an early stage of the picture header and slice header. This involves APS ID of ALF, LMCS and scaling list. The suggested location is just after the poc\_msb\_val syntax element.

It was commented that it is unknown in general whether an APS is used in subsequent later NAL units or not (unless some special knowledge is available about how the data was encoded).

No action unless offline discussion indicates otherwise. Revisiting was later requested.

1. JVET-Q0419 aspect 2: the value of slice\_type in slice\_header () could be constrained by or inferred from syntax elements signaled in PH. Note that this may be paired with JVET-Q0428.

This was addressed by other actions taken at the meeting.

1. JVET-Q0426 aspect 5: Move mvd\_l1\_zero\_flag from the picture header to the slice header since that is only relevant for the B slice type.

No action seemed necessary for this.

1. JVET-Q0273 editorial input on picture header

This contribution was only editorial – providing improvements for the text relating to the PH.

* It proposes to use “ph\_” consistently for PH syntax elements.
* It corrects a mismatch of syntax element names for SAO
* It proposes to use a shared syntax structure for RPL syntax in the PH and SH. (There was a comment that this should be double-checked.)

These editorial improvements were appreciated.

Decision (Ed.): The editor should consider this input, which seems quite helpful.

[JVET-Q0115](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8940) AHG9: On AU and picture start detection [Y.-K. Wang (Bytedance)]

[JVET-Q0177](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9002) AHG9: On picture identification and PH repetition [L. Chen, C.-Y. Chen, C.-Y. Lai, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0116](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8941) AHG9: PH and SH syntax clean-ups [Z. Deng, L. Zhang, Y.-K. Wang (Bytedance)]

[JVET-Q0130](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8955) On improvement of collocated\_ref\_idx [T. Chujoh, T. Hashimoto, E. Sasaki, T. Ikai (Sharp)]

[JVET-Q0153](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8978) AHG9: On picture header [M. Coban, V. Seregin, Y.-J. Chang, M. Karczewicz (Qualcomm)]

Items 1 and 2 of this contribution belong to this category.

[JVET-Q0154](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8979) AHG9: On picture header IRAP/GDR signalling [M. Coban, V. Seregin, A. K. Ramasubramonian, Y.-J. Chang, M. Karczewicz (Qualcomm)]

[JVET-Q0155](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8980) AHG9: On separate colour plane coding [V. Seregin, B. Ray, A. K. Ramasubramonian, Y.-J. Chang, M. Coban, G. Van der Auwera, M. Karczewicz (Qualcomm)]

Item 1 of this contribution belongs to this category.

[JVET-Q0176](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9001) AHG9: Overhead reduction for picture header [S.-T. Hsiang, Y.-W. Huang, S.-M. Lei (MediaTek)]

Item 1 of this contribution belongs to this category.

[JVET-Q0198](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9023) AHG9: On picture header dependency [L. Chen, C.-Y. Chen, C.-Y. Lai, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0182](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9007) AHG9: Allowing slice-level scaling list and LMCS [C.-Y. Lai, T.-D. Chuang, O. Chubach, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0200](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9025) [AHG9]: On picture level and slice level tool parameters [Hendry, S. Kim, S. Lee (LGE)]

[JVET-Q0207](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9032) [AHG9]: On signalling of TMVP enabled flag and collocated reference picture [Hendry, S. Kim, J. Nam, J. Lim (LGE)]

[JVET-Q0208](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9033) [AHG9]: On TMVP collocated reference picture [Hendry (LGE)]

[JVET-Q0245](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9070) [AHG9]: On signalling slice type information in the picture header [S. Paluri, Hendry, J. Zhao, S.H. Kim (LGE)]

[JVET-Q0247](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9072) [AHG9]: Signalling the prediction weight table in the picture header [S. Paluri, Hendry, J. Zhao, S. H. Kim (LGE)]

[JVET-Q0255](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9080) AHG9: Coded Picture NAL unit [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

[JVET-Q0259](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9084) AHG9: On picture header [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

[JVET-Q0270](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9095) AHG9: On Picture Header Modifications [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

[JVET-Q0358](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9183) AHG9: Constraints on ALF APS [X. Ma, H. Yang (Huawei)]

[JVET-Q0376](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9201) AhG9: Picture header refinement [G. Laroche, N. Ouedraogo, P. Onno (Canon)]

[JVET-Q0379](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9204) AhG9: On the position of APS IDs in Picture Header [G. Laroche, N. Ouedraogo, P. Onno (Canon)]

[JVET-Q0400](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9225) AHG9: On extra picture header bits in VVC [K. Sühring, R. Skupin, Y. Sanchez, T. Schierl (HHI)]

[JVET-Q0414](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9239) AHG9: A fix for GDR signalling [J. Chen, R.-L Liao, Y. Ye, J. Luo (Alibaba)]

[JVET-Q0419](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9244) AHG 9: On picture header [L. Li, B. Choi, X. Xu, X. Li, S. Wenger, S. Liu (Tencent)]

Items 1 and 2 of this contribution belong to this category.

[JVET-Q0426](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9251) AHG9: Picture header enabled flag [R. Sjöberg, M. Pettersson, M. Damghanian, D. Saffar (Ericsson)]

[JVET-Q0428](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9253) AHG 9: Picture header syntax clean-ups [X. Xu, B. Choi, L. Li, X. Li, S. Wenger, S. Liu (Tencent)]

[JVET-Q0481](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9308) AHG9: Ordering of partition constraints syntax elements in the sequence parameter set and picture header [W. Wan, B. Heng (Broadcom)]

The PH aspect of this contribution belongs to this category.

[JVET-Q0775](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9621) AHG9: Picture Header in Slice Header [J. R. Pettersson, M. Damghanian, D. Saffar (Ericsson), L. Li, B. Choi, X. Xu, X. Li, S. Wenger, S. Liu (Tencent)] [late] [Add more names from website]

This contribution was discussed Sunday 12 January at 1445 in Track A (chaired by GJS).

This contribution contains a proposal for signalling the picture header in the slice header. The contribution is based on JVET-Q0255, JVET-Q0419, JVET-Q0426. The introduction and overhead analysis provided in the contribution has been copied from JVET-Q0255.

This uses a flag in the SH; it can only be equal to 1 when there is a single slice per picture. A constraint specifies that the entire CLVS will have this flag equal to the same value.

When the flag is equal to 1, no PHs are allowed in the CLVS.

Decision (cleanup): Adopt. Additionally, it was agreed to condition the no\_output\_of\_prior\_pics\_flag on the indication that the picture is a GDR or IRAP picture and to put ph\_pic\_parameter\_set\_id before ph\_pic\_order\_cnt\_lsb, which would be followed by recovery\_poc\_cnt. If there is something that can be sent either in the PH NAL unit or in the SH, it shall be in the PH structure when the PH is in the SH.

It was agreed that we will keep the PH syntax structure the same in the PH NAL unit and the SH.

[JVET-Q0273](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9098) AHG9: Editorial changes related to picture header [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

[JVET-Q0781](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9627) AHG 9: On conditioning the presence of inter-/intra- related syntax elements in PH [X. Xu, B. Choi, L. Li, X. Li, S. Wenger, S. Liu (Tencent), S. Paluri, Hendry, J. Zhao, S. Kim (LGE), Z. Deng, L. Zhang, Y.-K. Wang (ByteDance), M. Coban, V. Seregin, Y.-J. Chang, M. Karczewicz (Qualcomm), S.-T. Hsiang, Y.-W. Huang, S.-M. Lei (MediaTek), J. Samuelsson, S. Deshpande, A. Segall (Sharp)] [late]

### Mixed NAL unit types within a coded picture (7)

Contributions in this category were discussed in Track A Friday 10 January 2020 at 1500 (chaired by GJS).

[JVET-Q0773](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9619) AHG9: A summary of HLS contributions on mixed NAL unit types within a coded picture [Hendry (LGE)] [late]

This contribution is for information summarizing contributions on mixed NAL unit type within a coded picture.

1. In addition to coded picture with mixed IRAP and non-IRAP NAL unit type (indicated by a flag in the PPS), do we want to allow mixes of other NAL unit types as well? (JVET-Q0206, JVET-Q0239, JVET-Q0284, and JVET-Q0396).
   1. Allow more mixing, still use the mixed\_types\_in\_pic\_flag as indication.
      1. JVET-Q0206 aspect 2 & JVET-Q0284 aspect 3: allow picture to have mixed NAL unit types of leading picture type (i.e., RASL / RADL) and non-IRAP, non-leading picture NAL unit types.
      2. JVET-Q0239: remove the constraint about what types can be mixed.
   2. JVET-Q0163: allow picture to have mixed NAL unit types. When mixed\_types\_in\_pic\_flag is equal to 1, signal another flag mixed\_irap\_types\_in\_pic\_flag to specify if the mixture involve IRAP and non-IRAP.
   3. JVET-Q0284 & JVET-Q0396: change mixed\_nalu\_types\_in\_pic\_flag to mixed\_nalu\_types\_in\_pic\_idc

* JVET-Q0284: 0 means no mix; 1 means IRAP type with non-IRAP type; 2 means RASL/RADL/GDR\_NUT with other non-IRAP types; 3 is reserved.
* JVET-Q0396: 0 means no mix; 1 means non-IRAP type with non-IRAP type; 2 means IRAP type with non-IRAP type; 3 means IDR\_W\_RADL with CRA\_NUT.
* Allow a mixing of leading and trailing pictures? An example given was mixing bitstreams that have different CRA RA periods – e.g., one refreshing twice as often as the other. It was agreed to allow this.
* Mixing of IDR and CRA? – proposed to be treated as a CRA. (And mixing of RASL and RADL?)
  + Mixing of IDR and CRA does not seem necessary; the encoder can just not use IDR and instead use CRA with RADL pictures.
* But mixing of RASL and RADL pictures is desirable.

Decision (cleanup): Allow mixing of leading pictures with trailing pictures and mixing of RASL pictures with RADL pictures is desirable (unless mixing of RASL pictures with RADL pictures gets too complicated). Revisit for text with offline consideration of the raised questions below.

It was commented that having additional indicators for different types of mixing does not seem necessary or helpful to the decoder.

Constraints are needed on the RPLs and referencing. The exact text is to be prepared.

Note that when we have a mixed picture, we already have some constraints on referencing.

It was discussed whether the mixed indication should be a “one-way constraint” versus a requirement for mixed pictures to actually contain a mixture.

1. What kind of picture is the picture that has mixed NAL unit types?
   1. JVET-Q0239 and JVET-Q0284: Picture containing mixed NAL unit types is a trailing picture.
   2. JVET-Q0396: Picture type depends on mixture:

* If containing TRAIL slices,
* Otherwise (no TRAIL), picture is treated as leading picture with differentiation of RADL and RASL
* Otherwise (no TRAIL, no RAS/DL), picture is treated as CRA.

Revisit after offline consideration for mixing of picture types that involve RASL pictures.

1. New syntax element?
   1. JVET-Q0284: move the flag from PPS to PH and add a flag in SPS to specify that mixed NAL unit picture may be present in the CLVS.

Revisit after offline consideration

1. The following changes are proposed:
   1. JVET-Q0206: add a constraint such that the value of sps\_idr\_rpl\_present\_flag shall be equal to 1 when there is at least one PPS referring to the SPS with the value of mixed\_nalu\_types\_in\_pic\_flag is equal to 1.

Decision (Ed.): This is already required by the requirement for the RPS to be the same for all slices in the picture; editorial clarification (e.g., in a NOTE) may be helpful to ensure that this is understood by the reader. If to be expressed, this should be phrased as a constraint on the PPS content, not the SPS content.

* 1. JVET-Q0208 aspect 1: have a constraint such that pictures that follow the current picture, which is a mixed of IRAP and non-IRAP NAL unit picture, in the decoding order do not use pictures that precede the current picture in decoding order as TMVP collocated reference pictures.

Revisit after offline consideration

* 1. JVET-Q0239: a picture referring to PPS with mixed\_nalu\_types\_in\_pic\_flag equal to 1 may or may not contains VCL NAL unit of different NAL types.

This is the “one way” constraint to be discussed offline.

* 1. JVET-Q0289: similar in spirit with JVET-Q0239 that allow a picture referring to PPS with mixed\_nalu\_types\_in\_pic\_flag equal to 1 may or may not contains VCL NAL unit of different NAL types. When mixed\_nalu\_types\_in\_pic\_flag is equal to 1, signal a flag in PH to specify whether the picture associated with the PH contains slices with different NAL unit types.

This is related the “one way” constraint to be discussed offline. It was commented that extraction could cause a need to rewrite the PH.

It was commented that needing to rewrite the PH was highly undesirable, esp. for the extraction case.

* 1. JVET-Q0261: modify current constraint to make the current NAL unit mixed work particularly when a picture contains CRA and trail NAL units.

This is part of planned offline work.

* 1. JVET-Q0284: add text to define picture handling according to types of their VCL NAL units.

This is part of planned offline work.

* 1. JVET-Q0284: constraint that if mixed NAL unit picture use inter-layer prediction, the inter-layer ref pic must also be mixed NAL unit picture.

No action on this seemed necessary, as there was no indication that this case would be a problem for a decoder to handle (regardless of whether it would seem sensible to do or not).

1. How do we want to handle mixing of STSA slices?
   1. JVET-Q0284: disallow mixture of STSA and IRAP, or remove TemporalId constraint for STSA\_NUT.

Decision (Ed. BF): Do not include STSA in the list of NAL unit types that can be mixed with IRAP. (This just for clarity, as the mixture is already prohibited by the TiD constraint.)

* 1. JVET-Q0396: have a flag called leading\_stsa\_pictures\_flag in general\_constraints\_info( ).

**leading\_stsa\_pictures\_flag** equal to 1 specifies that inter prediction references for RADL and RASL pictures are constrained as specified below. leading\_stsa\_pictures\_flag equal to 0 does not impose such a constraint.

When leading\_stsa\_pictures\_flag equal to 1, the following applies:

* When the current picture is a RASL or RADL picture, there shall be no active entry in RefPicList[ 0 ] or RefPicList[ 1 ] that has TemporalId equal to that of the current picture.
* When the current picture is a picture that follows, in decoding order, a RASL or RADL picture and precedes the associated IRAP picture that has TemporalId equal to that of the current picture, there shall be no picture that has TemporalId equal to that of the current picture included as an active entry in RefPicList[ 0 ] or RefPicList[ 1 ] that precedes the RASL or RADL picture in decoding order.

The proposal is to allow RASL and RADL NUTs to be mixed with STSA pictures and provide an indicator of whether RASL and RADL pictures (all of them, whether mixed or not) can be used as STSA pictures.

This is similar in spirit to the proposal to allow leading and trailing picture NAL units to be mixed.

It was remarked that defining the indicator is not so necessary and could be done later, as it is just metadata, so it was suggested not to act on that.

Decision (cleanup): Allow RASL or RADL NUTs to be mixed with STSA NUTs.

See Q0751 for candidate text developed in offline work.

[JVET-Q0163](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8988) AHG9: On mixed NAL unit types in a video picture [P. Wu (ZTE)]

[JVET-Q0206](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9031) AHG9: On picture with mixed NAL unit types [Hendry (LGE)]

[JVET-Q0239](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9064) AHG9: On mixed NAL unit types in a coded picture [M. M. Hannuksela (Nokia)]

[JVET-Q0261](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9086) AHG9: On mixed NAL unit types [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

[JVET-Q0284](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9109) AHG9: On mixed NAL unit type [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

[JVET-Q0289](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9114) AHG9/AHG12: Comments on miscellaneous HLS text [L. Chen, C.-W. Hsu, C.-C. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

Item 2 of this contribution belongs to this category.

[JVET-Q0751](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9597) AHG9: On mixed NAL unit types [J. Samuelsson, S. Deshpande (Sharp), M. M. Hannuksela (Nokia), Hendry, S. Paluri (LGE)] [late]

[JVET-Q0396](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9221) AHG9: On mixing NAL unit types in a coded picture [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

[JVET-Q0751](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9221) AHG9: On mixed NAL unit [J. Samuelsson, S. Deshpande (Sharp), M. M. Hannuksela (Nokia), Hendry, S. Paluri (LGE)]

This contribution provides candidate draft text for combined proposals developed in offline work.

TBP.

### Reference picture list (RPL) signalling (2)

[JVET-Q0197](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9022) AHG9: Miscellaneous fixes for HLS in Specification [B. Wang, S. Esenlik, A. M. Kotra, H. Gao, E. Alshina (Huawei)]

Discussion of this contribution was discussed Monday 13 January at 2100 in Track A (chaired by GJS).

1st aspect fix

In the SH and PH header, semantics related to **ref\_pic\_list\_sps\_flag** and **ref\_pic\_list\_idx** are broken.

* **ref\_pic\_list\_sps\_flag** has beenreplaced by
  1. slice\_rpl\_sps\_flag in SH
  2. pic\_rpl\_sps\_flag in PH
* **ref\_pic\_list\_idx** has been replaced by
  1. slice\_rpl\_idx in SH
  2. pic\_rpl\_idx in PH

2nd aspect fix

* **ph\_poc\_msb\_cycle\_present\_flag** has been replaced by
  1. ph\_poc\_msb\_present\_flag

3rd: a suggestion

* have a unified prefix in picture header, either ph\_XXX or pic\_XXX, but not both

V1 of the document contained an aspect that was then withdrawn.

Decision (Ed.): The editor is requested to address these clear editorial errors.

It was commented that this could have been addressed by an edit

[JVET-Q0217](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9042) AHG9: On Reference Picture List Information Signalling [S. Deshpande (Sharp)]

Discussion of this contribution was discussed Monday 13 January at 2105 in Track A (chaired by GJS).

The contribution proposed modifications to the reference picture list information signaling for cleanup and bug-fix purposes.

