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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**  18th Meeting: by teleconference, 15–24 April 2020 | Document: JVET-R\_Notes\_dD |

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| *Title:* | **Meeting Report of the 18th Meeting of the Joint Video Experts Team (JVET), by teleconference, 15–24 Apr. 2020** | | |
| *Status:* | Report document from the chairs of JVET | | |
| *Purpose:* | Report | | |
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| *Source:* | Chairs of JVET | | |

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# Summary

The Joint Video Experts Team (JVET) of ITU-T WP3/16 and ISO/IEC JTC 1/ SC 29/ WG 11 held its eighteenth meeting during 15–24 April 2020 as an online-only meeting. It had previously been planned to be held in Alpbach, Austria, at Congress Centrum Alpbach. The conversion of the meeting to be conducted only online was necessitated due to issues associated with the recently declared COVID-19 pandemic. 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 0500 hours UTC on Wednesday 15 April 2020. Meeting sessions were held on all days (including weekend days) until the meeting was closed at approximately XXXX hours UTC on Friday 24 April 2020. On the first and second day of the meeting, only aspects related to high level syntax were on the agenda. Approximately 298 people attended the JVET meeting, and approximately XXX input documents, and 16 AHG reports were discussed. The meeting took place in a collocated fashion with a meeting of WG11 – one of the two parent bodies of the JVET. The subject matter of the JVET meeting activities consisted of developing video coding technology with a compression capability that significantly exceeds that of the current HEVC standard, or otherwise gives better support regarding the requirements of future application domains of video coding. As a primary goal, the JVET meeting reviewed the work that was performed in the interim period since the seventeenth JVET meeting in producing an eighth draft of the VVC standard and the eighth version of the associated VVC test model (VTM). Further important goals were reviewing 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.

[UTC cleanup, chaired by cleanup, signaling, signaled, styles, artifacts]

The JVET produced 11 output documents from the meeting (update):

* JVET-Q2001 Versatile Video Coding specification text (Draft 8)
* JVET-Q2002 Algorithm description for Versatile Video Coding and Test Model 8 (VTM 8)
* JVET-Q2004 Algorithm descriptions of projection format conversion and video quality metrics in 360Lib (Version 10)
* JVET-Q2005 Methodology and reporting template for coding tool testing
* JVET-Q2007 Supplemental enhancement information messages for coded video bitstreams (Draft 3)
* JVET-Q2008 Conformance testing for versatile video coding (Draft 2)
* JVET-Q2009 Preliminary plan for VVC verification testing (Draft 1)
* JVET-Q2013 JVET common test conditions and software reference configurations for non-4:2:0 colour formats
* JVET-Q2014 JVET common test conditions and software reference configurations for lossless, near lossless, and mixed lossy/lossless coding
* JVET-Q2015 JVET functionality confirmation test conditions for reference picture resampling
* JVET-Q2016 Summary information on BD-rate experiment evaluation practices.

For the organization and planning of its future work, the JVET established 17 “ad hoc groups” (AHGs) to progress the work on particular subject areas. At this meeting, no Core Experiments (CE) were defined. The next four JVET meetings were planned for 23 June – 1 July 2020 under ITU-T SG16 auspices in Geneva, CH, during 7–16 October 2020 under WG 11 auspices in Rennes, FR, during 6–15 January 2021 under WG 11 auspices in Capetown, ZA, and during 20–28 April 2021 under ITU-T SG16 auspices in Geneva, CH.

The document distribution site <http://phenix.int-evry.fr/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 eighteenth meeting during 15–24 April 2020 as an online-only meeting, using Zoom teleconferencing tools. 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\_04\_R\_Alpbach/](http://wftp3.itu.int/av-arch/jvet-site/2020_04_R_Alpbach/).

## 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 an eighth draft of the VVC standard and the eighth version of the associated VVC test model (VTM). Further important goals were reviewing 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.int-evry.fr/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 Wednesday, 8 April 2020. Any documents uploaded after 1159 hours Paris/Geneva time on Thursday 9 April 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.

Prior to the regular JVET meeting, a series of AHG meetings were held during 6-8 and on 13 April for HLS topics (“category 1”: AHG8/AHG9/AHG12), as well as and on 9 and 14 April for coding tools (“category 2”: AHG2/AHG3/AHG6/AHG7/AHG11/AHG14/AHG16). An earlier upload deadline of 3 April 2020 had been announced for documents to be discussed in those meetings. Results of these meetings can be found in documents JVET-R0339 and JVET-R0340.