Following is proposed:

* Proposal 1: Asserted bug-fixes are proposed to the semantics of slice\_rpl\_sps\_flag[ i ]. This aspect had been addressed by actions taken previously at the meeting.
* Proposal 2: It is proposed to specify an inference rule for the syntax element pps\_ref\_pic\_list\_sps\_idc[ i ] when it is not present. This aspect had been addressed by actions taken previously at the meeting.
* Proposal 3: Asserted bug-fix is proposed for the semantics of rpl1\_idx\_present\_flag to correctly account for the reference picture list related signalling in picture header and slice header. This aspect had been addressed by Q0197.
* Proposal 4: It is proposed to move the location of syntax element rpl1\_idx\_present\_flag in PPS and it is proposed to conditionally signal rpl1\_idx\_present\_flag based on the value of pps\_ref\_pic\_list\_sps\_idc[ 1 ]. This aspect had been addressed by actions taken previously at the meeting.
* Proposal 5: The condition for calculation of AbsDeltaPocSt[ listIdx ][ rplsIdx ][ i ] is modified to signal the value as a “minus1” for the 0-th entry. In the reference picture list, the short-term 0th entry cannot have a zero-valued delta POC, so the proposal this in a current condition check the semantics. (The other case is already there, so this is using the same equation as for when weighted prediction is not used.) Decision (cleanup): Adopt.
* Proposal 6: A bug-fix is proposed for the signalling of POC LSB information related syntax to correctly use the derived variable related to picture header. Decision (expression of existing intent): Adopt.
* Proposal 7: Editorial improvement is proposed for ltrp\_in\_slice\_header\_flag[ listIdx ][ rplsIdx ] since the information related to this can be now present in picture header or slice header. Decision (Ed.): This should be considered by the editor.

### Virtual boundary signalling (5)

[JVET-Q0181](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9006) AHG9: On signalling of virtual boundary [C.-Y. Chiu, C.-C. Chen, C.-W. Hsu, L. Chen, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

Sun 1345 Track A (GJS)

In VVC Draft 7, the signalling of virtual boundary is present in either sequence parameter set (SPS) or picture header (PH). The syntax design reportedly lacks flexibility and is inefficient to handle the use case that only some pictures have different virtual boundaries from other pictures in the same sequence, e.g., 360-degree video with gradual decoding refresh (GDR) enabled. In this contribution, two methods are proposed to provide more flexibility. The proposed method 1 is to override the information of virtual boundaries in PH. The proposed method 2 is to signal an extra virtual boundary dedicated for GDR in the PH.

For 360° applications, the boundary is typically static. For GDR it is changing from picture to picture.

Using both virtual and GDR boundaries together causes repetition of the virtual boundaries at the PH level.

At most there are three boundaries horizontally and three vertically.

It was commented that the envisioned combined scenario is not a common use case and the overhead of repeating a few boundary locations at the PH level is not so bit, so no action was taken on this.

[JVET-Q0210](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9035) [AHG9]: Miscellaneous HLS clean-ups [Hendry, S. Paluri (LGE)]

Sun 1400 Track A (GJS)

Items 6 and 7 of this contribution belong to this category.

1. Specify a constraint such that when RPR is enabled, the signalling of virtual boundary position, if present, shall be in picture header. This is related to contribution Q0417 (esp. its Method 3).
2. Specify a constraint such that when subpicture signalling is present, the signalling of virtual boundary position, if present, shall be in SPS. Decision (cleanup): Adopt. Proponent to provide spec text in revision (which should be sufficiently simple that text review is not needed).

[JVET-Q0417](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9242) AHG8/AHG9: On SPS level virtual boundary [J. Chen, Y. Ye, R.-L. Liao, J. Luo (Alibaba)]

Sun 1445 Track A (GJS)

This is related to contribution Q0210.

In VVC draft 7, virtual bounary is signaled in either SPS or PH. When virtual boundary is signaled in SPS, there is a constraint on the virtual boundary position that depends on the picture width and height, which are signaled in PPS. When the picture width or height is changed, it is not clear how the SPS virtual boundary constraint should be applied, that is, which width/height should be referred to. Three methods are proposed in this contribution to solve this problem.

Method 1 proposes to restrict the virtual boundary signaled in the SPS with the maximum picture width and height that are also signaled in the SPS and only consider the virtual boundaries within the current picture boundary when it is applied to each picture.

Method 2 proposes to scale the virtual boundaries signaled in SPS to fit the size of each picture. By doing this, virtual boundary could reportedly be better combined with reference picture resampling (RPR).

Method 3 proposes to use SPS level virtual boundary signaling and RPR in a mutually exclusive manner, that is, one is disallowed when the other is in use. This restriction can be imposed separately for horizontal and vertical dimensions (“way 1”) or to both dimensions together (“way 2”). Way 2 of Method 3 is the same as proposed in Q0210 item 6.

Decision (cleanup): Adopt “Method 3, way 2” of Q0417 (the same as Q0210 item 6). Text is available in the contribution. Software should be provided by the proponent as a conformance condition check.

[JVET-Q0246](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9071) [AHG9]: On virtual boundary signalling [S. Paluri, Hendry (LGE)]

This contribution was discussed Sunday 12 January at 1445 in Track A (chaired by GJS).

In the current design, if the virtual boundary information is not needed, there are two flags (i.e., sps\_virtual\_boundaries\_present\_flag and ph\_virtual\_boundaries\_present\_flag) still need to be signalled. Particularly, the signalling of ph\_virtual\_boundaries\_present\_flag still need to be present in every picture header even when no virtual boundary is needed. It is asserted that this redundant and unnecessary signalling should be fixed.

This contribution proposes a flag (i.e., sps\_virtual\_boundaries\_disabled\_flag) in the SPS to specify whether loop filters may be disabled along virtual boundaries in the coded pictures within the CLVS. When this flag is equal to 1, virtual boundary signalling may be present in either SPS or PH, but not in both.

This is the same as what is proposed in Q0258 (except there it uses an enable flag rather than a disable flag).

It was commented that, aside from more efficient signalling, this would provide a high-level indication when virtual boundaries will not be used anywhere in the CLVS.

Decision (cleanup): Adopt as an enable flag. Text to be provided in Q0246-v3.

[JVET-Q0258](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9083) AHG9: On virtual boundary signalling [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

See notes for Q0246.

### Gradual decoding refresh (2)

[JVET-Q0527](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9357) AHG9: Gradual Decoding Refresh for VVC [L. Wang, S. Hong, K. Panusopone (Nokia)] [late]

[JVET-Q0754](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9600) Crosscheck report for JVET-Q0527 (AHG9: Gradual Decoding Refresh for VVC) [H. Jang (LGE)] [late]

[JVET-Q0560](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9406) AHG9: Gradual Decoding Refresh without Forcing Intra Area [L. Wang, S. Hong, K. Panusopone (Nokia)] [late]

[JVET-Q0755](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9601) Crosscheck report for JVET-Q0560 (AHG9: Gradual Decoding Refresh without Forcing Intra Area) [H. Jang (LGE)] [late]

### Hypothetical reference decoder (HRD) (10)

[JVET-Q0743](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9589) AHG9: A summary of proposals on HRD [Y. Sanchez (HHI)] [late]

This contribution provided a summary of some of the proposals on HRD.

This summary was used for the reviewing of these proposals, such that the discussions could be in a more structured and efficient manner.

1. Mandate a bitstream order for BP/PT/DUI SEI message that obeys the parsing dependency (Q0048)?

Decision (expression of existing intent): Adopt. The exact expression may need some improvement.

1. Not signal and infer cpb\_removal\_delay\_delta\_idx[ i ] to be 0 when there is only one cpb\_removal\_delay\_delta[ i ] in BP SEI message? (Q0216)?

Decision (cleanup): Adopt.

1. Signal the alternative times in the PT SEI message for each sub-layer when sub-layer information is present instead of a single value (Q0219, Q0407)?

Decision (BF): Adopt per Q0219 proposal 2.

1. Signal alternative times for VCL HRD and NAL HRD and not only one value (Q0219)?

Revisit after offline study.

1. Change the semantics of non-nested BP/PT/DUI SEI messages to apply to the bitstreamToDecode, which is an OLS (Q0394)? Decision (cleanup): Adopt.

Additional aspects:

1. The extraction process exchanges the non-nested BP/PT/DUI SEI messages with the corresponding nested BP/PT/DUI SEI messages?
2. Add a flag to general\_constraint\_flag() to indicate the PT SEI message applies to any OLS, which happens when no DU information is included and same framerate in all OLSs?
   1. if yes, modify PT SEI message to support the same functionality for DU-based extraction (e.g. for subpicture extraction).?

du\_common\_cpb\_removal\_delay\_flag is changed to be used when each DU corresponds to a single VCL NAL unit. The number of DUs within an AU is derived to be equal to ClockTick \* ( elemental\_duration\_in\_tc\_minus1[ i ] + 1 ) divided by ClockSubTick \* (du\_cpb\_removal\_delay\_increment\_minus1[ i ][ j ] + 1)

It was commented that using a general constraint flag is not appropriate, as those flags should not affect the interpretation of the bitstream.

Revisit the additional aspects after offline discussion.

1. If DU level HRD parameters are present, a flag is signalled in Buffering period SEI message to control whether DU level picture DPB output delay information is signalled only in picture timing SEI message or in DU information SEI message. (Q0221)? Decision (cleanup): Adopt.
   1. If desired to signal it in both, in addition to the previous flag, signal the presence of the information also in the DUI SEI message with a flag in the PT SEI message? This aspect is not applicable since it was agreed not to signal in both.
2. Remove the loop over temporal sub-layers for DU information in PT/DUI SEI message and derive a different ClockSubTick by indicating a scaling factor for the different sub-layers in the HRD parameters in parameter set (Q0393)?

Revisit after offline discussion.

Q0283 and Q0397 and Q0404 were not included in the summary and are TBP.

[JVET-Q0048](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8873) AHG9: On order of HRD related SEI messages [V. Drugeon (Panasonic)]

[JVET-Q0216](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9041) AHG9: On Picture Timing Information Signalling [S. Deshpande (Sharp)]

[JVET-Q0219](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9044) AHG9: On Alternative Timing Information Signalling [S. Deshpande (Sharp)]

[JVET-Q0221](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9046) AHG9: On Decoding Unit Parameters Signalling [S. Deshpande (Sharp)]

[JVET-Q0283](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9108) AHG9: On subbitstream extraction [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

[JVET-Q0393](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9218) AHG9: On DU based HRD with temporal scalability [Y. Sanchez, R. Skupin, K. Sühring, T. Schierl (HHI)]

[JVET-Q0394](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9219) AHG9: On OLS extraction and scalable nesting SEI message [Y. Sanchez, R. Skupin, K. Sühring, T. Schierl (HHI)]

[JVET-Q0397](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9222) AHG12: On subpicture extraction [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

[JVET-Q0404](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9229) AHG12: On CBR subpicture extraction [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

[JVET-Q0407](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9232) AHG9: On alternative HRD timing and temporal sublayers [Y. Sanchez, R. Skupin, K. Sühring, T. Schierl (HHI)]

### VUI and SEI (13)

[JVET-Q0042](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8867) AHG9: On Video Usability Information [V. Drugeon (Panasonic)]

This contribution was discussed Sunday 12 January at 1445 in Track A (chaired by GJS).

The VUI syntax structure contains essential information for proper display of the video. The current specification text contains several comments on the VUI syntax and semantics. Suggested fixes for three of these comments are proposed in the present document. Specifically, it is proposed to

1. Move the overscan information to immediately follow the aspect ratio information;
2. Infer that the chroma sample location type is unspecified when not present;
3. Use the two flags general\_progressive\_source\_flag and general\_interlaced\_source\_flag as condition to switch between signalling of chroma\_sample\_loc\_type\_frame and chroma\_sample\_loc\_type\_top\_field/‌chroma\_sample\_loc\_type\_bottom\_field.

It was commented that there are a couple of issues:

* The general\_progressive\_source\_flag and general\_interlaced\_source\_flag are in the PTL syntax structure, so it was agreed not to move these and to refer to externally specified values for these in the SEI spec.
* The VVC spec should not refer to a value in the SEI spec. In the semantics of the frame-field information SEI message (which is in the VVC spec), there is a constraint on source scan type that refers to the two flags proposed to be moved to VUI. Such a constraint can just be rephrased to be imposed the other way around.

Decision (cleanup): Adopt (all three aspects, with modifications as described above.

It was commented that a small change should allow moving the frame-field information SEI message to the SEI spec. Revisit after offline study coordinated by Ye-Kui Wang for that.

[JVET-Q0159](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8984) AHG8: Indication for output picture size [V. Seregin, A. K. Ramasubramonian, M. Coban, M. Karczewicz (Qualcomm)]

This contribution was discussed Sunday 12 January at 1445 in Track A (chaired by GJS).

Reference picture resampling allows to have different decoded picture sizes and such different size pictures can be output. In such cases, the application may need to rescale the output picture before displaying to have a uniform size of the pictures. The VVC decoder has resampling filters and the decoder may perform output picture scaling process, however the target picture size is not currently present in the bitstream.

In this contribution, it is proposed to provide alternative picture output information, which can be used to rescale an output picture. The output picture size is proposed to be signalled in the VUI.

It was commented that if the same filters are applied as in RPR, the output could be more consistent if the same processing is appled for such an output.

Potential constraints were discussed, such as requiring the suggested output size to be less than or equal to the max picture size indicate in the SPS and requiring the actual picture size of all pictures in the CLVS to be less than or equal to the expressed suggested output size.

It was commented that the display size depends on the receiving system rather than the encoding. Certainly a decoder would not always be directly connected to a known display.

It was commented that the cropping window size rather than the coded picture size is the most relevant size to consider.

It was commented that there is an issue of cross-spec referencing for the VUI potentially referring to various variables in the video coding spec.

It was commented that the conformance output is specified, with specific values required at the output, and that this might make it less clear what should be the output of the decoder.

It was commented that receiving systems generally apply their own (often rather sophisticated) post-decoding signal processing, and would tend to apply that regardless of what is indicated.

There were two other closely related contributions, Q0260 and Q0288. See notes below.

[JVET-Q0260](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9085) AHG9: Intended display resolution [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

This contribution was discussed Sunday 12 January at 1445 in Track A (chaired by GJS).

This is closely related to Q0159 and Q0288.

This contribution contains a proposal for syntax elements to be added to the Decoding Parameter Set (DPS). The syntax elements indicate the intended display resolution of the pictures encoded in the layer to which the DPS applies. It is asserted that it is of high importance for receivers and decoders to determine the resolution that the decoded pictures are intended to be displayed at. It is asserted that dynamic encoding techniques used for example in adaptive bit rate (ABR) streaming applications and reference picture resampling (RPR) makes it difficult for receivers and decoders to determine the intended display resolution.

An example shown by the proponent, where the SPS maximum is 1920x1088 (1088 rather than 1080 due to the 8-sample granularity of the allowed coded picture size expression). The cropping window is at the PPS level, and there may be a number of lower-resolution pictures decoded in the bitstream before encountering a picture with a cropping window size of 1920x1080.

It was suggested that the SPS could carry a max cropping window size.

It was suggested to express such a concept in terms of an indication of a source video size, as an SPS VUI property.

Another suggestion was to express a maximum cropping window size.

The contributor said that their preference would be to not constrain the size to the maximum coded picture size expressed in the SPS.

[JVET-Q0288](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9113) AHG9: On picture output [B. Choi, S. Wenger, S. Liu (Tencent)]

This contribution was discussed Sunday 12 January at 1710 in Track A (chaired by GJS).

This is closely related to Q0159 and Q0260.

The parameters are similar and are proposed to be in VUI.

It was suggested to discuss in a plenary and determine the level of interest at that time. Revisit after that.

[JVET-Q0214](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9039) [AHG9/AHG12] Subpicture reposition indication SEI message [Y. He, A. Hamza (InterDigital)]

This contribution was discussed Sunday 12 January at 1720 in Track A (chaired by GJS).

This contribution proposes an SEI message to indicate the mergeable sub-pictures and the reposition layout.

It was commented that this is similar to a subset of what the region-wise packing SEI message does, although using subpicture concepts rather than spatial positions.

Region-wise packing converts the decoded picture to spherical coordinate positions.

The region-wise packing SEI message also supports rotations and resizing.

Further study was needed to determine if something other than the region-wise packing SEI message is needed.

[JVET-Q0234](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9059) AHG12 SEI message signalling of display region in picture for merged picture [M. Hirabayashi, M. Katsumata, T. Suzuki (Sony)]

This contribution was discussed Sunday 12 January at 1740 in Track A (chaired by GJS).

It was commented that this is closely related to Q0281 and Q0411, and that there were several related contributions to the previous meeting.

This contribution considers some proposed contributions about cropping information signaling of subpicture and pictures that have an uncoded area. It proposes a general signaling of the information of display region in the picture using SEI message. It can be applied to pictures containing samples that are not used for display in decoded picture in the DPB.

As proposed, it requires the conformance cropping window flag to be 0.

It lists a number of rectangles that contain regions that are suitable for display.

In the discussion, it was commented that an alternative approach is to indicate which regions are *not* intended for display. There were discussions of the two alternatives.

[Track A stopped here 1800 Sunday]

[JVET-Q0272](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9097) AHG9: Compact Region-Wise Packing SEI message [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

[JVET-Q0281](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9106) AHG12: Independently coded regions output window SEI message [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

[JVET-Q0343](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9168) AHG6/AHG9: Signalling guard band type for generalized cubemap projection [Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek)]

[JVET-Q0345](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9170) AHG6/AHG9: Signalling EAP via the ERP SEI message [Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek)]

[JVET-Q0395](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9220) AHG12: On subpicture level information SEI message [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

[JVET-Q0443](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9269) Independent Subpictures [K. Sharman, S. Keating, A. Browne (Sony)]

Item 2 (the SEI message aspect) of this contribution belongs to this category.

[JVET-Q0488](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9315) AHG9: Bounding redundant SEI messages [W. Wan, B. Heng (Broadcom)]

## AHG12: high-level parallelism and coded picture regions (54)

### Subpictures (31)

[JVET-Q0694](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9540) AHG12: A summary of proposals on subpicture extraction [R. Skupin (HHI)] [late]

TBP.

[JVET-Q0630](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9476) AHG9: Parsing dependency for subpicture level information SEI (Ticket 775) [K. Sühring, R. Skupin, Y. Sanchez, T. Schierl (HHI)] [late]

TBP – This had accidentally been moved to transform category.

#### General and misc. subpicture aspects (10)

[JVET-Q0592](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9438) AHG12: A summary of proposals on general and misc. subpicture aspects [Y.-K. Wang (Bytedance)] [late]

This contribution was discussed Tuesday 7 January 2020 at 1400 (chaired by GJS).

This contribution provides a summary of all proposals on general and misc. subpicture aspects submitted to this JVET meeting. It is suggested that this summary is used for the reviewing of these proposals, such that the discussions can be in a more structured and efficient manner.

The summary was used to structure the notes and discussion.

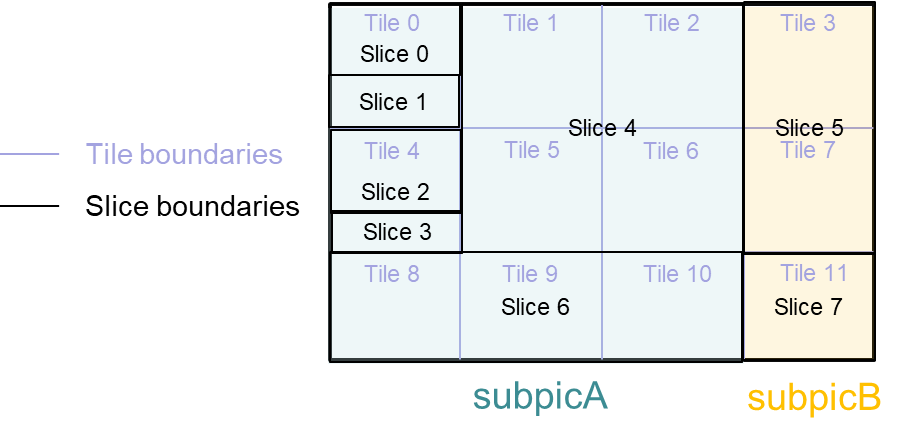
[JVET-Q0044](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8869) AHG9/AHG12: Simplification of slice index with subpictures [T. Nishi, V. Drugeon (Panasonic)]

This contribution was discussed Tuesday 7 January 2020 at 1405 (chaired by GJS).

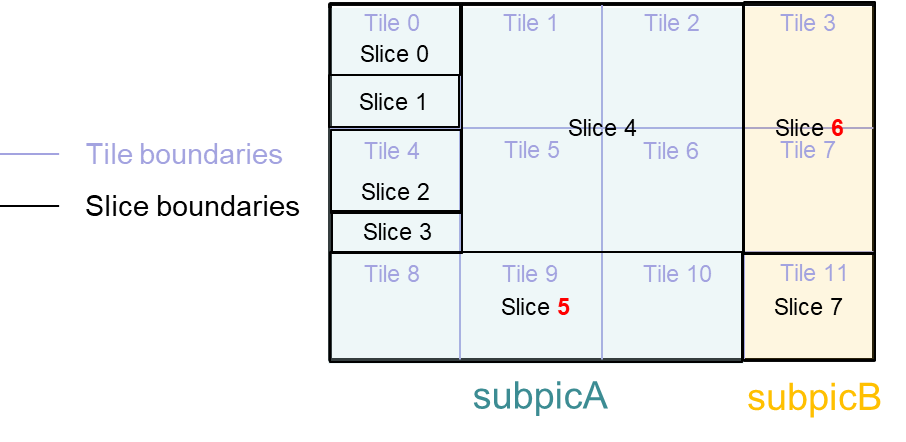
It is suggested to simplify the indexing of slices by aligning the picture level slice index to the subpicture level slice index, thereby removing the need to map the subpicture level slice index to the picture level slice index.

That means, disallow the picture-level slice index values allocated as shown in the first figure below. For the same picture partitioning (into subpictures, slices and tiles), use the picture-level slice index values as in the second figure below.

In other words, picture-level slice index values for slices within a subpicture are required to be continuous. In other words, for any two slices sliceA and sliceB belonging to different subpictures subpicA and subpicB, respectively, when the subpicture index of subpicA is less than that of subpicB, the picture-level slice index value of sliceA shall be less than that sliceB.



**Picture divided in 12 tiles, 8 slices and 2 subpictures**



**Picture divided in 12 tiles, 8 slices and 2 subpictures with slices indexed according to their decoding order**

It was commented that it is only an editorial matter what slice numbers are assigned to the slices in the text, and that the proposal does simplify the concept in the text by removing a LUT concept.

The proponent indicated that they intended for the text to also align the slice index values with the slice order, i.e., that the slice index values within each subpicture are consecutive. Decision: Adopted in principle (text to be provided and checked in a revisit).

[JVET-Q0113](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8938) AHG9/AHG8/AHG12: Some general HLS syntax clean-ups [Y.-K. Wang (Bytedance)]

Item 2 of this contribution belongs to this category.

This contribution was discussed Tuesday 7 January 2020 at 1430 (chaired by GJS).

1. Text changes for the blank clause for specifying the order of VCL NAL units and association to coded pictures and related. Besides some editorial changes for reorganization of the clauses and addition of a clause on order of PUs and their association to AUs, the proposed text changes include the following aspects:
   1. The terms picture-level slice index and subpicture-level slice index are defined, as the order of the slices within a picture and subpicture, respectively, being signalled in the PPS when rect\_slice\_flag is equal to 1. Note that the term slice index and picture-level slice index are currently used but not defined.
   2. When rect\_slice\_flag is equal to 1, the decoding order of VCL NAL units within a subpicture is specified to be in increasing order of their subpicture-level slice index values, i.e., the slice\_address values. See the notes for JVET-Q0044 for this aspect.
   3. It is required that the values of subpicture IDs are increasing in increasing order of the subpicture indices. It was commented that this constraint would harm some BEAM functionality. The draft already contains a uniqueness constraint, that the combination of slice\_subpic\_id and slice\_address shall be unique among the slices of a picture. No action was thus needed for this.
   4. When slice\_subpic\_id is not present, the value of slice\_subpic\_id is inferred to be equal to 0. The proponent indicated that, following the discussion of item c, this change is not needed.

Decision (expression of existing intent): The general editorial contribution was appreciated. The specification of the decoding order of the VCL NAL units in the picture should use the subpicture index and slice address rather than the subpicture ID and slice address.

[JVET-Q0119](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8944) AHG12: Cleanups on signalling of subpictures, tiles, and rectangular slices [Y.-K. Wang (Bytedance)]

This contribution was discussed Tuesday 7 January 2020 at 1450 (chaired by GJS).

Item 1 of this contribution belongs to this category.

1. The contribution proposes to change the coding of sps\_num\_subpics\_minus1 from u(8) to ue(v), and the value of sps\_num\_subpics\_minus1 is restricted to be in the range of 0 to Ceil( pic\_width\_max\_in\_luma\_samples ÷ CtbSizeY ) \* Ceil( pic\_height\_max\_in\_luma\_samples ÷ CtbSizeY ) − 1, inclusive.

Byte alignment is not an issue, since there is already some other variable-length syntax before it.

Aside from adding the flexibility to use larger numbers, this could save a few bits when the number of subpictures is small.

Decision (cleanup): Adopt (item 1).

It was commented that profile/level constraints are needed, regardless of the specifics of this proposal.

[JVET-Q0222](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9047) AHG12: On Subpicture Signalling [S. Deshpande (Sharp)]

This contribution was discussed Tuesday 7 January 2020 at 1500 (chaired by GJS).

Item 4 of this contribution belongs to this category.

Proposal 4: Either reserve or allow the value 255 for sps\_num\_subpics\_minus1.

This is just basically a text bug report. The specific issue is resolved by the action taken on Q0119.

[JVET-Q0157](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8982) AHG12: On motion compensation for sub-pictures [V. Seregin, Y.-J. Chang, M. Coban, M. Karczewicz (Qualcomm)]

This contribution was discussed Tuesday 7 January 2020 at 1845 (chaired by GJS).

1. To fix an asserted decoding problem of repositioned sub-pictures by considering boundaries of a reference sub-picture in the motion compensation process and TMVP derivation.

In the current text, inter prediction does not check the subpicture ID of the collocated region in the reference picture.

It was commented that it is intended that when the subpicture ID of a position in the picture changes in bitstream order, the slices of the subpicture would need to be IRAP slices, although this is not currently expressed in the text.

The proposal is to offset the position in the reference picture by the difference in position of the subpicture with the same subpicture ID. (A constraint would be needed that the reference picture must contain a subpicture with the same ID.)

It was commented that we should also think about whether the subpicture would have the same size in the reference picture.

It was commented that the proposed scheme could avoid the need for some post-decoding repositioning of the decoded regions – for example, the decoded picture could be made more spatially sensible, rather than using some post-decoding operation to rearrange the regions into a spatially sensible picture. However, another participant indicated that post-decoding rendering work is ordinarily needed anyway.

This would have an offset per subpicture for the motion compensation position calculation, which has some low-level decoding process change. The range of values of MVs could become larger than what it would otherwise be unless there is some additional constraint.

Temporal MVP would also involve considering the spatial offset relative to the corresponding position in the collocated picture.

While some participants liked the idea, we need to be very conservative about introducing changes to the low-level decoding process.

Further study of this was encouraged.

Revisit to review text of the IRAP constraint to be prepared by YKW.

1. Additionally, it is proposed to replace a current picture size with a reference picture size in the clipping (motion padding) since the reference picture may have different size than the current picture when reference picture resampling is enabled.

Decision (bug fix of existing intent): Adopt this aspect.

[JVET-Q0169](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8994) AHG9/AHG12: Bitstream conformance requirements on subpicture ID [C.-Y. Lai, C.-Y. Chen, T.-D. Chuang, O. Chubach, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

This contribution was discussed Tuesday 7 January 2020 at 1505 (chaired by GJS).

This contribution proposes two constraints:

1. The maximum value of subpicture ID derived by the signalled subpicture ID length shall be greater than or equal to the number of subpicture IDs.

In the discussion, it was commented that it would be better to send only the amount by which the ID length exceeds what is necessary, rather than to send the entire ID length and constrain its value to be sensible. Some participants liked this suggestion, while others said it might be more complicated to understand.

Decision (Ed.): Adopt as originally proposed. (This is not strictly necessary, since there are other constraints that prevent this problem, but it is desirable to limit the allowed range to sensible values.)

1. For each signalled subpicture ID, it shall be different from all other subpicture IDs in the same picture. Decision (Ed.): Adopt, either as a NOTE or as a requirement. (Expressing this as a requirement is not strictly necessary, since there is already an existing constraint that would require this, but it seems helpful to have it clearly expressed.)

[JVET-Q0210](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9035) [AHG9]: Miscellaneous HLS clean-ups [Hendry, S. Paluri (LGE)]

This contribution was discussed Tuesday 7 January 2020 at 1535 (chaired by GJS).

Items 1, 3, and 4 of this contribution belong to this category.

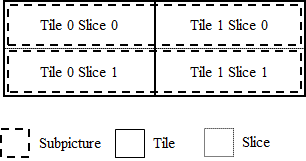
1. Prohibit rectangular slices in a tile belonging to different subpictures.

Specify a constraint as follows: When a picture is partitioned onto two or more subpictures, one or both of the following conditions shall be fulfilled for each subpicture and tile:

* 1. All CTUs in a tile belong to the same subpicture.
  2. All CTUs in a subpicture belong to the same tile.

It was discussed whether there is a real problem caused by the lack of this constraint. One use case was described in which it would be desirable to violate the constraint, which is an ERP viewport-dependent streaming (figs. D.8 and D.9 of OMAF).

The lack of this constraint involves potentially having NAL units of the same tile that not contiguous in decoding order. The scan order of CTUs within a slice is in tile scan order. Slices are ordered consecutively within a subpicture.



In the above picture, the order of slices in the bitstream is 1) tile 0 slice 0, 2) tile 1 slice 0, 3) tile 0 slice 1, then tile 1 slice 1.

Further study was encouraged to determine whether there are additional use cases in which this constraint would be desirable to violate, and to determine whether the lack of the constraint really causes a problem. The relationship of this to the subpicture level information SEI message should also be studied.

1. Specify a constraint such that when subpicture signalling is present, there shall be at least one subpicture that is an independently coded subpicture.

It was commented that this doesn’t really seem necessary. (And some subpicture characteristics may not be fully expressed within the bitstream – e.g., encoder-side MCTS referencing restrictions.) No action was taken on this.

1. Specify a constraint such that when subpicture ID is signalled in PPS or picture header, all subpictures are independently coded subpictures.

It was commented that although bitstream merging would likely be done at boundaries that are independent, some subpicture boundaries that are not at those boundaries may not need to be treated as picture boundaries. There is no clear need for the constraint, so no action was taken on this.

[JVET-Q0271](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9096) AHG9: On Subpicture Ordering [M. Damghanian, R. Sjöberg, M. Pettersson (Ericsson)]

This contribution was discussed Tuesday 7 January 2020 at 1800 (chaired by GJS).

This contribution proposes the following changes:

1. To define an independent subpicture as a subpicture for which the subpicture boundaries are treated as picture boundaries in the decoding process and no loop filtering across the subpicture boundaries is done. (Editorial)

It was commented that this does not really seem necessary (esp. since aspect #3 is not adopted), but the question can be left to the editors for consideration.

1. To add a syntax element sps\_independent\_subpics\_flag in the SPS. When equal to 1 it specifies that all subpicture boundaries in the CLVS are treated as picture boundaries and there is no loop filtering across the subpicture boundaries. subpic\_treated\_as\_pic\_flag[ i ] and loop\_filter\_across\_subpic\_enabled\_flag[ i ] are signalled only when sps\_independent\_subpics\_flag is equal to 0. (Signalling efficiency)

This is just a syntax optimization, but it would be a shortcut for a common use case. It was commented that a common example for viewport-dependent streaming uses 96 subpictures, and this would avoid the need to send 2\*96 flags.

Decision (cleanup): Adopt this aspect.

1. To specify that the subpicture availability rule applies only when sps\_independent\_subpics\_flag is equal to 0. (Functionality)

This change would allow arbitrary subpicture order in the bitstream when the subpictures are independent. Currently, subpicture order is constrained by the availability rule.

It was commented that this would impose a substantial buffering burden on decoder implementations with some architectures. Some decoders are envisioned to operate most of the decoding process in raster order. No action was taken on this.

[JVET-Q0406](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9231) AHG12: On CABAC zero words for subpictures [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

TBP.

This contribution asserts that subpicture extraction could result in violating the bin-to-bit ratio constraint as CABAC zero words are not associated to subpictures. Therefore, it is proposed to add a bitstream constraint for the VCL NAL units of subpictures to fulfil the bin-to-bit ratio constraint individually in addition to the picture unit level constraint when the following conditions apply:

– a subpicture has subpic\_treated\_as\_pic\_flag[ ] equal to 1.

– a subpicture level information SEI message is present in the CLVS.

[either or both?]

[JVET-Q0443](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9269) Independent Subpictures [K. Sharman, S. Keating, A. Browne (Sony)]

TBP.

Item 1 (the aspect on CABAC zero words and MinCR constraints) of this contribution belongs to this category.

Subpictures allow regions of a picture to be independently decodable, with care to handle edges of subpictures and describe the subpicture requirements at different levels via a dedicated SEI message.

1. This contribution proposes that constrains are added to subpictures so that CABAC zero words and MinCR picture level constraints are also applied at a subpicture level.

#### Subpicture layout signalling (7)

[JVET-Q0591](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9437) AHG12: A summary of proposals on subpicture layout signalling [Y.-K. Wang (Bytedance)] [late]

This contribution was discussed Tuesday 7 January 2020 at 2000 (chaired by GJS).

This contribution provides a summary of all proposals on subpicture layout signalling submitted to this JVET meeting. It is suggested that this summary is used for the reviewing of these proposals, such that the discussions can be in a more structured and efficient manner.

The proposed changes in this category were summarized as follows:

1. Modify the signalling (in the SPS) for subpicture layout by signalling the bottom-right CTU position and deriving other information needed for a subpicture (i.e., the top-left CTU position, the width, and the height). The reported bit saving is 60% for subpicture signalling. (JVET-Q0202)

This would make the signalling similar to what was previously used to identify bricks in rectangular slices. It would use a map (tileToSliceMap[ m ][ n ]) of the CTUs to derive the subpicture rectangles.

There was a similar contribution JVET-P0143 at the previous meeting. One participant commented that we should avoid needing a complicated derivation scheme. Another participant expressed a general sympathy with that type of concern. No action was thus taken on this.

1. When subpicture signalling is present but there is only one subpicture (e.g., due to extraction of a single subpicture from a larger bitstream), omit the signalling of subpicture layout and the syntax elements subpic\_treated\_as\_pic\_flag[ 0 ], and loop\_filter\_across\_subpic\_enabled\_flag[ 0 ]. (JVET-Q0210, JVET-Q0215, JVET-Q0413).

Decision (cleanup): Adopt. Hendry is responsible for the software. Revisit for text to be prepared (coordinated by Hendry).

1. Remove the following constraint: When subpics\_present\_flag is equal to 0, single\_slice\_per\_subpic\_flag shall be equal to 0, and use the flag to change some derivation equations suitably for this case. (JVET-Q0210, a similar proposal is said to be in Q0224)

It was commented (by those who wrote that sentence) that this sentence had been put into the text by mistake.

Removing the constraint would skip some unnecessary slice syntax elements by setting single\_slice\_per\_subpic\_flag equal to 1.

Decision (cleanup): Adopt. Hendry is responsible for the software. Revisit for text to be prepared (coordinated by Hendry). Editorially, it was suggested to also consider renaming the flag to make it clear that that the flag is not irrelevant when subpics\_present\_flag is equal to 0.

1. Skip the signalling and infer the top-left position for the first subpicture. (JVET-Q0215, JVET-Q0222)

The first one is required to be the top-left one by the availability constraint.

Decision (cleanup): Adopt. S. Deshpande is responsible for the software. Text is in Q0222.