All contribution documents with registration numbers higher than JVET-R0398 were registered after the “officially late” deadline (and therefore were also uploaded late). Likewise, AHG pre-meeting related proposal documents with registration numbers higher than JVET-R0336 were considered late, and most of them were only considered in the main meeting. However, some documents in the “late” range might include break-out activity reports that were generated during the meetings, 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:

* JVET-R0XXX (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-R0XXX (a document on …), uploaded XX-XX.
* …

All cross-verification reports at this meeting (except for JVET-R0XXX) 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-R0XXX, ….

“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-R0XXX, … .

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

* JVET-R0XXX (…)
* …

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-Q2000, the Versatile Video Coding specification text (Draft 8) JVET-Q2001, the Algorithm description for Versatile Video Coding and Test Model 8 (VTM 8) JVET-Q2002, the Algorithm descriptions of projection format conversion and video quality metrics in 360Lib (Version 10) JVET-Q2004, the Methodology and reporting template for coding tool testing JVET-Q2005, the Supplemental enhancement information messages for coded video bitstreams (Draft 3) JVET-Q2007, the Conformance testing for VVC (Draft 2) JVET-Q2008, the Preliminary plan for VVC verification testing (Draft 1) JVET-Q2009, the JVET common test conditions and software reference configurations for non-4:2:0 colour formats JVET-Q2013, the JVET common test conditions and software reference configurations for lossless, near lossless, and mixed lossy/lossless coding JVET-Q2014, and the Summary information on BD-rate experiment evaluation practices JVET-Q2016, had been completed and were approved. The software implementation of VTM (versions 8.0 and 8.1) 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 with a minor modification of including a missing output document in a list.

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.

It was further announced that it is necessary to register for the meeting on the WG11 host’s website. Access to the teleconference sessions of the main JVET meeting was controlled with a password that is distributed to the registered participants; this should help overloading the teleconferencing tool.

The following rules were initially set up for the Zoom teleconference meeting:

o Use the “hand-raising” function to enter yourself in the queue to speak (unless otherwise instructed by the session chair). If you are dialed in by phone, request your queue position verbally.

o Stay muted unless you have something to say. (people were muted by default when they join and would need to unmute themselves to speak. The chair may mute anyone who is disrupting the proceedings (e.g. by forgetting they have a live microphone while chatting with their family or by causing bad noise or echo).

o Identify who you are and your affiliation when you begin speaking.

o Use your full name and company/organization affiliation in your joining information. We will use the participation list for attendance records.

o Turn on the chat window and watch for chair communication and side commentary there as well as by audio.

o Avoid overloading people’s internet connections, we do not plan to use video for the teleconferencing calls – only voice and screen sharing. Extensive use of screen sharing is encouraged.

## Agenda

The agenda for the meeting was as follows:

* Opening remarks and review of meeting logistics and communication practices
* ISO Code of Conduct, IPR policy reminder and declarations
* Contribution document allocation
* Review of results of the previous meeting
* Reports of ad hoc group (AHG) activities
* Consideration of contributions on high-level syntax
* Consideration of contributions and communications on project guidance
* Consideration of 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 (if any), establishment of AHGs, meeting planning, other planning issues
* Other business as appropriate for consideration

On the first two days of the meeting (April 15 and 16), only aspects related to high level syntax (including AHG8, AHG9, and AHG12 reports) were on the agenda. In the morning of April 17 (UTC), the meeting was continued with general status review and administrative matters, and then proceeded with reports of ad *hoc* group activities, and other matters.

The plans for the times of meeting sessions were established as follows, in UTC (2 hours behind the time in Geneva, Paris (and Alpbach); 7 hours ahead of the time in Los Angeles, etc.). No session should last longer than 2 hrs.

* 0500-0700 1st “morning” session [break after 2 hours]
* 0715-0915 2nd “morning” session
* [“lunch” break – nearly 4 hours]
* 1300-1500 1st “afternoon” session [break after 2 hours]
* 1515-1715 2nd “afternoon” session

## IPR policy reminder

[+ISO Code of Conduct]

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.int-evry.fr/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**: Adaptive frame-field
* **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).
* **GPM**: Geometry partitioning mode
* **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.
* **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 Wednesday 15 April at 0500 UTC (chaired by GJS and JRO) were as follows.

* The first two days were dedicated to high-level syntax (incl. AHGs 8, 9, 12)
* Timing and organization of online meetings, calendar
* Balloting and approval timelines:   
  "H.VVC" | ISO/IEC 23090-3 for VVC and H.SEI | ISO/IEC 23002-7
* The meeting logistics, agenda, working practices, policies, and document allocation were reviewed.
  + The meeting is conducted using Zoom
  + 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
* AHG pre-meetings
* 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 … .
* Due to the high number of input contributions, parallelization and breakout work were planned to be used at the meeting.
* Visual comparison of VVC vs. HEVC – how to make progress with remote meeting in that?
* 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

The plans for the times of meeting sessions were established as follows, in UTC (2 hours behind the time in Geneva, Paris (and Alpbach); 7 hours ahead of the time in Los Angeles, etc.). No session should last longer than 2 hrs.