1. Skip the signalling and infer the size of the last subpicture. (JVET-Q0215, JVET-Q0222, JVET-Q0413)

Decision (cleanup): Adopt. S. Deshpande is responsible for the software. Text is in Q0222 (alternative text is in Q0413, and the proponents will check offline whether that is editorially better).

1. Skip the signalling and infer the upper-left corner of the last subpicture position (JVET-Q0215)

Text was not provided for this. It was commented that the text might not be so straightforward. Revisit for review of candidate text.

1. Remove subpicture signalling from SPS, and signal subpicture layout in PPS based on the layout of rectangular slices instead. (JVET-P0475)

The motivation for this would be alignment of the signalling of subpicture layout with slice structure, since slices are a partitioning of subpictures. It was commented that the subpicture structure is required to be constant for a CLVS; with this proposal, that property would need to be achieved by a constraint on the PPS-level syntax. With the current scheme, that constraint cannot be violated.

It was remarked that if multiple PPSs are used in the bitstream, this would require repeating the identical subpicture map information in all of them.

No action was taken on this.

[JVET-Q0202](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9027) [AHG12]: On signalling of subpicture and rectangular slice [Hendry, S. Paluri (LGE)]

The subpicture layout signalling part of this contribution belongs to this category.

[JVET-Q0210](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9035) [AHG9]: Miscellaneous HLS clean-ups [Hendry, S. Paluri (LGE)]

Items 2 and 5 of this contribution belong to this category.

[JVET-Q0215](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9040) AHG9/AHG12: Comments on signalling subpicture layout [L. Chen, C.-C. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0222](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9047) AHG12: On Subpicture Signalling [S. Deshpande (Sharp)]

Items 1-2 of this contribution belong to this category.

[JVET-Q0413](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9238) AHG9/AHG12: On subpicture partitioning signaling [J. Chen, R.-L. Liao, Y. Ye, J. Luo (Alibaba)]

[JVET-Q0475](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9301) [AHG9/AHG12] On subpicture signaling [Y. He, A. Hamza (InterDigital)]

Items 1 and 2 of this contribution belong to this category.

[JVET-Q0787](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9633) AHG9: Subpicture location signalling bugfix [K. Sühring, J. Li, Y.-K. Wang]

#### Subpicture ID signalling (9)

[JVET-Q0590](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9436) AHG12: A summary of proposals on subpicture ID signalling [Y.-K. Wang (Bytedance)] [late]

This contribution was discussed Tuesday 7 January 2020 at 2145 (chaired by GJS).

This contribution provides a summary of all proposals on subpicture ID signalling submitted to this JVET meeting. It is suggested that this summary is used for the reviewing of these proposals, such that the discussions can be in a more structured and efficient manner.

1. When subpics\_present\_flag is equal to 0, i.e., there is no subpicture layout informaton signalled and no subpicture ID signalled in SHs, the current draft allows subpicture ID mapping to be explicitly signalled in the SPS/PPS/PH. A subpicture map can be sent even when there are no subpicture IDs in the slice headers, which doesn’t make sense. Proposals to fix this bug are:
   1. Condition slice\_subpic\_id on "if( subpics\_present\_flag  | |  sps\_subpic\_id\_present\_flag )"? (JVET-Q0222)
   2. Condition sps\_subpic\_id\_present\_flag on "if( subpics\_present\_flag )" and infer the value of sps\_subpic\_id\_present\_flag to be equal to 0 when it is not present. (JVET-Q0119, JVET-Q0290, JVET-Q0222)
   3. Constrain the value of sps\_subpic\_id\_present\_flag to be equal to 0 when subpics\_present\_flag is equal to 0.

Decision (BF): Adopt approach “b”. Y.-K. Wang is responsible for the software. Text is in Q0119.

1. Remove signalling of the subpicture ID mapping from PH? (JVET-Q0119)

If the mapping is in the PH, then subpicture-based extraction would have to change PHs.

Decision (cleanup): Adopt. Y.-K. Wang is responsible for the software. Text is in Q0119 (but may need separation from other proposed changes).

1. There is a bug in the text where SubpicIdList[ i ] is used without being defined in some cases. Proposals to fix this bug are:
   1. Require signalling in the SPS or PPS when sps\_subpic\_id\_present\_flag is equal to 1. (JVET-Q0119, JVET-Q0222, JVET-Q0375, JVET-Q0412)
   2. Infer a value for pps\_subpic\_id[ i ] when sps\_subpic\_id\_present\_flag is equal to 1 but the subpicture ID mapping is not signalled in SPS, PPS or PH. This is said to be what the software does. (JVET-Q0412)

It was remarked that approach b is not especially useful since it is just a description of what happens when sps\_subpic\_id\_present\_flag is equal to 0, saying that sps\_subpic\_id\_present\_flag equal to 1 was intended to indicate that explicit signalling was present. There was discussion of whether this remark was correct or not.

This was further discussed in Track A Wednesday 8 January 2020 at 1935 (chaired by GJS).

A difference between the two described cases was pointed out, which was that the SPS applies more globally than the PPS. In approach b, it would be possible to have the inference switched on and off at the PPS level. There was further discussion of whether this ability to switch inference on and off at the PPS level is useful or not, and there was no clear use case that was described for this switching. Another participant commented that a presence flag would ordinarily be expected to mean that something is actually present rather than that it might be present. Other than the proponent of approach b, participants preferred approach a. Decision (BF): Adopt approach a. The text change is trivial, and can be found in Q0119 and in the other proposals of approach a. There is no necessary software impact, since this is just a conformance requirement that is not violated by the current software. Y.-K. Wang is responsible for any potential software work for this, such as adding a decoder-side conformance check.

The next aspect was discussed in Track A Wednesday 8 January 2020 at 1920 (chaired by GJS).

1. There is a bug in the current text. When subpicture IDs are not explicitly signalled, the slice header syntax element slice\_subpic\_id still needs to be signalled as long as subpics\_present\_flag is equal to 1, including when sps\_num\_subpics\_minus1 is equal to 0. However, subpicture IDs are not explicitly signalled, the subpicture length is not explicitly signalled, either, and the length of slice\_subpic\_id is currently specified as Ceil( Log2 ( sps\_num\_subpics\_minus1 + 1 ) ) bits, which has two issues. The first issue is that the length would be 0 bits when sps\_num\_subpics\_minus1 is equal to 0. The second issue is that, when the original bitstream of the CLVS has subpics\_present\_flag equal to 1 and sps\_num\_subpics\_minus1 greater than 0, when the subpicture ID length is not explicitliy signalled, extraction of a subset of the subpictures would require changing of the slice headers. To fix these problems, it is proposed that when subpics\_present\_flag is equal to 1, the subpicture ID length would be explicitly signalled in the SPS regardless of whether subpicture IDs are explicitly signalled, and the length of slice\_subpic\_id is always specified by that length. (JVET-Q0119)

Decision (BF): Adopt. Y.-K. Wang is responsible for the software. Text is in Q0119 (but may need separation from other proposed changes).

Remaining aspects were discussed in Track A Wednesday 8 January 2020 at 2010 (chaired by GJS).

1. It is proposed to restrict explicit subpicture ID signalling to the case where all signalled subpictures are treated as pictures. (JVET-Q0152)

Arguing against this proposal, a participant suggested a use case where parts of the picture consist of one or more extractable subpictures or extractable groups of subpictures but other parts of the picture are not intended to be extractable by themselves. The extractable subpictures would treat their boundaries as picture boundaries but the other subpictures would not. Only the extractable subpictures would be used for BEAM operations.

It was also commented that extractability can be achieved by encoder referencing restrictions without treating subpicture boundaries as picture boundaries, and the restriction would not allow sending subpicture ID for such a usage.

No action was taken on this aspect.

1. It is proposed to do something to allow different CLVSs referring to the same SPS to have different subpicture information, including subpicture ID mappings, such that subpicture ID mapping redundancy can be avoided/reduced. Two approaches for enabling this were proposed. (JVET-Q0213)
   1. Variation 1: Signal subpicture sets in SPS, in which each subpicture set would identify a number of subpictures applying to a CLVS of the CVS referring to the SPS. (JVET-Q0213)
   2. Variation 2: Signal the subpicture ID mapping for those subpictures in a coded picture associated with the PPS and/or PH. (JVET-Q0213)

After discussion, a problem was identified in variation 1. Variation 2 was not understood. It was suggested for offline discussion to be held and to revisit if needed.

1. It is proposed to replace the sps\_subpic\_id\_present\_flag with a new flag indicating whether to describe subpicture ID mapping in SPS. (JVET-Q0235)

There was a missing constraint or inference bug in the proposed semantics. If that bug is fixed, this has the same syntax and the same functionality as item 3 option a, which was agreed previously in the meeting. It would have different semantics, using different flag combinations for indicating particular cases. It would signal two flags in the SPS to indicate implicit subpicture ID mapping, while the other approach would use one flag in that case. It otherwise seems the same. After discussion, item 3 option a was (very slightly) preferred and seemed to have better draft text, so no action was taken on this.

1. It is proposed to signal, in each APS, the list of the subpicture IDs of subpictures that reference that APS. This information would be used by the decoder to distinguish between APSs that have the same APS ID, and could also be used by an extractor to identify APSs that can be discarded when performing an extraction. (JVET-Q0285)

The signalling of the list would be optional. Subpictures that have subpicture IDs that are not found in any signalled list would use the APS that does not contain a list.

There was discussion of whether this list would just be metadata or would be used in the decoding process, and the proposal did use the data in the decoding process, to establish a different value space for APSs with the same APS type and the same APS ID. It was commented that the decoder-side identification aspect would conflict with the prior intent of how APSs would be identified, adding extra decoder-side operations to identify the APS to be applied during the decoding process. It was commented that we would already expect encoding to be operated in a sufficiently coordinated fashion that clashes of APS ID values would be prevented in the original encoding process.

It was commented that if the decoder aspect is removed so that the list just becomes metadata, then it is not appropriate to put this in the APS, since it could be carried in some other way, such as an SEI message.

No action was taken on this. It was remarked that further study might develop an alternate approach such as carrying such information in SEI messages.

[JVET-Q0119](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8944) AHG12: Cleanups on signalling of subpictures, tiles, and rectangular slices [Y.-K. Wang (Bytedance)]

Items 2-5 of this contribution belong to this category.

[JVET-Q0290](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9115) AHG9/AHG12: Modifications related to subpicture signalling and RPR [S.-T. Hsiang, C.-Y. Chen, T.-D. Chuang, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

Item 3 of this contribution belongs to this category.

[JVET-Q0152](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8977) AHG9/AHG12: Miscellaneous HLS topics [M. Coban, V. Seregin, Y.-J. Chang, M. Karczewicz (Qualcomm)]

Item 1 of this contribution belongs to this category.

[JVET-Q0213](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9038) [AHG9/AGH12] On subpicture ID mapping signaling [Y. He, A. Hamza (InterDigital)]

[JVET-Q0222](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9047) AHG12: On Subpicture Signalling [S. Deshpande (Sharp)]

Item 3 and 5 of this contribution belong to this category.

[JVET-Q0235](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9060) AHG12 Simplifying the nesting condition of subpicIdList[i] [M. Hirabayashi, M. Katsumata, T. Suzuki (Sony)]

[JVET-Q0285](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9110) AHG9: On adaptation parameter set ID [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

Item 1 of this contribution belongs to this category.

[JVET-Q0375](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9200) AHG9: A cleanup on the signalling of subpicture IDs [D. Kim, G. Ko, J. Jung, J. Son, J. Kwak (WILUS)]

[JVET-Q0412](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9237) AHG9/AHG12: A syntax and semantics fix for subpicture ID mapping [J. Chen, R.-L. Liao, Y. Ye, J. Luo (Alibaba)]

#### Subpicture based bitstream merging (5)

[JVET-Q0233](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9058) AHG17 Signalling subpicture without slice for merged and other use cases [M. Hirabayashi, M. Katsumata, T. Suzuki (Sony)]

[JVET-Q0401](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9226) AHG9/AHG12: On bitstream merging [R. Skupin, Y. Sanchez, K. Sühring, T. Schierl (HHI)]

[JVET-Q0409](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9234) AHG12: On APS id for bitstream merging for VVC [N. Ouedraogo, E. Nassor, F. Denoual, F. Mazé (Canon)]

[JVET-Q0410](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9235) AHG12: Bitstream merging with variable initial Qp [N. Ouedraogo, E. Nassor, G. Kergourlay, F. Mazé (Canon)]

[JVET-Q0411](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9236) AHG12: On Subpictures merging for VVC [N. Ouedraogo, F. Denoual, F. Mazé (Canon)]

### Slices and tiles (19)

#### General

[JVET-Q0586](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9432) AHG9/AHG12: A summary of HLS contributions on tiles and slices [Hendry (LGE)] [late]

This contribution was discussed in Track A Wednesday 8 January 2020 at 2200 (chaired by GJS).

This contribution is an information contribution summarizing contributions on tiles and slices.

*On tiles*:

1. JVET-Q0244 aspect #1: signal a flag in the PPS to specify whether the widths of the tile columns are the same as the heights of the tile rows, with an exception for the last column and last row. If true, tile row information can be derived from tile column information.

It was commented that this is a high degree of customization for a very specialized use, motivated by bit savings at the PPS level and that the bit savings would likely not be very large. No action was taken on this.

1. JVET-Q0244 aspect 6: Proposed fixes for out of bound bugs in the derivation of CtbToTileColBd[ ] and CtbToTileRowBd[ ]. The proposed fixes are shown below:

The list CtbToTileColBd[ ctbAddrX ] for ctbAddrX ranging from 0 to PicWidthInCtbsY − 1, inclusive, specifying the conversion from a horizontal CTB address to a left tile column boundary in units of CTBs, is derived as follows:

tileX = 0  
for( ctbAddrX = 0; ctbAddrX < PicWidthInCtbsY; ctbAddrX++ ) {  
 if( tileX < NumTileColumns – 1 && ctbAddrX = = tileColBd[ tileX + 1 ] ) (27)  
 tileX++  
 CtbToTileColBd[ ctbAddrX ] = tileColBd[ tileX ]  
}

The list CtbToTileRowBd[ ctbAddrY ] for ctbAddrY ranging from 0 to PicHeightInCtbsY − 1, inclusive, specifying the conversion from a vertical CTB address to a top tile column boundary in units of CTBs, is derived as follows:

tileY = 0  
for( ctbAddrY = 0; ctbAddrY < PicHeightInCtbsY; ctbAddrY++ ) {  
 if( tileY < NumTileRows – 1 && ctbAddrY = = tileRowBd[ tileY + 1 ] ) (28)  
 tileY++  
 CtbToTileRowBd[ ctbAddrY ] = tileRowBd[ tileY ]  
}

Decision (BF): Adopted.

1. JVET-Q0359 aspect 1: proposes a constraint that the syntax shall not indicate a sum of tile widths/heights that is wider than the picture width/height.

Decision (editorial BF): Adopted. The editors are given discretion to finalize how this is expressed. It was suggested to express this as a constraint on the value range of the width and height syntax elements rather than as a constraint on the sum.

1. JVET-Q0359 aspect 2: Add the following: for i in the range of 0 to num\_slices\_in\_pic\_minus1-1, inclusive , the sum of tile\_idx\_delta[ i ] shall less than NumTilesInPic.

This proposed change was not necessary because of existing constraints expressed on syntax elements in the text, so no action was needed on this.

*On rectangular slices containing one or more tile*

This contribution was further discussed in Track A Thursday 9 January 2020 at 0810 (chaired by GJS).

1. Rectangular slice layout signalling:
   1. Keep the current signalling method (i.e., signalling slice width, slice height, and tile idx delta). If we do this, we’ll need to consider all proposed miscellaneous changes in the next list below.
   2. Go back to previous signalling method such as for each rectangular slice, signal only the information about the bottom-right tile index (JVET-Q0202). If we do this, we can skip discussing most proposed improvements in the next list below below, except item h.

The subpicture aspect of this proposal was discussed earlier in the meeting with no action. Due to a need for consistency in the signalling schemes, no action was taken on this.

1. Proposed additional features for rectangular slices:
   1. Allow the possibility to define rectangular slice in PPS based on CTU height. This is asserted will allow defining rectangular slice within subpicture without tiles (JVET-Q0164).

A participant commented that the current scheme can do essentially what is proposed, although it is not customized to be especially efficient in that case.

With the current scheme, vertical slice boundaries must be tile boundaries. (What about single\_slice\_per\_subpic\_flag? Revisit after double-checking that – it was commented that the design intent was to not have vertical cuts within a tile in that case either. That flag was just proposed as a signalling shortcut – not with an intent to provide alternative functionality. See the definition of *slice* in the text for an expression of this.)

It is not allowed to have vertical subpicture boundaries within a tile.

The contributor agreed that this proposal was not mature for action at this meeting, because it would pose implementation difficulties as proposed. However, the contributor wanted to raise awareness of the limitation in the design, such that the current scheme requires the use of tiles to achieve some subpicture layouts.

There is a current specified limit on the number of tile cuts as a function of level (Annex A), for example HD 60 fps would ordinarily use level 4, in which there is a limit of 5 tiles vertically and 5 tiles horizontally. It was asked whether, if vertical boundaries are the primary problem, why not allow more horizontal cuts than vertical cuts? There should be additional study to check that. It was commented that not a lot of thought went into whether the numbers that were put into the draft were appropriate in the VVC context, as they came from HEVC.

* 1. To have a signalling shortcut single\_tile\_per\_slice\_flag in the PPS and use it to condition further signalling of syntax elements in the PPS related to rectangular slices. Also to condition the presence of single\_tile\_per\_slice\_flag on the value of single\_slice\_per\_subpic\_flag (JVET-Q0204, JVET-Q218 aspect 2, and JVET-Q0289 aspect 1)

It was commented that we already have a shortcut for a single slice per subpicture. This proposed flag would be for when that does not apply. For example, when there are tiles but there are no subpictures, and each tile is a slice. A potential use case that was mentioned was ultra-low-delay using tiles. Using raster scan slices with one tile per slice was suggested as the more likely approach for this.

It was not clear that this is needed for a common use case. There was also a concern that adding another special case complicates the scheme for determining the segmentations. No action was thus taken.

* + 1. loop\_filter\_across\_tiles\_enabled\_flag is proposed to not be present when the value of single\_tile\_per\_slice\_flag is equal to 1 (JVET-Q0289 aspect 1)

No action was taken on this since there was no action on the above item.

* 1. Replace num\_slice\_in\_pic\_minus1 with num\_slice\_in\_subpic\_minus1[ i ] (JVET-Q0377 aspect 1).

This would be a change in the PPS, based on information from the SPS. A revision of the proposal fixed the parsing dependency by ensuring that the number of subpictures is available in the PPS for use by this signal.

This is one part of a larger proposal that also includes another item below. See the notes on the aspect 2 of JVET-Q0377.

1. Misc proposed changes for rectangular slice signalling:
   1. Condition the presence of tile\_idx\_delta\_present\_flag on the value of num\_slices\_in\_pic\_minus1. It is asserted that tile\_idx\_delta\_present\_flag is not necessary to be present when the value of num\_slices\_in\_pic\_minus1 is equal to 0 (JVET-Q0218 aspect 1).

This is just a syntax table presence conditioning for a case where a flag is not relevant.

Decision (cleanup): Adopt. Text is in the proposal document (proposal #1).

* 1. Add inference value for single\_slice\_per\_subpic\_flag when not present to be equal to 0. This is asserted to be needed since the flag is used in the conditioning of syntax elements in PPS and also in the derivation of CTB raster scanning, tile scanning, and subpicture scanning processes. (JVET-Q0218 aspect 3).

This is just a little spec bug fix for the sake of making sure that anything that is referred to has a value. It may not be really necessary but is desirable for the sake of completeness, so that there is a defined value for anything that is checked in any “if” statement, regardless of whether its value matters or not.

Decision (Ed. BF): Adopt. Text is in the proposal document (proposal #3).

* 1. Replace tile\_idx\_delta[ i ] with tile\_idx\_delta\_minus1[ i ] and tile\_idx\_delta\_sign[ i ]. tile\_idx\_delta\_sign[ i ] is not present for the first slice (JVET-Q0228 aspect 1).

This is just an alternative to se(v) coding that complicates the syntax table and doesn’t seem necessary, so no action was taken on this.

* 1. Signal the following two new flags (JVET-Q0230):
* multiple\_slice\_in\_tile\_present\_flag to indicate whether at least one tile is composed of more than slice or not
* multiple\_slice\_in\_tile\_flag[ i ] to indicates whether a tile is composed of more than one slice or not.

This would be a syntax shortcut. The proponent said it would save about 17 bits per PPS in an example OMAF use case. It was commented that this seems like over-optimization with additional checks for a very specialized case, and that bit savings in the PPS is not especially high priority. So no action was taken on this.

* 1. Signal a flag for each rectangular slice in the picture to indicate if the slice height in tiles is the same as the slice width in tiles. If this flag is false, then the slice height would explicitly signalled (JVET-Q0244 aspect 2).

This would be a syntax shortcut for a special case that doesn’t seem important to optimize for. No action was taken on this.

* 1. Signal rectangular slice width in tiles only when number of tile column is greater than 1; likewise, signal rectangular slice height only when the number of tile row is greater than 1 (JVET-Q0244 aspect 3).

This is a typical logic flow adjustment to avoid sending something that is required to have a specific value. Decision (cleanup): Adopt. Text in JVET-Q0244 aspect 3 and software responsibility to be from its proponent.

* 1. Remove the second condition that guards the presence of tile\_idx\_delta[ i ] (i.e., i < num\_slices\_in\_pic\_minus1) is not really needed as it is always true anyway (JVET-Q0244 aspect 5).

After some offline discussion, this was withdrawn as not valid.

* 1. Replace the signalling of the number of slices in picture with the signalling of the delta between the number of subpictures in picture and the number of slices in picture. Instead of num\_slices\_in\_pic\_minus1, signal num\_slices\_in\_pic\_minus\_num\_subpics (JVET-Q0332).

The proposal had a parsing dependency bug, and was revised to fix the bug. The fix would involve moving pps\_num\_subpics\_minus1 outside of a condition check, which would not provide a bit savings (and would likely have a bit penalty) in the case where pps\_num\_subpics\_minus1 would not have been sent (since sending *a* and *b* tends to require sending more bits than sending *a+b*). This didn’t seem to be substantially beneficial, so no action was taken on it.

* 1. Propose that when in raster rectangular slice mode (tile\_idx\_delta\_present\_flag equals 0), only specify the slice\_height\_in\_tiles\_minus1 syntax element at the start of each rectangular slice row. If it is asserted that this would prevent possibility to signal a slice height that is illegal (JVET-Q0480)

It was asked whether the current design allows rectangular slices that have a decreasing height within a row. There are two modes of signalling rectangular slices based on the tile\_idx\_delta\_present\_flag; this contribution deals with the shortcut case when that flag is 0. In that shortcut case, it is not possible to have this behaviour.

This proposal is a typical logic flow adjustment to avoid sending something that is required to have a specific value and to more clearly define when the shortcut case can be used.

Decision (BF & cleanup): Adopt. Text in JVET-Q0480 (needing an editorial adjustment to not set a syntax element to a value in an equation) and software responsibility to be from its proponent.

* 1. Editorial changes for semantics of tile\_idx\_delta[ i ] and num\_tiles\_in\_slice\_minus1 (JVET-Q0289 aspect 3).

Decision (Ed.): The first aspect is editorial and was delegated to the editors for consideration.

The second part of this (an inference) is only really needed if it is possible to have a raster scan slice when no\_pic\_partition\_flag is equal to 0 but there is only one tile. It was remarked that there is a ticket about this case and there had been email reflector discussion. It was agreed that this combination should not be supported, since the intent is that rectangular slice mode should be used instead in this case.

Decision (BF): If NumTilesInPic is equal to 1, don’t signal the rect\_slice\_flag and infer its value to be 1. Text and software (which are minor) to be provided by Ye-Kui Wang.

*On rectangular slices within a tile*

1. Remove signalling of slices within a tile. It is asserted initial concept of “tile-fraction” slices targets bitstream extraction and merging operations for omnidirectional content for which subpictures where adopted in VVC (JVET-Q0377 aspect 2).

If we do this, we would not need to discuss the proposed items 2 and 3 below.

Currently SPS defines the subpicture layout, PPS defines the slice layout, with semantics constraint so that each subpicture contains a number of complete slices. (The slice address specifies the slice index within the subpicture.)

This contribution proposes to change the syntax so that, rather being a matter of semantics constraint, it would not be possible to express a violation of that semantics constraint. Instead, the PPS syntax would have a loop on the number of subpictures, and then describe the slices as a subset of each subpicture.

The relationship to Q0044 was discussed. A participant said that this proposal would be helpful as syntax cleanup, but that the action taken on Q0044 already accomplishes that goal, so this proposal becomes appropriate only if some additional allowed cases are desirable to prohibit by syntax design.

* A side effect of the proposal is that it would not be possible to have a subpicture that contains multiple incomplete tiles – i.e., it would enforce the constraint proposed in item 1 of Q0210.
* A second side effect is that it would not be possible to have a subpicture that is a subset of a tile to contain multiple slices.

It was commented that if a constraint is imposed by syntax rather than semantics, it would not be possible to use profiling to enable or disable the constraint.

The second side effect was considered more serious than the first one. Some participants objected to the proposal, saying there are some scenarios where it would be desirable to use the disallowed combination. Thus, no action was taken on this.

1. In the PPS, for signalling of slices within a tile, instead of signalling all the slice heights, except for the last slice in that tile, signal explicit slice height, which may be less than the number of slices within that tile minus 1, and the height of the rest of slices in that tile is derived (JVET-Q0203, JVET-Q0228 aspect 2, and JVET-Q0373 aspect 3).

This is a syntax modification to establish a shortcut for slice structure signalling (in the PPS) that is similar to a shortcut used for tile structure signalling (also in the PPS). This would improve design consistency.

Decision (cleanup): Adopt based on text for Q0203. Hendry responsible for software.

1. Signal the number of rectangular slices in a tile only when the number of CTU rows within the tile is greater than 1 (JVET-Q0244 aspect 4 and JVET-Q0373 aspect 2).

This is consistent with the idea of not signalling things that are required to have a specific value.

Decision (cleanup): Adopt based on text for Q0244. Hendry responsible for software.

1. Propose to infer the syntax element of slice\_height\_in\_ctu\_minus1 as value of 0 when the corresponding tile’s height is the same as the number of slice in the tile in the unit of CTU (JVET-Q0373 aspect 1). This was no longer needed due to the action on item 2 above.

*On other aspects of slices*

1. JVET-Q0119 aspect 6: When rect\_slice\_flag is equal to 1, the length of slice\_address is specified to be Max( Ceil( Log2( NumSlicesInSubpic[ SubPicIdx ] ) ), 1 ) bits, as opposed to be Ceil( Log2( NumSlicesInSubpic[ SubPicIdx ] ) ) bits. This is a bug fix proposal.

Decision (cleanup): Instead, condition the presence of the slice\_address on NumSlicesInSubpic[ SubPicIdx ] being greater than 1 (in addition to the other presence conditions). Ye-Kui Wang responsible for text and software.

1. The following may need to be discussed (See summary for each contribution in section 5):
   1. JVET-Q0201: Asserted that there are some problems with slice\_data signalling and proposes fixes for them

It was commented that the three proposed bug reports may not be valid, so it was agreed not to take action unless offline study indicates otherwise.

* 1. JVET-Q0223: Proposes having dependent slices.

The motivation for having dependent slices is to have a fragmentation of a slice into multiple NAL units (at a coding-level feature, rather than depending on system-level fragmentation), primarily for delay optimization (so the encoder can send a NAL unit without first generating the data for the remaining CTUs), without breaking prediction processes.

The proposal did not provide complete text.

It was commented that the picture header can be used to reduce the overhead of slice headers, which is somewhat similar to the abbreviated slice header design used in dependent slices.

In addition to saving header overhead, dependent slice segments (in HEVC) do not reset decoder state and have prediction processes that can cross slice segment boundaries. This has a coding efficiency benefit relative to using separate slices.

Each slice segment is proposed to be composed of an integer number of tiles. It was pointed out that prediction across tile boundaries is not allowed, so the claimed coding efficiency benefit is not really provided.

The slice segment header would say how many tiles of the slice are in the slice segment.

The proposed syntax includes indicating in the slice header the number of dependent slices. It was commented that this may be undesirable as it may not have been been determined in advance.

Since this was a large proposed change and the proposal was incomplete and had readily apparent problems in its design and claimed benefits, no action was taken on this.

* 1. JVET-Q0224 & JVET-Q0225: Allow CTU-based raster-scan slices, in addition to tile-based raster-scan slice.

Text for the decoding process was not provided. Since this was a large proposed change and the proposal was incomplete, no action was taken on this.

#### Tile and rectangular slice signalling in the PPS (14)

[JVET-Q0164](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8989) AHG9: On indication of rectangular slice height in video subpictures [P. Wu (ZTE)]

[JVET-Q0202](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9027) [AHG12]: On signalling of subpicture and rectangular slice [Hendry, S. Paluri (LGE)]

The rectangular slice signalling part of this contribution belongs to this category.

[JVET-Q0203](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9028) [AHG12]: On signalling of multiple rectangular slices in a tile [Hendry, S. Paluri (LGE)]

[JVET-Q0204](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9029) [AHG12]: On single tile per slice flag [Hendry, S. Paluri (LGE)]

[JVET-Q0218](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9043) AHG12/ AHG9: On Slice Signalling [S. Deshpande (Sharp)]

[JVET-Q0228](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9053) AHG12: Signalling of rectangular slices [B.-K. Lee (Xris), D. Jun (Kyungnam University)]

[JVET-Q0230](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9055) AHG12: Signalling of multiple slices in a tile [B.-K. Lee (Xris), D Jun (Kyungnam University)]

[JVET-Q0244](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9069) [AHG12]: Misc improvements to tile and rectangular slice signalling [S. Paluri, Hendry (LGE)]

[JVET-Q0289](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9114) AHG9/AHG12: Comments on miscellaneous HLS text [L. Chen, C.-W. Hsu, C.-C. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

Items 1 and 3 of this contribution belong to this category.

[JVET-Q0332](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9157) AhG12: On the numbers of slices and subpictures [Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-Q0359](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9184) AHG12: Constraints on tile signaling [X. Ma, H. Yang (Huawei)]

[JVET-Q0373](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9198) AHG12: On signalling of slice [J. H. Do, Y.-U. Yoon, D. H. Park, J.-G. Kim (KAU)]

[JVET-Q0377](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9202) AHG12: On "tile-fraction" slices and signaling of slices per subpicture [N. Ouedraogo, G. Laroche, P. Onno (Canon)]

[JVET-Q0480](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9307) AHG9: A More Robust Syntax for Raster Rectangular Slices [W. Wan, T. Hellman, B. Heng (Broadcom)]

#### Other aspects of slices (5)

[JVET-Q0119](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8944) AHG12: Cleanups on signalling of subpictures, tiles, and rectangular slices [Y.-K. Wang (Bytedance)]

Item 6 of this contribution belongs to this category.

[JVET-Q0201](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9026) [AHG12]: On slice data signalling [Hendry, S. Paluri (LGE)]

[JVET-Q0223](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9048) AHG9/AHG12: On dependent slice and slice header [L. Chen, C.-C. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-Q0224](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9049) AHG9/AHG12: On raster scan slice within a picture [L. Chen, C.-C. Chen, C.-W. Hsu, Y.-L. Hsiao, Y.-W. Huang, S.-M. Lei (MediaTek)]

See also the notes for Q0210 aspect #5 (section 6.20.1.2) for one aspect of this contribution.

[JVET-Q0579](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9425) Crosscheck report of JVET-Q0224 [X. Xu (Tencent)] [late]

[JVET-Q0225](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9050) AHG9/AHG12: On raster scan slice within a tile [L. Chen, C.-C. Chen, C.-W. Hsu, Y.-L. Hsiao, Y.-W. Huang, S.-M. Lei (MediaTek)]

### Control of loop filtering across subpicture/tile/slice boundaries (4)

See also

[JVET-Q0120](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8945) AHG12: Control of loop filtering across subpicture/tile/slice boundaries [L. Zhang, Y.-K. Wang, K. Zhang (Bytedance)]

[JVET-Q0317](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9142) AHG9: A cleanup on de-blocking filtering between subpictures [K. Zhang, L. Zhang, Y.-K. Wang, H. Liu, J. Xu, Z. Deng (Bytedance)]

This includes some changes to the deblocking filtering process.

[JVET-Q0352](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9177) AHG9/AHG12: On subpicture boundary [H. Jang, J. Nam, N. Park, S. Kim, J. Lim (LGE)]

Item 1 of this contribution belongs to this category.

[JVET-Q0475](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9301) [AHG9/AHG12] On subpicture signaling [Y. He, A. Hamza (InterDigital)]

Item 3 of this contribution belongs to this category.

### Tile/WPP entry point offset signalling (2)

[JVET-Q0151](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8976) AHG12: On entry point offset signalling [M. Coban, Y.-J. Chang, V. Seregin, A. K. Ramasubramonian, M. Karczewicz (Qualcomm)]

[JVET-Q0205](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9030) [AHG12]: On the presence of entry point signalling [Hendry, S. Kim, S. Lee (LGE)]

## AHG8: layered coding and resolution adaptivity (19)

### Scalability specific HLS (20)

#### VPS scalability information signalling (6)

[JVET-Q0046](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8871) AHG9: On signalling of PTL/HRD parameters for single layer OLSs and DPB parameters for independent layers [T. Nishi, K. Abe, V. Drugeon (Panasonic)]

Sat 1010 Track A GJS

In the current draft specification, PTL parameters and HRD parameters are not signalled in the VPS for OLSs which have only one layer since the PTL and HRD parameters signalled in the corresponding SPS are used instead. Similarly, DPB parameters from the VPS are not used for independent layers. In order to know the characteristics of the whole multi-layer bitstream by parsing only the VPS, it is proposed to signal, in the VPS, identical PTL/DPB/HRD parameters as in the corresponding SPS for single layer OLS and independent layers.

It was commented that there are especially related proposals on this topic, Q0118 and Q0220.

There are three relevant issues addressed in these related proposals relating to the one-layer case:

* Whether to signal PTL info of OLSs containing only one layer in the VPS (in addition to signalling them in the SPS). This was agreed.
* Whether to signal HRD parameters info of OLSs containing only one layer in the VPS (in addition to signalling them in the SPS). It was agreed not to do this.
* Whether to signal DPB parameters (max dec pic buffering, max reordering, max latency) of OLSs containing only one layer in the VPS (in addition to signalling them in the SPS). Revisit after considering other contributions.

Revisit for review of text for the first two items to be developed offline.

[JVET-Q0047](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8872) AHG9: Unified signalling of PTL and HRD parameters in VPS [T. Nishi, K. Abe, V. Drugeon (Panasonic)]

This contribution proposes to signal PTL and HRD for each OLS individually. Others commented that this might result in repeating some information too many times, so no action was taken on this.

[JVET-Q0118](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8943) AHG8/AHG9: Scalability HLS clean-ups [Y.-K. Wang (Bytedance)]

Sat 1500 Track A GJS

For the PTL and HRD signalling aspects, see notes for Q0046.