* 0500-0700 1st “morning” session [break after 2 hours]
* 0715-0915 2nd “morning” session
* [“lunch” break – nearly 4 hours]
* 1300-1500 1st “afternoon” session [break after 2 hours]
* 1515-1715 2nd “afternoon” session

All sessions were announced via the new calendar in the JVET document site at least 22 hrs. in advance. Particular scheduling notes are shown below, although not necessarily 100% accurate or complete:

* Wed. 15 Apr., 1st day
  + 0500–0530 Opening remarks, review of practices, agenda, IPR reminder
  + 0530–0545 Reports of AHGs 8, 9, 12
  + 0545-0700 6.1.2.4 (High-level control of features that use APSs: LMCS, scaling lists, and ALF), 6.1.2.5 (High level control of other tools)
  + 1515-1715 …
* Thu. 16 Apr., 2nd day
  + 0500–0700, 0715–0915 6.1.2 High-level tool control and 6.1.5 general constrains
  + 1300-1500, 1515-1715 6.2.1 sub-pictures and 6.2.2 tiles and slices, 6.2.3 filtering across boundaries
* Fri. 17 Apr., 3rd day
  + 0500–0700, 0715–0915 JVET plenary: Review of AHG reports (non-HLS)
  + 1300-1500 and 1515-1715 Track A: 6.3.1.1 General scalability HLS topics, 6.3.1.2 Scalability information signalling and related, 6.3.2 Reference picture resampling (RPR) specific HLS
  + 1300-1500 Track B: 5.1.1 Inter prediction
  + 1515-1715 Track B: 5.1.2 Intra prediction
* Sat. 18 Apr., 4th day
  + 0715-0915 Track A: 6.1.9 Mixed NAL unit types within a coded picture
  + 1300-1500 Track A: 6.1.10 RPL, WP, and collocated picture signalling
  + 1515-1715 Track A: 6.2 Subpictures, tiles, slices, 6.3 Scalability and RPR
  + 0715–0915 Track B: 5.1.4 Transforms
  + 1300-1530 Track B: 5.3 Lossless & near-lossless coding
  + 1545-1725 Track B: 5.3 Lossless & near-lossless, 5.1.4 ACT
* Sun. 19 Apr., 5th day
  + 0500-0700 and 0715-0915 Track A: 6.1.12 HRD (0/9), 6.3.1.2 Scalability information signalling and related (13/17), 6.1.3 General and misc. HLS topics (5/9)
  + 0500-0710 Track B: 4.4 Verification test, 5.1.5 Partitioning
  + 0725-0930 Track B: 5.1.3 Loop filtering, 5.2 Screen content
  + 1300-1530 JVET plenary
* Mon. 20 Apr., 6th day
  + 0500-0630 MPEG plenary
  + 1300-1500 and 1515-1715 Track A: 6.1.6 Parameter sets cleanups, 6.1.9 Mixed NAL unit types within a coded picture , 6.1.10 RPL, WP, and collocated picture signalling
  + 0715-0830 Track B: 5.1.5 Partitioning
  + 0830-0930 Track B: 5.1.6 ACT
  + 1300-1510 Track B: 4.3 Test conditions, 4.8 Implementation studies, 8. Encoder optimization
  + 1525-1730 Track B: 8. Encoder optimization, Revisits 5.1.1/5.1.2
* Tue. 21 Apr., 7th day
  + 0500-0610 Joint meeting with parent bodies: VVC profile definition
  + 0630-0730 Track B: Revisits
  + 0715-0915 Track A: 6.1.11 Signalling of virtual boundaries, 6.2.1 Subpictures, 6.2.2.3 Raster-scan slices, 6.2.3 Control of loop filtering across subpicture/tile/slice boundaries, …
  + 1300-1500 Track A: 6.1.2.5 High level control of other tools, 6.1.2.4 High-level control of features that use APSs: LMCS, scaling lists, and ALF
  + 1515-1615 Track B side activity: 360° video verification test planning
  + 1630-1730 Track B side activity: HDR video verification test planning
  + 1730-1930 Track A: 6.2.1 Subpictures, 6.1.3 General and misc. HLS topics, 6.1.10 RPL, WP, and collocated picture signalling, 6.1.13 DCI, VUI, and SEI
* Wed. 22 Apr., 8th day
  + 0500-0700 Track A: 6.1.4 Profile, tier, level (PTL), 6.1.5 General constraints information (GCI)
  + 0600-0705 Track B: Remaining revisits
  + 0715-0915 JVET Plenary: plenary matters, plus remainders of 6.1.1 and 6.1.2
  + 1415-1615 Track A remainders, incl. 6.2.2.3, 6.2.3, remainders in 6.1.3 to 6.1.6
  + 1630-1830 Track A remainders, 6.1.14 and 6.1.8 to 6.1.13
  + 1515-1715 Track B: Track B: Verification test side activity reporting and further planning
* Thu. 23 Apr., 9th day
  + 0500-0615 Joint meeting with parent bodies on VVC profiles and film grain for VVC & HEVC
  + 0630-0830 JVET Plenary: plenary matters, plus Track A remainders, incl. 6.2, 6.3, 6.1.1
  + 0845-1015 JVET Plenary: plenary matters, plus remainders in 6.1, 6,2, 6.3
  + 1300-1505 JVET Plenary: plenary matters, plus reviewing of editors' notes in the spec, and the text in JVET-R0481
  + 1520-1715 JVET Plenary: plenary matters, plus remainders in 6.1, 6,2, 6.3 (chaired by GJS)
  + 1520-1730 Separate plenary track: 6.1.2.3, 6.1.2.4, 6.1.2.5 (chaired by JRO)
* [Out of date – The meeting calendar linked on the JVET document archive site]
* ……[+Draft text editor note review]