This contribution proposes the following scalability HLS cleanup changes:

1. Require the slice\_type to be 2, not only for the first picture in an AU that is an IRAP picture, but also for IRAP pictures in independent layers. Decision (expression of existing intent): Agreed.
2. Infer the value of ols\_ptl\_idx[ i ] to be equal to 0 when the syntax element is not present. See notes for Q0046.
3. Specify the variable LayerUsedAsOutputLayerFlag[ i ] indicate whether the i-layer is used as an output layer in whichever OLS, and when the value of the variable is equal to 0, the signalling of layer\_output\_dpb\_params\_idx[ i ] is avoided. In the review of this, a bug was found in its pseudo-code. It was commented that it seems nice to have a clear identification that a layer is used as an output layer. It was also suggested to check whether it is possible for the expressed constraint to be violated. Decision (cleanup): Adopt with correction of the bug. Text to be provided in a revision.
4. Change vps\_num\_dpb\_params to vps\_num\_dpb\_params\_minus1. Revisit after offline checking.
5. Signal the PTL information for OLSs containing only one layer also in the VPS for session negotiation purpose and consequently change vps\_num\_ptls to vps\_num\_ptls\_minus1. See notes for Q0046.
6. Replace the following constraint:

When sps\_video\_parameter\_set\_id is equal to 0, the CVS shall contain only one layer (i.e., all VCL NAL unit in the CVS shall have the same value of nuh\_layer\_id).

with the following constraint:

The value of sps\_video\_parameter\_set\_id shall be the same in all SPSs that are referred to by coded pictures in a CVS and that have sps\_video\_parameter\_set\_id greater than 0.

After discussing the implications of the proposal, it was agreed *not* to do this.

Decision (Ed.): Review the clarity and potentially remove/rephrase all instances of “and that” in the text (at least when not preceded with a comma).

[JVET-Q0122](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8947) AHG9/AHG8: Some HRD clean-ups [Y.-K. Wang (Bytedance)]

Sat 1545 Track A GJS

This contribution proposes the following cleanup changes on HRD:

* The vps\_general\_hrd\_params\_present\_flag is not signalled when vps\_general\_hrd\_params\_present\_flag is equal to 1, and when not present, the value of vps\_general\_hrd\_params\_present\_flag is inferred to be equal to 0. Furthermore, the syntax condition for num\_ols\_hrd\_params\_minus1, i.e., "if( TotalNumOlss > 1 )", is removed.
* The HRD parameters for OLSs containing only one layer are only signalled in SPSs, not in the VPS.

Both aspects had been addressed by other actions that were taken at the meeting, so no additional action was needed.

[JVET-Q0220](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9045) AHG8/AHG9: On VPS and Output Layer Set Signalling [S. Deshpande (Sharp)]

Sat 1550 Track A GJS

For the PTL and HRD signalling aspects, see notes for Q0046.

The issues discussed in the contribution had been addressed by other actions that were taken at the meeting, so no additional action was needed.

[JVET-Q0786](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9632) AHG9: On PTL and HRD Parameters Signalling in VPS [S. Deshpande (Sharp), Y.-K. Wang (Bytedance), V. Drugeon (Panasonic)]

#### DPB operation for multi-layer OLSs (2)

[JVET-Q0158](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8983) AHG8: Clarification on DPB structure and picture output [V. Seregin, A. K. Ramasubramonian, M. Coban, M. Karczewicz (Qualcomm)]

Sat 1555 Track A GJS

This contribution proposes clarifications for picture output process and DPB structure considering multi-layer coding.

* If the DPB parameter max\_dec\_pic\_buffering\_minus1[ ] signalled per layer indicates the sub-DPB requirements, and not full DPB requirements, to decode a picture of a layer without considering inter-layer prediction, then it is proposed to add a constraint that the sum of max\_dec\_pic\_buffering\_minus1[ Htid ] across layers is in the range of 0 to MaxDpbSize – 1 for any OLS.
* It is proposed to clarify what processes are invoked for a sub-DPB (pictures with the current picture nuh\_layer\_id) and processes invoked across all layers in DPB.

The intent is that the DPB capacity is shared across all layers.

It was also discussed whether we count pictures or bytes. It was agreed that we always count in units of pictures.

It was also agreed that (e.g., as has been the case for single-layer AVC and HEVC bitstreams), that the DPB capacity in units of pictures can be larger when the picture size is smaller.

The conceptual picture size is the largest value of max\_width \* max\_height among all the SPSs in the OLS. This needs to be signalled in the VPS (and this isn’t currently in the pictures).

It is currently specified that the DPB capacity can never be higher than 16 pictures.

It was discussed whether we need a “sub-DPB” concept. Perhaps not.

It was agreed that when the decoder needs to bump a picture, it bumps the lowest-layer picture with the oldest POC that is waiting for output. This way the pictures will always be output in the correct order across all layers.

Revisit after offline consideration.

[JVET-Q0308](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9133) [AHG9]: On DPB parameter for output layer set [Hendry (LGE)]

Sat 1800 Track A GJS

It is asserted that the current VVC draft text has the following problems related to the signalling of DPB parameter for multilayer bitstream:

1. The required DPB size for decoding an OLS is not known. The sum of max\_dec\_pic\_buffering\_minus1[ ] + 1 of each layer in the OLS may not be the actual required DPB size for the OLS.
2. The condition for invoking bumping process may not be adequate since it only considers DPB parameter for the layer containing the current picture being decoded. Bumping process may not be invoked even when there is not enough buffer in the DPB.

This contribution proposes the following:

1. In addition to signalling DPB parameter to each layer mapping, signal also DPB parameter to OLS mapping.
2. The signalling of DPB parameter to OLS mapping may be optional. When not present, the value of max\_dec\_pic\_buffering\_minus1[ i ] for each OLS is derived to be equal to the sum of max\_dec\_pic\_buffering\_minus1[ i ] plus 1 of all layers in the OLS minus 1.
3. The value of max\_dec\_pic\_buffering\_minus1[ hightes temporal sublayer ] of each OLS shall not be greater the MaxDpbSize minus 1 and also sum of max\_dec\_pic\_buffering\_minus1[ hightes temporal sublayer ] plus 1 of each layer in the OLS minus 1.
4. DPB parameter assigned for an OLS may contain only DPB size information.
5. Update the conditions for invoking bumping process to also consider the number of pictures in the DPB and the value of max\_dec\_pic\_buffering\_minus1[ i ] of the OLS being processed by the decoder.

Revisit after offline consideration.

#### STSA picture related (3)

[JVET-Q0156](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8981) AHG8: Enabling inter-layer prediction for STSA pictures [V. Seregin, A. K. Ramasubramonian, M. Coban, M. Karczewicz (Qualcomm)]

Sat 1830 Track A GJS

In VVC draft 7, STSA pictures cannot use a reference picture having the same temporal ID equal to the temporal ID of the STSA, which includes inter-layer reference pictures. This disables a use of inter-layer prediction for STSA pictures. In this contribution, it is proposed to enable inter-layer prediction for STSA pictures.

The contribution has a second aspect that isn’t mentioned in the summary and isn’t about the bug fix.

Decision (expression of existing intent): Adopt (first aspect only).

[JVET-Q0237](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9062) AHG8/AHG9: On STSA pictures in dependent layers [M. M. Hannuksela (Nokia)]

Sat 1840 Track A GJS

The contribution proposes the following items:

1. It is proposed to keep the VVC Draft 7 design that there is no requirement on having aligned STSA pictures in an access unit. This was confirmed.
2. It is proposed to allow STSA picture with TemporalId equal to 0 in a dependent layer. Decision (expression of existing intent): Adopt.
3. It is proposed to allow inter-layer prediction of an STSA picture in a dependent layer. This is the same bug reported in Q0156.

[Unless specified otherwise, text is in the meeting notes or the contribution and the first author of the first document listed is responsible for the software and for fixing any text deficiencies.]

[JVET-Q0279](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9104) AHG8/AHG9: On alignment across layers [B. Choi, S. Wenger, S. Liu (Tencent)]

Sat 1845 Track A GJS

Item 2 of this contribution belongs to this category.

This aspect was the same as the second aspect of Q0156; see the notes for that contribution.

#### Colour format and bit depth cross layers (3)

[JVET-Q0172](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8997) AHG9: Chroma format and bitdepth constraint for multi-layer structure [T.-D. Chuang, L. Chen, O. Chubach, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

Sat 1850 Track A GJS

In VVC Draft 7, the chroma format and bitdepth of each video layer are independently signalled in the SPS without any constraint. In this contribution, for chroma format, it is proposed to add a bitstream conformance requirement that the values of chroma\_format\_idc in all video layers shall be the same, or the value of chroma\_format\_idc in a video layer shall be greater than or equal to the value in any lower reference video layer. For bitdepth, a bitstream conformance requirement is proposed: the value of bit\_depth\_minus8 in a video layer shall be greater than or equal to the value in any lower reference video layer. The corresponding decoding process modifications for supporting different chroma formats or different bitdepths in reference picture are also provided in this contribution.

This includes 4:2:0 chroma location shifts across layers.

For prediction from monochrome, the prediction would be the mid-level (neutral chroma) value.

It was discussed that this could affect the Main 10 profile in three ways:

* 10 bit enhancement with 8 bit base layer
* 4:2:2 enhancement with monochrome base layer
* 4:2:0 enhancement with 4:2:0 base layer with different chroma positioning alignments

Software for the scheme had not yet been tested.

Decision: Disallow differing chroma format and different bit depths for cross-layer prediction. Text is delegated to the editors. (This would still allow, for example, an OLS to contain two independent layers with different chroma formats or bit depths – e.g., 4:2:0 texture with a monochrome depth map.)

[JVET-Q0279](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9104) AHG8/AHG9: On alignment across layers [B. Choi, S. Wenger, S. Liu (Tencent)]

Sat 1940 Track A GJS

Item 3 of this contribution belongs to this category, and is on the same subject as Q0172; see the notes for that contribution.

[JVET-Q0355](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9180) AHG8/AHG9: Cleanup on multi-layer coding [X. Ma, H. Yang (Huawei)]

Sat 1940 Track A GJS

Item 2 of this contribution belongs to this category, and is on the same subject as Q0172; see the notes for that contribution.

#### Misc. scalability HLS topics (6)

[JVET-Q0170](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8995) AHG9: On inter-layer referencing of ALF [O. Chubach, C.-Y. Lai, C.-Y. Chen, L. Chen, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

Sat 1950 Track A GJS.

In this contribution, it is proposed to add support for inter-layer referencing between a direct reference layer and the current layer for adaptive loop filter (ALF) adaptation parameter set (APS). For that, two syntax designs are proposed.

It was commented that sharing an APS across layers is allowed, so no action was needed.

[JVET-Q0180](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9005) AHG9: On inter-layer referencing of scaling list and LMCS [C.-Y. Lai, O. Chubach, C.-Y. Chen, L. Chen, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

Sat 1950 Track A GJS.

In this contribution, it is proposed to add support for inter-layer referencing between a direct reference layer and the current layer for two adaptation parameter set (APS) types: scaling list (SL) and luma mapping with chroma scaling (LMCS). For that, two syntax designs are proposed.

It was commented that sharing an APS across layers is allowed, so no action was needed.

[JVET-Q0277](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9102) AHG8/AHG9: Layer dependency constraints for parameter set reference [B. Choi, S. Wenger, S. Liu (Tencent)]

Sat 1955 Track A GJS.

In this contribution, it is proposed to impose additional constraints to make the support of parameter set reference across layers clear. The proposed constraint is that a coded slice NAL unit shall only refer to a PPS/APS in the same layer or in a (direct) reference layer, and a PPS NAL unit shall only refer to a SPS in the same layer or in a (direct) reference layer.

The proposal would disallow sharing across independent layers.

The current text could be misinterpreted as saying that there must be some VCL NAL unit that refers to the SPS/PPS/APS.

Decision: Only allow references to SPSs/PPSs/APSs that are in the current or lower layer that is in an OLS that includes the VCL NAL unit. Ye-Kui Wang is responsible for the providing text. B. Choi is to provide the conformance check for the decoder software.

[JVET-Q0279](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9104) AHG8/AHG9: On alignment across layers [B. Choi, S. Wenger, S. Liu (Tencent)]

Sat 2030 Track A GJS.

Item 1 of this contribution belongs to this category.

Item 1 proposes that if the current picture is RASL, a picture referencing the current picture in the same AU shall be equal to RASL.

It was remarked that we do not require IRAP pictures to be aligned across layers, so it should be allowed for a RASL to reference a trailing picture in a reference layer. Thus, no action was taken on this.

[JVET-Q0342](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9167) AHG9: on signaling inter-layer dependency information in SPS [B. Wang, S. Esenlik, A. M. Kotra, H. Gao, E. Alshina (Huawei)]

Sat 2040 Track A GJS.

It is asserted that the current semantics of inter\_layer\_ref\_pics\_present\_flag is not sufficient to address a situation when a sequence parameter set (SPS) is shared by multiple video coding layers wherein some of the shared layers are independent while the others have dependent layers. In such a case, the value of inter\_layer\_ref\_pics\_present\_flag shall be 1 for the dependent shared layers but at the same time shall be 0 for independent shared layer. This contribution proposes two alternative solutions to this issue.

The current text prohibits sharing in some cases. An SPS cannot be shared by a dependent layer and an independent layer.

The proposed approach #1 seemed awkward, as it would add a multilayer loop in the SPS. The proposed approach #2 would disallow sharing. The current approach seems acceptable, so no action seemed necessary. Further study was encouraged.

Decision (Ed.): The name and phrasing of the semantics of inter\_layer\_ref\_pics\_present\_flag should be editorially reviewed.

[JVET-Q0355](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9180) AHG8/AHG9: Cleanup on multi-layer coding [X. Ma, H. Yang (Huawei)]

Sat 2100 Track A GJS.

Item 1 of this contribution belongs to this category.

Item 1 proposes Constrains sps\_poc\_msb\_flag to be 0 when vps\_max\_layers\_minus1 is equal to 0.

It was remarked that this could cause a problem for extraction with VPS rewriting, and did not seem necessary, so no action was taken on this.

### Reference picture resampling (RPR) specific HLS (0)

# Complexity analysis (3)

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

[JVET-Q0049](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8874) Bit Stream Feature Analyzer (BSFA) for Coding Tool Statistics Based on VTM-7.0 [C. J. Herglotz, M. Kränzler, A. Kaup]

[JVET-Q0051](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8876) Analysis of the Energy-Time Relationship for VVC and HEVC Software Video Decoders [M. Kränzler, C. J. Herglotz, A. Kaup]

[JVET-Q0052](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8877) Modeling of the Decoding Energy for VTM-7.0 with a Bit Stream Feature-Based Model [M. Kränzler, C. J. Herglotz, A. Kaup]

# Encoder optimization (7)

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

[JVET-Q0433](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9258) Encoder only: On unbalanced luma/chroma gains for dependent quantization [H. Schwarz (Fraunhofer HHI)]

[JVET-Q0447](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9273) Encoder estimation of weighted\_prediction parameters [P. Bordes, T. Poirier, F. Le Léannec (InterDigital)]

[JVET-Q0492](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9320) Non-CE2: Palette encoding with high QPs [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-Q0717](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9563) Crosscheck of JVET-Q0492 (Non-CE2: Palette encoding with high QPs) [Y.-C. Nien, T.-H. Li, Y.-C. Yang (Foxconn)] [late]

[JVET-Q0493](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9321) Non-CE2: Palette encoder improvements for lossless coding [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-Q0587](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9433) Crosscheck of JVET-Q0493 (Non-CE2: Palette encoder improvements for lossless coding) [R.-L. Liao (Alibaba)] [late]

[JVET-Q0502](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9330) Non-CE2: Encoder only approach for CTU row palette predictor initialization [Y.-H. Chao, W.-J. Chien, C.-H. Hung, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-Q0657](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9503) Cross-check of JVET-Q0502 (Non-CE2: Encoder only approach for CTU row palette predictor initialization) [Y.-W. Chen (Kwai Inc.)] [late]

[JVET-Q0503](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9331) CE2-related: Encoder improvement for palette mode [Y.-H. Chao, C.-H. Hung, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm), R.-L. Liao, M. Sarwer, J. Chen, Y. Ye, J. Luo (Alibaba)]

[JVET-Q0596](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9442) Crosscheck of JVET-Q0503 (CE2-related: Encoder improvement for palette mode) [H.-J. Jhu (Kwai Inc.)] [late]

[JVET-Q0712](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9558) Non-CE2: Extension of JVET-Q0503 to high QP [Y.-H. Chao, C.-H. Hung, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm), H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai), R.-L. Liao, M. Sarwer, J. Chen, Y. Ye, J. Luo (Alibaba)] [late]

[JVET-Q0772](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9618) Crosscheck of JVET-Q0712 (Non-CE2: Extention of error limit table in JVET-Q0503 to high QP) [[S. Yoo](mailto:sunmi.yoo@lge.com), J. Lim (LGE)] [late]

# Metrics and evaluation criteria (0)

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

# Withdrawn (18)

Section kept for future use.

JVET-Q0083 Withdrawn

JVET-Q0087 Withdrawn

JVET-Q0135 Withdrawn

JVET-Q0231 Withdrawn

JVET-Q0252 Withdrawn

JVET-Q0286 Withdrawn

JVET-Q0372 Withdrawn

JVET-Q0383 Withdrawn

JVET-Q0384 Withdrawn

JVET-Q0415 Withdrawn

JVET-Q0418 Withdrawn

JVET-Q0454 Withdrawn

JVET-Q0465 Withdrawn

JVET-Q0563 Withdrawn

JVET-Q0574 Withdrawn

JVET-Q0602 Withdrawn

JVET-Q0709 Withdrawn

JVET-Q0713 Withdrawn

JVET-Q0722 Withdrawn

JVET-Q0732 Withdrawn

# Plenary meetings, joint meetings, BoG reports, and summary of actions taken

## High-level syntax / systems relation meeting

This planned session was cancelled due to a lack of identified need.

## Plenary meeting Sunday 12 Jan. 0800-1215

Reports of the tracks were presented as follows:

The general status of tracks A and B was presented and discussed, which particularly included the following aspects:

Track A:

* CE4 and CE4-related (some addressed in BoG): Geometric prediction mode (0.3% RA, 0.7% LB, relative to the non-triangle anchor with approx. same complexity 0.7% RA, 1.6% LB)
  + CE4 test of harmonized design removing separate triangle mode confirmed: coding efficiency benefit, likely subjective benefit and possible other utility, no significant complexity impact (although extra verification effort), so mode adopted
  + Simplification by reducing number of partition modes to 64 from 82
  + Further simplification / consistency cleanup by sampling position change JVET-Q0188
  + Further complexity reduction & text simplification by LUT replacement with equation JVET-Q0365
  + Further complexity / verification effort reduction by disabling for 8x64 and 64x8
* Open question: Syntax level for signalling number of merge candidates (for multiple uses)
  + This involves four syntax elements –for regular mode, for triangle (geometry), for IBC and for subblock. They should be handled consistently, at the same syntax level. It was agreed (Saturday in Track A CE4 related discussion) that as far as the triangle/geometry control perspective is concerned, SPS level control over the number of merge candidates seemed sufficient. As far as Track A was concerned, establishing the max number of merge candidates for all of these at the SPS level without lower-level control seemed sufficient.

In the plenary, it was agreed to move all this control to the SPS level. Suggestion of flag and conditional send number minus 1 (except for geometry mode, which is to be signalled as a delta similar to VVC draft 7). Revisit in Track A for review of candidate text to be provided by Ling Li, Y.-J. Chang and S. Esenlik.

* High-level syntax
  + Various minor cleanups, bug fixes, clarifications, highlights:
    - Restructuring of the PH
    - POC LSB in the PH rather than the SH
    - Considering to allow PH to be put into SH for single-slice use
  + Two constraints similar to AVC and HEVC profiles
    - Disallow separate colour plane mode in the 4:4:4 profile(s); Revisit in Track A check whether there is a functioning specification of that case, consider renaming or removing the flag
    - Disallow in base and dependent enhancement layer differences of bit depth and chroma format (different chroma positions allowed)
  + A substantial amount of TBPs and revisits
  + A major BoG that has not yet finished or reported to the track

For software coordination, there was discussion of whether to set up a separate reflector for that, but it was agreed that such discussions can just be conducted on the main JVET reflector.

It was agreed in the plenary that palette mode will be prohibited in the planned 4:2:0 profiles.

Track B:

CE1: Deblocking

* Subjective (informal) viewing conducted
* Adopt JVET-Q0054, variant CE1-1-1. This resolves oversmoothing of long deblock filter.
* No action on other sub-CEs

CE2: Palette. No action from the CE itself, but there is a contribution related to CE2-1 recommended for adoption (improvement at low QP and lossless)

CE3: Lossless and near lossless

* Adopt JVET-Q0088, CE3-2.3, high-level switch between RRC and TSRC for TS.
* Further candidate for adoption: BDPCM for chroma in 4:2:0 (JVET-Q0089), extension on CE3-2.3 into CE3-2.4. Pending revisit on availability of CTC results
* This makes VVC slightly more efficient for lossless than HEVC, but more likely application of these modes is mixed lossy/lossless
* TSRC turns out rather being an SCC tool, but is efficient for SC.

CE5: CCALF

* Subjective (informal) viewing performed, visual artifact problem of CCALF resolved by encoder modification
* Candidate for adoption: CE5-2.1 (JVET-Q0073), simplification of common base, replacing multiplications by shift operations, same filter shape
* Roughly 1% gain in AI, 1.2-1.3% in RA, 1% in LB/LP (when shifting rate from chroma to luma)
* Pending further review of CE5 related contributions, looking for possible further improvements of CE5-2.1
* Desire to enable/disable at SPS, following ALF, no operation separate from ALF

Non-CE:

* Deblocking (CE1 related): Nothing noteworthy
* Loop filtering: Some cleanups, contribution on virtual ALF boundary problem (subjective viewing)
* Palette (CE2 related): Some cleanups and bug fixes, predictor initialization in WPP (JVET-Q0501), improved escape coding at low rates (JVET-Q0491), palette for non-444 (JVET-Q0503) – not intended for 4:2:0 profile, but 4:2:0 and 4:2:2 capable, restriction of 4x4 blocks
* Lossless coding (CE3 related): Nothing noteworthy
* Intra prediction: Some cleanups and bug fixes, MIP with constant shift/offset without loss (JVET-Q0446)
* Reference picture resampling: Only low-level reviewed, bug fix filters for normal blocks (JVET-Q0449) and downsampling filters for affine blocks (JVET-Q0517) -> most remaining aspects HLS, for track A
* Transforms and signaling: Some cleanups and bug fixes on MTS and LFNST
* Entropy coding: Update zero word threshold, only for high tier (JVET-Q0436)
* Quantization: Bugfix on inconsistency chroma QP adaptation, other items ongoing
* Remaining items: Partitioning, ACT and other chroma tools, CE5 related (BoG), inter prediction (new in track B, BoG), other tools, encoder optimization, etc.

Decisions recommended from trackA and B were agreed and approved, unless otherwise noted:

[Ed. check additional authors for Q0330, title for Q0366 (removing “non-CE3”), “P” 🡪 “Q” for titles of JVET-Q0531, Q0544, Q0545, and Q0546, check title of Q0427.]

[Q0242 should be grouped with Q0438.]

[RPR HLS aspects 🡪 plenary 🡪 Track A (session TBA)]

Subjective viewing VTM vs. HM was planned if feasible [M. Wien to coordinate]

Mathias, Ken, Dan and some other experts will identify suitable rate/quality points for VVC vs. HEVC comparison, in coordination with Vittorio, such that later during the week “dry run” tests could be done for checking the selection.

* Text and software development (2 → 1 )
* Test conditions (0)
* Performance assessment (3 TBP)
* Coding studies and tools on specific use cases (3 → 4 → 3) – Film grain discussed in plenary and planned for further study in an AHG
* Test Material (0)
* Conformance (1)
* Implementation studies (11) – moved most to inter prediction
* Profile/level specification (4) – two for parent-body joint meeting discussion, two others more specific

Among implementation studies, two software decoder implementation contributions were presented.

Conformance testing was discussed (see section 4.6).

Profile, tier and level were discussed (see section 4.6).

Need more consideration of potential removal of low-coding-gain stuff.

## Plenary meeting XXday, time.

VUI/SEI for source video size / suggested display size Q0159 / Q0260 / Q0288

## Closing Plenary meeting Friday 17 Jan.

… .

## Joint meeting XXday XX March XXXX-

JVET with … .

## BoGs (X)

[JVET-Q0625](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9471) Report of BoG on high level tool control and feature combinations [J. Boyce]

Discussed Monday 1400 in Track A (GJS).

The BoG met on 7 Jan 2020, from 14:00 to 18:00, and from 19:00 to 22:30. The BoG met again on 10 Jan 2020, from 08:00 to 11:00. The BoG met again on 11 Jan from 11:15 to 13;30. The BoG met again on 12 Jan from 18:00 to 21:15. [integrate above]

Discussed Monday 1400 in Track A (GJS).

The BoG recommends the following (first listed contribution responsible for text and software, unless otherwise noted):

* JVET-Q0346: Add slice\_lmcs\_enabled\_flag as proposed. Decision (cleanup): Adopt.
* JVET-Q0444: Make the presence of the sps\_affine\_amvr\_enabled\_flag in the SPS conditioned on the value of sps\_amvr\_ enabled\_flag. Decision (cleanup): Adopt.
* Avoid signalling SPS elements that are not relevant for the ChromaArrayType (3 aspects). Decision (cleanup): Adopt.
  + JVET-Q0147/Q0117/Q0265/Q0329/Q0155: conditional signaling of sps\_joint\_cbcr\_enabled\_flag based on ChromaArrayType.
  + JVET-Q0265/Q0329/Q0520/Q0155: Make the presence of sps\_act\_enabled\_flag conditional based on value of ChromaArrayType,
  + JVET-Q0520/Q0265/Q0329/Q0155: Make the presence of sps\_bdpcm\_chroma\_enabled\_flag conditional based on value of ChromaArrayType,
* JVET-Q0152/Q0117: Move sps\_seq\_parameter\_set\_id to beginning of the SPS. Decision (cleanup): Adopt.
* JVET-Q0420: Add a flag in the PPS to condition the presence of chroma QP-related elements: pps\_cb\_qp\_offset, pps\_cr\_qp\_offset, pps\_joint\_cbcr\_qp\_offset\_present\_flag, pps\_joint\_cbcr\_qp\_offset\_value, pps\_slice\_chroma\_qp\_offsets\_present\_flag and pps\_cu\_chroma\_qp\_offset\_list\_enabled\_flag. Decision (cleanup): Adopt.
* JVET-Q0481: Reorder the syntax elements in the SPS and PH to group intra syntax elements and inter syntax elements. Decision (cleanup): Adopt (text per Q0781, software by Q0481 or may be combined)
* JVET-Q0043: Disallow for both subpics\_present\_flag and ref\_pic\_resampling\_enabled\_flag to be equal to 1. Decision (cleanup): Adopt.
* JVET-Q0764: Move ref wraparound offset syntax to the PPS and add a ref wraparound enable flag in the PPS, while maintaining the ref wraparound enable flag in the SPS, and introduce a variable to disable the ref wraparound operation when ref pic scaling is enabled for the current picture relative to the reference picture. Decision (cleanup): Adopt.
* JVET-Q0117: Add constraint to require that all DPSs have the same content. Decision (expression of existing intent): Adopt.
* JVET-Q0117: In the PTL syntax structures in the DPS, the value of dps\_max\_sublayer\_minus1 will be replaced with 0, to avoid signaling sub-layer levels in the DPS. Decision (BF): Adopt (unless further discussion requested with text to clarify what the semantics would be if we don’t do this).
* JVET-Q0117: Add DPS constraint “When a DPS is present, each OLS in a CVS in the bitstream shall conform to at least one of the PTL syntax structures in the DPS” and remove the first sentence in the second paragraph of 7.4.4.1 General profile tier, and level semantics: “When the profile\_tier\_level( ) syntax structure is included in a DPS, the OlsInScope is OLS that includes all layers in the the entire bitstream that refers to the DPS.” Decision (expression of existing intent): Adopt.
* JVET-Q0117/Q0045: Remove dps\_id from DPS conditioned on review of the text. Also consider renaming DPS. Decision (expression of existing intent): Adopt.
* JVET-Q0117: Editorial improvement of APS rule for APS ID value space. Decision (Ed.): Editor requested to consider.
* JVET-Q0280: SPS constraint on VPS id: “The value of sps\_video\_parameter\_set\_id shall be the same in all SPSs that are referred to by CLVSs in a CVS.” Decision (expression of existing intent): Adopt.
* JVET-Q0355: Express the intent that the max level in the DPS shall not be less than the highest level in an SPS, with the exact language to be delegated to the editors. Decision (expression of existing intent): Adopt.
* PPS reordering: Move the mixed\_nalu\_types\_in\_pic\_flag just after the SPS\_ID in the PPS. (J. Samuelsson to be responsible for the software.) Decision (cleanup): Adopt.
* JVET-Q0399: Add inference of scaling window parameters equal to the conformance window parameters, and change the name of scaling\_window\_flag to something like scaling\_window\_explicit\_signalling\_flag. Decision (cleanup): Adopt.
* JVET-Q0416: Modification to the name and semantics of ref\_wraparound\_offset\_minus1 to remove the minus1 and change the lowest allowable signalled value to 0. Decision (cleanup): Adopt.

The BoG suggests that the editors consider the following:

* Consider the naming of the syntax elements in the spec for deblocking parameter override in PH and SH to improve clarity. Decision (Ed.): Editor requested to consider.

The BoG suggested discussion of the following topics at the track or plenary level:

* Review contribution to remove uek(v) syntax type with k=3 in the ALF APS, replacing it with a signalled length followed by FLC (from JVET-Q0210). Test results for LB were reported as 0.02% (with also 0.02% in Class E), which were similar to what was reported for AI and RA. Decision (cleanup): Adopt (aspect 8 of Q0210).

Revisit as Track or Plenary for:

* If the functionality of slice-level scaling list enabling/disabling is useful (from JVET-Q0346)
* If current functionality to allow per slice chroma QP offset signaling is useful (from JVET-Q0484)
* If functionality to have separate deblocking parameters for the two chroma components is useful (from JVET-Q0121). It was commented that nearly all other aspects of chroma handling have separate control. Is the syntax detail appropriate?
* If functionality to support a larger range of deblocking offset values in the slice header is useful (from JVET-Q0121) – In Track B, it was agreed to allow a larger range, but should this be a delta relative to what was sent in the PPS or an override? (It is currently an override.)

The BoG had one remaining revisit and one TBP.

[JVET-Q0761](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9607) BoG report of CE4 related contributions on inter prediction with geometric partitioning [H. Yang]

See section 6.4.

[JVET-Q0780](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9626) BoG Report on CE5 Related Contributions [A. Segall, C.-Y. Chen]

Presented in track B MondayMon 13 January,Jan 1310

The BoG met during the following time:

January 10th from 8:00-10:30AM

January 10th from 5:00-6:45PM

January 10th from 8:00-10:00PM

The mandate of the BoG was to review all CE5 related contributions.

Recommendations were determined during the BoG meetings. However, it was largely agreed that most of the recommendations should be revisited by the BoG subject to JVET decisions on CE5. Thus, the BoG has not yet closed and would plan to reconvene as needed.

The BoG met again during the following times:

January 11th from 7:00-9:30PM

January 12th from 6:30-7:50PM

The mandate of the BoG was to re-review all CE5 related contributions given the decision use CE5-2.1 as a base for the CC-ALF design.

The BoG provided the following recommendations:

* CC-ALF design
  + Incorporate DC neutrality constraint from JVET-Q0165 into the CC-ALF design
  + Incorporate aspect 2 (Disabling CC-ALF when luma ALF is disabled) from JVET-Q0190-v1.docx into the CC-ALF design.
  + (Bugfix) Align boundary handling of CC-ALF specification text with current ALF boundary handing.
  + Incorporate the second and third aspects of JVET-Q0382 into the CC-ALF design
    - Second aspect: Do not signal CC-ALF syntax if chroma arrays are unavailable
    - Third aspect: Remove signaling for the number of filters in the slice and picture headers
  + Incorporate JVET-Q0782 into the CC-ALF design.
  + Syntax elements related to CC-ALF should not be signalled if ChromaArrayType is equal to 0.
* Track to discuss if CC-ALF should be controlled by flag in SPS. (Related proposals include JVET-Q0253 and JVET-Q0520.)
* Review JVET-Q0494 in the context of ALF
* Formal study of JVET-Q0125 in a CE – revisit in track B – see notes under JVET-Q0125 – no CE

The BoG also created integrated text that included the recommendations. The text is available in JVET-Q0795.

[JVET-Q0795](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9641) CC-ALF: Integrated Text for the Cross Component Adaptive Loop Filter [K. Misra, F. Bossen, P. Cowan, A. Segall (Sharp Labs of America), N. Hu, J. Dong, V. Seregin, M. Karczewicz (Qualcomm), P. Onno, C. Gisquet, G. Laroche (Canon), J. Li, C.S. Lim, C.-W. Kuo (Panasonic), J. Nam, J. Choi, J. Lim, S. Kim (LGE), O. Chubach, C.-Y. Lai, C.-Y. Chen, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek), Z. Zhang, J. Ström, K. Andersson (Ericsson), A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei), Y. Wang, L. Zhang, K. Zhang, W. Zhu (Bytedance), F. Chen, L. Xu, L. Wang (Hikvision), X.W. Meng (PKU), X. Zheng (DJI), S.S. Wang, S.W. Ma (PKU)] [late]

Decision: Adopt JVET-Q0795.

The integrated text had been made available shortly before the BoG reported. It was briefly reviewed in track B, seemed, seems to be complete. It is asked by another expert if also the software including all intagrations could be made available for checking if is matching the text. Proponents will make best effort to provide the integrated software as soon as possible during this week. Other experts are asked to carefully perform further checks and report back if any issues are found. Revisit.

[JVET-Q0794](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9640) BoG report of contributions on inter prediction and motion vector coding [H. Yang]

## List of actions taken affecting the draft text of VVC, the VTM, and 360Lib

The following is a summary, in the form of a brief list, of the actions taken at the meeting that affect the text of the VVC draft text, VTM or 360Lib description. Both technical and editorial issues are included. This list is provided only as a summary – details of specific actions are noted elsewhere in this report and the list provided here may not be complete and correct. The listing of a document number only indicates that the document is related, not that it was adopted in whole or in part. The description given in the “Tool” column is a best effort for the sake of understanding but may not precisely reflect the functionality of the tool. It is also noted that in cases where several contributions proposed the same method, usually only one of the is listed as adoption below; refer to the meeting notes about the adoption to see which other contributions are related.

…

# Project planning

## Core experiment planning

See final planning under JVET-Q2021…Q202X.

## 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 Apr 2020.

As general guidance, it was suggested to avoid usage of company names in document titles, software modules etc., and not to describe a technology by using a company name.

## General issues for experiments

It was emphasized during the opening plenary on January 9 that those rules which had been set up or refined during the 12th meeting should be observed. In particular, for some CEs, results were available late, and some changes in the experimental setup (particularly in CE4) were not discussed on the JVET reflector.

Group coordinated experiments have been planned as follows:

* “Core experiments” (CEs) are the coordinated experiments on coding tools which are deemed to be interesting but require more investigation and could potentially become part of the draft standard by the next meeting.
* A CE is a test of a specific fully described technology in a specific agreed way. It is not a forum for thinking of new ideas (like an AHG). The CE coordinators are responsible for making sure tha the CE description is complete and correct and has adequate detail. Reflector discussions about CE description clarity and other aspects of CE plans are encouraged.
* A description of each experiment is to be approved at the meeting at which the experiment plan is established. This should include the issues that were raised by other experts when the tool was presented, e.g., interference with other tools, contribution of different elements that are part of a package, etc. The experiment description document should provide the names of individual people, not just company names.
* Software for tools investigated in a CE will be provided in one or more separate branches of the software repository. Each CE will have a “fork” of the software, and within the CE there may be multiple branches established by the CE coordinator. The software coordinator will help coordinate the creation of these forks and branches and their naming. All JVET members will have read access to the CE software branches (using shared read-only credentials; the method for members to obtain the credentials is TBA on the reflector).
* During the experiment, revisions of the experiment plans can be made, but not substantial changes to the proposed technology.
* The CE description must match the CE testing that is done. The CE description needs to be revised if there has been some change of plans.
* The CE summary report must describe any changes that were made in the process of finalizing the CE.
* By the next meeting it is expected that at least one independent cross-checker will report a detailed analysis of each proposed feature that has been tested and confirm that the implementation is correct. Commentary on the potential benefits and disadvantages of the proposed technology in cross-checking reports is highly encouraged. Having multiple cross-checking reports is also highly encouraged (especially if the cross-checking involves more than confirmation of correct test results). The reports of cross-checking activities may (and generally should) be integrated into the CE report rather than submitted as separate documents.