## Contribution topic overview

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

* AHG reports (17) (section 3) (Plenary)
* Project development (section 4) (Plenary or Track B)
  + General (2)
  + Text and software development (1)
  + Test conditions (2)
  + Verification test planning (3)
  + Coding studies and tools on specific use cases (2)
  + Test Material (0)
  + Conformance (2)
  + Implementation studies (3)
  + Profile/level specification (5)
* Low-level tool technology proposals (section 5) with subtopics (Track B)
  + Inter prediction and MV coding (15) (section 5.1.1)
  + Intra prediction and mode coding (10) (section 5.1.2)
  + Loop filtering (24) (section 5.1.3) (Track B)
  + Transforms and transform signalling (16) (section 5.1.4)
  + Partitioning (5) (section 5.1.5)
  + ACT related (6) (section 5.1.6)
  + AHG11: Screen content coding (9) (section 5.2)
  + AHG14: Lossless and near lossless coding (23) (section 5.3)
  + AHG15: Quantization control (4) (section 5.4)
* High-level syntax (HLS) proposals (section 6) with subtopics (Track A)
  + AHG9: General high-level syntax (173) (section 6.1)
  + AHG12: High-level parallelism and coded picture regions (51) (section 6.2)
  + AHG8: Layered coding and resolution adaptation (29) (section 6.3)
* Complexity analysis (0) (section 7) (Track B)
* Encoder optimization (6) (section 8) (Track B)
* Metrics and evaluation criteria (0) (section 9) (Track B)
* Withdrawn (8) (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 (253) was generally chaired by GJS and Track B (120+) by JRO.

**Status of HLS review:**

By the end of April 22, 2020, the meetings have reviewed approximately ***240 (92%) of the 261 contributions***, which resulted in **95 recommendations/adoptions** for normative action, 32 recommendations/adoptions for editorial action, and ***17 revisits***.

1. 6.1.1 Combinations of subpictures and other features (3/3): 1 recommendation, 1 revisit
2. (done) 6.1.2.1 Chroma deblocking tc and β offsets signalling (13/13), 2 recommendations
3. (done) 6.1.2.2 Deblocking control signalling - other aspects (4/5): 3 recommendations
4. 6.1.2.3 Quantization control signalling (6/6): 1 adoption, 1 revisit
5. 6.1.2.4 High-level control of features that use APSs: LMCS, scaling lists, and ALF (17/23): 12 recommendations/adoptions, 1 revisit, 6 TBP.
6. 6.1.2.5 High level control of other tools (11/17): 4 adoptions, 1 editor action item, 1 revisit, 6 TBP
7. (done) 6.1.3General and misc. HLS topics (9/9): 6 recommendations/adoptions
8. (done) 6.1.4 Profile, tier, level (PTL) (5/5): 3 recommendations/adoptions
9. 6.1.5 General constraints information (GCI) (9/9): 8 adoptions, 1 editor action item, 1 revisit
10. 6.1.6 Parameter sets cleanups (21/21): 9 recommendations, 3 revisits
11. (done) 6.1.7 Syntax for one slice per picture (14/14): 9 recommendations/adoptions
12. 6.1.8 Picture header and slice header (13/13): 7 adoptions, 1 revisit
13. 6.1.9 Mixed NAL unit types within a coded picture (11/11): 7 adoptions, 2 revisits
14. 6.1.10 RPL, WP, and collocated picture signalling (8/11): 6 adoptions, 3 TBP
15. (done) 6.1.11 Signalling of virtual boundaries (4/4): 1 adoption
16. 6.1.12 Hypothetical reference decoder (HRD) (9/9): 14 adoptions (of which 8 editorial bug fixes), 4 revists
17. 6.1.13 DCI, VUI, and SEI (0/7): 7 TBP
18. (done) 6.1.14 HLS editorial inputs (1/1): 1 editorial action item
19. (done) 6.2.1 Subpictures (26/26): 10 adoptions
20. (done) 6.2.2.1 Tile signalling (6/6): 4 recommendations
21. (done) 6.2.2.2 Rectangular slice signalling (11/11), 1 adoption, 1 editor action item
22. (done) 6.2.2.3 Raster-scan slices (2/2)
23. (done) 6.2.3 Control of loop filtering across subpicture/tile/slice boundaries (7/7): 1 adoption
24. 6.3.1.1General scalability HLS topics (7/8):9 adoptions, 1 revisit, 1 TBP
25. (done) 6.3.1.2 Scalability information signalling and related (18/18): 6 recommendations/adoptions
26. 6.3.2 Reference picture resampling (RPR) specific HLS (2/2): 1 revisit

# AHG reports (17)

These reports were discussed Friday 17 April 2020 during 0500-0700 and 0715-0915 UTC (chaired by GJS & JRO), except as otherwise noted.

The general status of AHGs for category 1 (see section 2.12 and R0339) and category 2 (see R0340) was reviewed.

[JVET-R0339](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9983) Agenda and report of the Category 1 AHG pre-meeting for the 18th JVET meeting [G. J. Sullivan, Y.-K. Wang]

[add abstract]

[JVET-R0340](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9984) Agenda and report of the category 2 AHG pre-meeting of the 18th JVET meeting [J.-R. Ohm, B. Bross, A. Segall, Y. Ye]

[add abstract]

[JVET-R0001](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10056) JVET AHG report: Project management (AHG1) [J.-R. Ohm, G. J. Sullivan]

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

[The better link is <http://phenix.int-evry.fr/jvet/>, not sud-paris; check the ITU’s link too]

[Incorporate r1 revision]

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/2020\_01\_ Q\_Brussels/](http://wftp3.itu.int/av-arch/jvet-site/2020_01_%20Q_Brussels/)), particularly including the following:

* The meeting report (JVET-Q2000) [Posted 2020-04-15]
* Versatile Video Coding (Draft 8) (JVET-Q2001) [Posted 2020-01-18, last update 2020-03-12]
* Algorithm description for Versatile Video Coding and Test Model 8 (VTM 8) (JVET-Q2002) [Posted 2020-01-21, last update 2020-03-24]
* Algorithm descriptions of projection format conversion and video quality metrics in 360Lib (Version 10) (JVET-Q2004) [Posted 2020-03-06]
* Methodology and reporting template for coding tool testing (JVET-Q2005) [Posted 2020-02-15]
* Supplemental enhancement information messages for coded video bitstreams (Draft 3) (JVET-Q2007) [Posted 2020-01-19, last update 2020-03-18]
* Conformance testing for Versatile Video Coding (Draft 2) (JVET-Q2008) [Posted 2020-03-04]
* Preliminary plan for VVC verification testing (Draft 1) (JVET-Q2009) [Posted 2020-02-28]
* JVET common test conditions and software reference configurations for non-4:2:0 colour formats (JVET-Q2013) [Posted 2020-03-02, last update 2020-04-02]
* JVET common test conditions and software reference configurations for lossless, near lossless, and mixed lossy/lossless coding (JVET-Q2014) [Posted 2020-02-24, last update 2020-04-09]
* JVET functionality confirmation test conditions for reference picture resampling (JVET-Q2015) [Posted 2020-03-04, last update 2020-03-05]
* Summary information on BD-rate experiment evaluation practices (JVET-Q2016) [Posted 2020-01-17, last update 2020-02-14]

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

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

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

Roughly 400 input contributions to the current meeting (not counting the AHG summary reports) had been registered for consideration at the meeting. More than two thirds of these documents were submitted on aspects of high-level syntax, whereas submissions on low-level coding tools has significantly decreased again. No CEs had been running.

A preliminary basis for the document subject allocation and meeting notes for the 18th meeting had been made publicly available on the ITU-hosted ftp site.

[JVET-R0002](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10057) 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]

[Add summary]

[JVET-R0003](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10058) JVET AHG report: Test model software development (AHG3) [F. Bossen, X. Li, K. Sühring]

This report summarizes the activities of the AhG3 on Test model software development that has taken place between the 17th and 18th JVET meetings.

*VTM software development*

VTM 7.2 was tagged on Jan. 17, 2020.

VTM 7.3 was tagged on Jan. 20, 2020.

After one release candidate, VTM 8.0 was tagged on Feb. 22, 2020.

VTM 8.1 was tagged during the 18th JVET meeting.

[Add 8.1 test results to be provided in a revision of R0003]

The following tables show **VTM 8.0** performance over **HM 16.20**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra** |  |  |
|  |  |  | **Over HM-16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -27.89% | -39.05% | -39.30% | 1865% | 221% |
| Class A2 | -27.49% | -29.04% | -26.48% | 2997% | 238% |
| Class B | -20.99% | -32.87% | -37.24% | 3361% | 227% |
| Class C | -21.74% | -25.20% | -28.82% | 4692% | 224% |
| Class E | -25.16% | -31.46% | -30.65% | 2667% | 206% |
| **Overall** | -24.09% | -31.32% | -32.82% | 3097% | 224% |
| Class D | -17.64% | -19.95% | -20.14% | 5303% | 217% |
| Class F | -38.68% | -43.85% | -46.26% | 5898% | 215% |
|  |  |  |  |  |  |
|  |  |  | **Random access** |  |  |
|  |  |  | **Over HM-16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -37.28% | -44.18% | -49.59% | 951% | 204% |
| Class A2 | -41.45% | -46.23% | -44.78% | 1080% | 222% |
| Class B | -34.02% | -53.72% | -51.85% | 991% | 192% |
| Class C | -29.08% | -38.81% | -40.31% | 1280% | 200% |
| Class E |  |  |  |  |  |
| **Overall** | -34.84% | -46.33% | -46.91% | 1070% | 202% |
| Class D | -26.89% | -35.50% | -34.96% | 1411% | 203% |
| Class F | -40.62% | -49.10% | -50.32% | 789% | 167% |
|  |  |  |  |  |  |
|  |  |  | **Low delay B** |  |  |
|  |  |  | **Over HM-16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -30.05% | -46.77% | -45.16% | 882% | 192% |
| Class C | -28.10% | -33.08% | -33.34% | 1015% | 178% |
| Class E | -32.53% | -48.40% | -44.05% | 423% | 138% |
| **Overall** | -30.02% | -42.62% | -40.94% | 769% | 172% |
| Class D | -25.19% | -28.47% | -28.37% | 1050% | 189% |
| Class F | -41.83% | -49.84% | -49.94% | 569% | 140% |
|  |  |  |  |  |  |
|  |  |  | **Low delay P** |  |  |
|  |  |  | **Over HM-16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -34.44% | -49.05% | -47.56% | 792% | 199% |
| Class C | -29.84% | -33.27% | -33.61% | 906% | 187% |
| Class E | -35.30% | -51.00% | -47.14% | 404% | 143% |
| **Overall** | -33.12% | -44.28% | -42.80% | 700% | 179% |
| Class D | -26.69% | -28.64% | -28.40% | 949% | 194% |
| Class F | -41.32% | -48.83% | -49.08% | 593% | 147% |

The following tables show **VTM 8.0** performance compared to **VTM 7.0**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra** |  |  |
|  |  |  | **Over VTM-7.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.50% | -8.28% | -8.23% | 114% | 128% |
| Class A2 | 0.67% | -11.87% | -15.48% | 112% | 130% |
| Class B | 0.35% | -16.13% | -13.68% | 115% | 123% |
| Class C | 0.33% | -6.85% | -6.57% | 114% | 122% |
| Class E | 0.32% | -11.88% | -5.54% | 113% | 125% |
| **Overall** | 0.42% | -11.34% | -10.14% | 114% | 125% |
| Class D | 0.22% | -6.67% | -5.31% | 117% | 116% |
| Class F | 0.44% | -7.96% | -8.06% | 122% | 119% |
|  |  |  |  |  |  |
|  |  |  | **Random access** |  |  |
|  |  |  | **Over VTM-7.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.07% | -6.93% | -6.95% | 115% | 118% |
| Class A2 | 0.08% | -12.25% | -17.23% | 115% | 116% |
| Class B | -0.04% | -18.85% | -15.02% | 112% | 113% |
| Class C | -0.66% | -6.25% | -5.64% | 111% | 103% |
| Class E |  |  |  |  |  |
| **Overall** | -0.16% | -11.79% | -11.35% | 113% | 112% |
| Class D | -0.76% | -6.76% | -5.30% | 115% | 88% |
| Class F | -0.30% | -5.29% | -5.32% | 122% | 106% |
|  |  |  |  |  |  |
|  |  |  | **Low delay B** |  |  |
|  |  |  | **Over VTM-7.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -0.32% | -20.85% | -18.23% | 114% | 115% |
| Class C | -0.78% | -7.15% | -6.08% | 111% | 94% |
| Class E | -1.87% | -15.88% | -6.66% | 105% | 88% |
| **Overall** | -0.86% | -15.04% | -11.29% | 111% | 100% |
| Class D | -0.98% | -7.37% | -5.90% | 108% | 77% |
| Class F | -0.70% | -9.68% | -6.98% | 110% | 90% |
|  |  |  |  |  |  |
|  |  |  | **Low delay P** |  |  |
|  |  |  | **Over VTM-7.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -0.03% | -19.62% | -17.65% | 113% | 117% |
| Class C | 0.11% | -5.40% | -4.86% | 108% | 96% |
| Class E | -0.72% | -14.74% | -5.41% | 106% | 90% |
| **Overall** | -0.16% | -13.66% | -10.33% | 110% | 103% |
| Class D | -0.28% | -6.00% | -4.10% | 106% | 78% |
| Class F | 0.07% | -8.01% | -5.66% | 110% | 92% |

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

Several issues were encountered during software development:

* It was noticed that the UseIdentityTableForNon420Chroma configuration parameter does not work as intended. This malfunction can greatly impact results encodings done with 4:2:2 and 4:4:4 chroma format. The issue was fixed shortly before the 18th JVET meeting.

*Status of implementation of proposals of previous JVET meetings*

All previously open implementation issues from the 15th meeting were resolved:

JVET-O1159 on scalable coding was reported to be resolved during the meeting 17th meeting.

The software for JVET-O1143 on subpictures was submitted on Jan. 21 2020 including updates for adoptions of the 16th meeting.

Open issues from the 16th meeting were resolved except for two issues:

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.

A decoder for checking completeness of access units was expected to be implemented. Proponents requested to further delay the implementation because a related specification issue was found. It was stated that a related proposal would be submitted to the 18th JVET meeting.

JVET-P0359: Add an SEI message that contains only a flag self\_contained\_cvs\_flag in its syntax.

The proponents confirmed that the implementation was still open.

*Status of proposals of the 17th JVET meeting (Brussels)*

At the beginning of the 18th meeting the software AHG tracking list contains a number of meeting decisions that were not marked as implemented. With the arrangements for changing the meeting into an teleconference meeting and related AHG meetings starting earlier, the software coordinators did not find the time to contact proponents to check the status, e.g. whether the implementation was included with a different merge request, or if no implementation is required.

A table was provided listing all adoptions that were not marked as merged or specification only change. Relevant parties were requested to check with the software coordinators to resolve these (some of which may have already been resolved but not marked as such).

|  |  |
| --- | --- |
| JVET-Q0112 | It is asserted that the first item (using the global maximum picture size to determine the DPB size) is required following the adoption of JVET-Q0814. Agreed. |
| JVET-Q0112 | It is asserted that the first part of the third item (using the global maximum picture size in computing limits instead of current picture size) is required following the adoption of JVET-Q0814. Agreed. |
| JVET-Q0112 | The fourth item proposes to use the cumulative worst-case picture size for all pictures in an AU to derive constraints on CPB removal time, etc. Agreed. |
| JVET-Q0398 | Sublayer wise dependency in multi-layer: when there is a dependent layer, there is an indication of the max\_tid\_il\_ref\_pics\_plus1 that the layer depends on, and if that value is 0, inter-layer prediction uses only IRAP pictures. |
| JVET-Q0247 | 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). |
| JVET-Q0154 | Disallow mixing of GDR and IRAP (Disallow mixing of GDR with any non-GDR). |
| JVET-Q0270 | Add a PPS flag to determine whether qp delta is sent in the PH or SH, like other things (e.g., ALF, deblocking, SAO). |
| JVET-Q0217 | 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.) |
| JVET-Q0404 | It proposes a way to associate filler data NAL units and filler payload SEI messages with subpictures. It was noted that these already have an association defined for association with VCL NAL units, and this should be sufficient to associate them with subpicture regions. Using this association and adding a CBR flag for the subpicture level information SEI message should be sufficient. The extraction process should account for the association.  Add a CBR flag to the subpicture level info SEI message, and change the semantics and extraction process as described. |
| JVET-Q0113 | The general editorial changes regarding the specifictaion of NAL unit decoding order. 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. |
| JVET-Q0271 | 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. |
| JVET-Q0164 | When single\_slice\_per\_subpic\_flag is equal to 1, each subpicture should contain only one slice and the vertical slice boundaries shall also be tile boundaries. |
| JVET-Q0119 | 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. Instead, condition the presence of the slice\_address on NumSlicesInSubpic[ SubPicIdx ] being greater than 1. |
| JVET-Q0786 | Not to repeat HRD parameters info of OLSs containing only one layer in the VPS (in addition to signalling them in the SPS). |
| JVET-Q0277 | 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-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. |
| 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.” |
| JVET-Q0402 | Establish the semantics of subpic\_treated\_as\_pic\_flag[ ] to allow SNR scalability with independent subpictures when subpictures are aligned. |
| JVET-Q0406 | Add a constraint on cabac\_zero\_word for subpictures treated as pictures to obey the bin-to-bit ratio on a subpicture basis. |
| JVET-Q0443 | Modification of the subpicture level SEI message semantics to impose a constraint on MinCR. |
| JVET-Q0395 | Add constraints for BitRate and number of tiles to the subpicture level SEI message. |

*Bug tracking*

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

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

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

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

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

The AHG recommended to:

* Continue to develop the VTM reference software
* Improve documentation, especially the software manual
* Resolve any normative issues resulting from the large number of integrations in the most recent development cycle
* Encourage people to test VTM software more extensively outside of common test conditions.
* Encourage people to report all (potential) bugs that they are finding.
* Encourage people to submit bit-streams/test cases that trigger bugs in VTM.
* Encourage people to submit non-normative changes that reduce encoder run time without significantly sacrificing compression performance
* Make sure that contributions considered for adoption in the future are subject to adequate text and software review by the JVET at large
* Design and add configuration files to the VTM software for testing of HLS features

The runtime of 8.0 versus 7.0 was discussed. It was noted that there may have been relevant differences between 7.0 and 7.2 that affect this comparison.

Mr Bossen indicated that the subpicture implementation seemed to be causing a runtime increase (perhaps related to memory allocation). This doesn’t appear make technical sense, and was encouraged to be investigated.

In the meeting discussion it was noted that CCALF had substantially changed the balance of luma and chroma fidelity. It was commented that this is discussed in R0076. The QP mapping table or an overall offset can be used to adjust this. Reducing lambda for luma and increasing it for chroma would also be a possibility. See further notes under Friday 24 April plenary.

[JVET-R0004](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10052) JVET AHG report: Test material and visual assessment (AHG4) [V. Baroncini, T. Suzuki, M. Wien, R. Chernyak, A. Norkin]

The draft verification test plan JVET-Q2009 was prepared and is available at the JVET web site.

Due to the coronavirus situation, activities on test sequence identification and viewing for the VVC verification tests have been much lower than intended. So far, RWTH have scanned through the JVET ftp site for material outside of the CTC set which could be useful, and also looked elsewhere a bit. A summary of this can be found in document JVET-R0461.

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).

One particularly related contribution was noted

* [JVET-R0461](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10123) AHG4: Candidate test sequences for verification tests [M. Wien (RWTH)]

The AHG recommended:

* To continue to study the coding performance comparison and to update the verification test plan.
* To collect volunteers to conduct the verification test, including volunteers to encode.
* To collect more variety of test sequences suitable for the verification test.
* To continue to collect new test sequences available for JVET with licensing statement.

It was commented that some preliminary experiments had begun in Rome, including some experiments with remote test operation.

It was commented that blurring is an increased phenomenon in VVC, and that subjective tuning (vs. PSNR emphasis) would be beneficial for use in subjective testing.

It was commented that the use of a VMAF measure for the optimization may be helpful. However, it was also commented that VMAF comparisons may be vulnerable to problems as well (e.g. too much weight given to the quantity of high frequencies). MS-SSIM was also suggested to be considered. How encoder control could optimize subjective quality and pseudo-subjective measures was discussed. The final judgment is to be a matter for human eyes, of course.

Assistance with computing resources for encoding experiments (coordinated by M. Wien and V. Baroncini) was requested. [Track B Sunday morning discussion was suggested]

[JVET-R0005](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10051) JVET AHG report: Conformance testing (AHG5) [J. Boyce, E. Alshina, K. Kawamura, I. Moccagatta, S. McCarthy, K. Sühring, W. Wan]

This document summarizes the activity of AHG5: “Conformance testing” between the 17th Meeting in Brussels, BE (7–17 Jan 2020) and the 18th Meeting (teleconference, 15-24 April 2020).

At the 16th JVET meeting the following preliminary timeline was 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/IEC22nd meeting April 2021: No action pending DIS ballot
* 23rd meeting July 2021: Final conformance specification

The AHG activities were reported to be on schedule with the preliminary timeline.

Output document JVET-Q2008 “Conformance testing for versatile video coding (Draft 1)” published on 4 March 2020. An editor’s update input document in JVET-R0405 provides additional improvements.

Support was added to the VTM 8.0 SW to output the log file by Alexey Filippov (Huawei), and he provided an initial test bitstream to be used as an example. Many test bitstreams have been provided and uploaded to <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVC/under_test/>, with the status summarized in Section 4. Most of the bitstreams are in the VTM-8.0 directory, which indicates that they are decodable by the VTM8.0 software. In some cases, modifications to VTM8.0 were required to decode the bitstreams, in which case the bitstreams are in the VTM-incompatible directory.

Bitstream volunteers are requested to update