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

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

The general agreed common conditions for single-layer coding efficiency experiments are described in the output document JVET-N1010.

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

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

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

[Add info on software access.]

Some agreements relating to CE activities were established as follows:

* Only qualified JVET members can participate in a CE.
* Participation in a CE is possible without a commitment of submitting an input document to the next meeting. Participation is requested by contacting the CE coordinator.
* All software, results, and documents produced in the CE should be announced and made available to JVET in a timely manner.
* A JVET CE reflector will be established and announced on the main JVET reflector. Discussion of logistics arrangements, exchange of data, minor refinement of the test plans, and preparation of documents shall be conducted on the JVET CE reflector, with subject lines prefixed by “[CEx: ]”, where “x” is the number of the CE. All substantial communications about a CE other than such details shall take place on main JVET reflector. In the case that large amounts of data are to be distributed, it is recommended to send a link to the data rather than the data itself, or upload the data as an input contribution to the next meeting.

General timeline for CEs

T1= 3 weeks after the JVET meeting: To revise the CE description and refine questions to be answered. Questions should be discussed and agreed on JVET reflector. Any changes of planned tests after this time need to be announced and discussed on the JVET reflector. Initially assigned description numbers shall not be changed later. If a test is skipped, it is to marked as “withdrawn”.

T2 = Test model software release + 2 weeks or X XX, whichever is earlier: Integration of all tools into a separate CE branch of the VTM is completed and announced to JVET reflector.

* Initial study by cross-checkers can begin.
* Proponents may continue to modify the software in this branch until T3
* 3rd parties are encouraged to study and make contributions to the next meeting with proposed changes

T3: 3 weeks before the next JVET meeting or T2 + 1 week, whichever is later: Any changes to the CE test branches of the software must be frozen, so the cross-checkers can know exactly what they are cross-checking. A software version tag should be created at this time. The name of the cross-checkers and list of specific tests for each tool under study in the CE plan description shall be documented in an updated CE description by this time.

T4: Regular document deadline – 1 week: CE contribution documents including specification text and complete test results shall be uploaded to the JVET document repository (particularly for proposals targeting to be promoted to the draft standard at the next meeting).

The CE summary reports shall be available by the regular deadline. This shall include documentation about crosscheck of software, matching of CE description and confirmation of the appropriateness of the text change, as well as sufficient crosscheck results to create evidence about correctness (crosscheckers must send this information to the CE coordinator at least 3 days ahead of the document deadline). Furthermore, any deviations from the timelines above shall be documented. The numbers used in the summary report shall not be changed relative to the description document.

CE reports may contain additional information about tests of straightforwared combinations of the identified technologies. Such supplemental testing needs to be clearly identified in the report if it was not part of the CE plan.

New branches may be created which combine two or more tools included in the CE document or the VTM (as applicable).

It is not necessary to formally name cross-checkers in the initial version of the CE description document. To adopt a proposed feature at the next meeting, we would like see comprehensive cross-checking done, with analysis that the description matches the software, and recommendation of value of the tool given tradeoffs.

The establishment of a CE does not indicate that a proposed technology is mature for adoption or that the testing conducted in the CE is fully adequate for assessing the merits of the technology, and a favourable outcome of CE does not indicate a need for adoption of the technology.

Availability of spec text is important to have a detailed understanding of the technology and also to judge what its impact on the complexity of the spec will be. There must also be sufficient time to study it in detail. CE contributions without sufficiently mature draft spec text in the CE input document should not be considered for adoption.

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 (update)

The planned timeline for software releases was established as follows:

* VTM7.0 will be released by 2019-11-11 including all adoptions necessary for CTC and CE basis references. VTM7.1 with non-CTC adoptions will be released later. Further versions of VTM may be released for additional bug fixing, as appropriate.
* Preparation of the VTM software will include immediate removal of macros that were added in the previous meeting cycle. The software coordinator has the discretion to retain some such macros.
* No change of of 360lib or HDRTools was noted in response to meeting.

# Establishment of ad hoc groups

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

New: Film grain?

|  |  |  |
| --- | --- | --- |
| **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 the 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-P2001 VVC text specification draft 7. * Produce and finalize JVET-P2002 VVC Test Model 7 (VTM 7) Algorithm and Encoder Description. * Gather and address comments for refinement of these documents. * Coordinate with test model software development AhG to address issues relating to mismatches between software and text. | B. Bross, J. Chen (co-chairs), J. Boyce, S. Kim, S. Liu, Y.-K. Wang, Y. Ye (vice-chairs) | N |
| **Test model software development (AHG3)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Coordinate development of test model (VTM) software and associated configuration files. * Produce documentation of software usage for distribution with the software. * Discuss and make recommendations on the software development process. * Propose improvements to the guideline document for developments of the test model software. * Perform tests of VTM behaviour relative to HEVC and the previous VTM using the VTM common test conditions. * Coordinate with AHG on Draft text and test model algorithm description editing (AHG2) to identify any mismatches between software and text, and make further updates and cleanups to the software as appropriate. * Coordinate with AHG6 for integration with 360lib software. | F. Bossen, X. Li, K. Sühring (co-chairs) | N |
| **Test material and visual assessment (AHG4)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Maintain the video sequence test material database for development of the VVC standard. * Identify and recommend appropriate test materials for use in the development of the VVC standard. * Identify missing types of video material, solicit contributions, collect, and make available a variety of video sequence test material. * Evaluate new test sequences. * Maintain and update the directory structure for the test sequence repository as necessary. * Prepare availability of viewing equipment and facilities arrangements for the next meeting, and prepare testing upon consultation with CE coordinators. * Begin planning for verification testing of VVC capability. * Coordinate with AHG11 on test material for screen content coding. | V. Baroncini, T. Suzuki, M. Wien (co-chairs), R. Chernyak, A. Norkin (vice-chairs) | N |
| **Conformance testing (AHG5)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study the requirements of VVC conformance testing to ensure interoperability. * Propose a work plan, including timeline, for preparation of a conformance testing specification and conformance bitstream database. * Study potential testing methodology to fulfil the requirements of VVC conformance testing. | J. Boyce and W. Wan (co-chairs), E. Alshina, I. Moccagatta, K. Kawamura, S. McCarthy, K. Sühring (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, including consideration of subpicture segmentations and adaptive viewport usage. * 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-10 software version and common test condition configuration files according to JVET-M1012. * Generate CTC anchors and PERP results for the VTM according to JVET-M1012 within two weeks of availability of SDR CTC anchors. * Produce documentation of software usage for distribution with the software. | J. Boyce and Y. He (co-chairs), K. Choi, J.-L. Lin, Y. Ye (vice-chairs) | N |
| **Coding of HDR/WCG material (AHG7)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study and evaluate available HDR/WCG test content. * Study objective metrics for quality assessment of HDR/WCG material, including investigation of the correlation between subjective and objective results. * Compare the performance of the VTM and HM for HDR/WCG content. * Generate CTC anchors for the VTM according to JVET-P2011 within two weeks of availability of SDR CTC anchors. * Prepare for expert viewing of HDR content at the next 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, S. Iwamura, D. Rusanovskyy (vice-chairs) | N |
| **Layered coding and resolution adaptivity (AHG8)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study adaptive-resolution coding approaches for real-time communication, adaptive streaming, and 360-degree viewport-dependent streaming, including subpicture-based 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. * Develop software for layered coding and resolution adaptivity modalities in the context of the VTM software. * Propose common test conditions for layered coding and resolution adaptivity. * Study approaches for support of layered coding scalability including spatial, temporal, quality, view, and region-of-interest scalability; and analyse their coding efficiency and complexity characteristics | S. Wenger and A. Segall (co-chairs), M. M. Hannuksela, Hendry, S. McCarthy, Y.-C. Sun, P. Topiwala, M. Zhou (vice-chairs) | N |
| **High-level syntax (AHG9)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study NAL unit header, decoding parameter set, video parameter set, sequence parameter set, picture parameter set, adaptation parameter set, picture header, and slice header syntax designs. * Study reference picture buffering and list construction. * Study random access signalling and random access approaches. * Study detection of AU and picture boundaries and properties. * Study the appropriate syntax level and signalling approaches for high-level signalling of control information for lower-level coding tools. * Coordinate with AHG2 and AHG3 for text drafting and software development for the high-level syntax in the VVC design. * Study syntax approaches for interoperability point signalling. * Study selection of constraint flags and their impact on syntax, semantics, and decoding process. | R. Sjöberg, J. Boyce (co-chairs), B. Choi, S. Deshpande, M. M. Hannuksela, R. Skupin, A. Tourapis, Y.-K. Wang, W. Wan (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 quality metrics for measuring subjective quality using e.g. the CfP response MOS scores. * Study the impact of adaptive quantization on individual tools in the test model. * Investigate other methods of improving objective and/or subjective quality, including adaptive coding structures and multi-pass encoding. * Study methods of rate control and their impact on performance, subjective and objective quality. | A. Duenas, A. Tourapis (co-chairs), S. Ikonin, A. Norkin, R. Sjöberg, J. Le Tanou, J.-M. Thiesse (vice-chairs) | N |
| **Screen content coding (AHG11)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Investigate coding tools targeted at screen content in terms of compression benefit and implementation complexity. * Identify test materials, discuss testing conditions for screen content coding, and propose associated updated common test conditions. * Study the impact of loop filters on screen content coding. | S. Liu (chair), J. Boyce, A. Filippov, Y.-C. Sun, J. Xu, H. Yang (vice-chairs) | N |
| **High-level parallelism and coded picture regions (AHG12)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study wavefront processing including the relationship with tiles and low delay characteristics. * Study flexible loop filter control and tile size restrictions, including identifying implications on coding tools and implementation. * Study support of independently coded picture regions, including easy extraction and merging of such regions into conforming bitstreams. * 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), B. Choi, M. M. Hannuksela, R. Sjöberg, R. Skupin, W. Wan, Y.-K. Wang (vice-chairs) | N |
| **Tool reporting procedure and testing (AHG13)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Prepare output document JVET-P2005, which describes the methodology of tool-off testing and a list of tools to be tested by identified testers, including non-CTC configurations as appropriate. * Provide configurations files, bitstreams, and results of tool-on/tool-off testing. * Maintain VTM software aspects for memory bandwidth analysis in coordination with AHG3. * Use the tool usage counts and memory bandwidth usage to study the decoder complexity of features in on/off testing. * Prepare a report with results of the tests. | W.-J. Chien, J. Boyce (co-chairs), W. Chen, Y.-W. Chen, R. Chernyak, K. Choi, R. Hashimoto, Y.**-**W. Huang, H. Jang, R.-L. Liao, S. Liu (vice-chairs) | N |
| **Lossless and near-lossless coding (AHG14)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study lossless and near-lossless coding, including transform skip, BDPCM, and other potential technologies. * Consider the interaction between coding tools and other processing such as loop filtering and LMCS for lossless and near-lossless coding. * Develop proposals for lossless and near-lossless coding for chroma and non-YCbCr colour space content. * Consider throughput bottlenecks for lossless and near-lossless coding at high resolutions and frame rates. | T. Nguyen and T.-C. Ma (co-chairs), M. Ikeda, H. Jang, X. Zhao (vice-chairs) | N |
| **Quantization control (AHG15)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Identify methods for quantization step size control for luma and chroma, including spatially and frequency-adaptive approaches. * Develop methods for evaluating quantization step size control operation. * Study the association between transforms and quantization scaling matrices. * Develop testing conditions for evaluating QP signalling improvements including rate control and perceptual optimization strategies as appropriate. * Evaluate the performance of the current VVC QP design using the adaptive quantization control techniques currently available in the VTM. | R. Chernyak (chair), E. François, C. Helmrich, S. McCarthy, A. Segall (vice-chairs) | N |
| **Implementation studies (AHG16)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study current 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 |

# Output documents (update)

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-P2000](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8865) Meeting Report of the 16th JVET Meeting [G. J. Sullivan, J.-R. Ohm] (2020-xx-xx, near next meeting)

Initial versions of the meeting notes (d0 … dA) were made available on a daily basis during the meeting.

[JVET-P2001](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8857) Versatile Video Coding (Draft 7) [B. Bross, J. Chen, S. Liu, Y.-K. Wang] [WG 11 DIS 23090-3, N18873] (2019-11-09)

Disposition of comments: WG11 N18875 also output by MPEG.

(Initial version planned to be made available by 2019-10-18.)

(Resolution impact: Adding Y.-K. Wang as editor)

DoCR also output by MPEG.

See the list of elements under section 11.7, [revisit to check].

[JVET-P2002](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8858) Algorithm description for Versatile Video Coding and Test Model 7 (VTM 7) [J. Chen, Y. Ye, S. Kim] [WG 11 N 18874] (2019-11-22)

(Initial version planned to be made available by 2019-10-31.)

Remains valid – not updated: [JVET-N1003](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6638) Guidelines for VVC reference software development [K. Sühring] (2019-04-01)

Remains valid – not updated: [JVET-M1004](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=5757) Algorithm descriptions of projection format conversion and video quality metrics in 360Lib (Version 9) [Y. Ye, J. Boyce] (2019-02-15)

[JVET-P2005](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8859) Methodology and reporting template for coding tool testing [W.-J. Chien and J. Boyce] (2019-11-25)

Initial version to be available by 2019-10-25; final version expected by two weeks after VTM 7 availability.

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-P2007](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8860) Supplemental enhancement information messages for coded video bitstreams [J. Boyce, G. J. Sullivan, Y.-K. Wang] [WG 11 DIS ISO/IEC 23002-7, N18873] (2019-11-09)

Disposition of comments: WG11 N18872 also output by MPEG.

See the list of elements under section 11.8 [revisit to check].

[JVET-P2008](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8861) Conformance testing for versatile video coding (Draft 1) [J. Boyce, E. Alshina, K. Kawamura, S. McCarthy, I. Moccagatta, W. Wan] [WG 11 N18927] (2019-11-22)

List volunteers (may be recruited later also).

No output P2009

Remains valid – not updated: [JVET-N1010](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=6643) JVET common test conditions and software reference configurations for SDR video [F. Bossen, J. Boyce, X. Li, V. Seregin, K. Sühring] (2019-04-12)

[JVET-P2011](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8862) JVET common test conditions and evaluation procedures for HDR/WCG video [A. Segall, E. François, W. Husak, S. Iwamura, D. Rusanovskyy] (2019-07-31)

(Will include correction of description of quantization aspects.)

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)

Drafts of CE plans were not reviewed during the meeting due to lack of time.

[JVET-P2021](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8855) Description of Core Experiment 1 (CE 1): Deblocking filtering [K. Andersson, A. Norkin]

See track A notes under JVET-P1033 about what to test.

[JVET-P2022](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8854) Description of Core Experiment 2 (CE2): Palette mode coding [X. Xu, Y.-H. Chao, Y.-C. Sun, J. Xu]

See track A notes under JVET-P0999 about what to test.

[JVET-P2023](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8856) Description of Core Experiment 3 (CE3): Lossless coding [T.-C. Ma, A. Nalci, T. Nguyen]

See track A notes under JVET-P0606 about what to test.

[JVET-P2024](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8863) Description of Core Experiment 4 (CE4): Inter prediction with geometric partitioning [C.-C. Chen, R.-L. Liao, X. Xiu, H. Yang]

To test P0884/P0885; also to test current design with TPM off

Combination with CIIP P0071 to also test

(P0174 and P0250 were not reviewed in detail, not to be tested in the CE, more complex)

P0583 (which part of P0248) disallows SBT with GEO, to also test.

It was suggested and agreed to test P0449

Also test blending disabling

[JVET-P2025](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8864) Description of Core Experiment 5 (CE5): Cross-component adaptive loop filtering [C.-Y. Chen, A. Segall]

See track A notes under JVET-P1033 about what to test.

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

Future meeting plans were established according to the following guidelines:

* Meeting under ITU-T SG 16 auspices when it meets (ordinarily starting meetings on the Tuesday of the first week and closing it on the Wednesday of the second week of the SG 16 meeting – a total of 9 meeting days), and
* Otherwise meeting under ISO/IEC JTC 1/SC 29/WG 11 auspices when it meets (ordinarily starting meetings on the Tuesday 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:

* Wed. 15 – Fri. 24 April 2020, 18th meeting under WG 11 auspices in Alpbach, AT.
* Tue. 23 June – Wed. 1 July 2020, 19th meeting under ITU-T auspices in Geneva, CH.
* Wed. 7 – Fri. 16 October 2020, 20th meeting under WG 11 auspices in Rennes, FR.
* Wed. 6 – Fri. 15 January 2021, 21st meeting under WG 11 auspices in Capetown, ZA.

The agreed document deadline for the 18th JVET meeting was planned to be Tuesday 7 April 2020. CE proposal documents are due one week ahead of that date. HLS only on 1st day if Tuesday.

University of Brussels (VUB) was thanked for the excellent hosting of the 17th meeting of the JVET.

Barco, GBTech, Philips, and Sharp Labs of America were thanked for providing equipment used for subjective viewing during the 17th JVET meeting. Kenneth Andersson, Vittorio Baroncini, Andrey Norkin, Andrew Segall, and Mathias Wien were thanked for preparing and conducting the subjective test efforts. The experts who participated in the role as test subjects were also thanked.

The 17th JVET meeting was closed at approximately XXXX hours on Friday 17 Jan. 2020.

# Annex A to JVET report: List of documents

# Annex B to JVET report: List of meeting participants

The participants of the sixteenth meeting of the JVET, according to an attendance sheet circulated during the meeting sessions (approximately 319 people in total), were as follows: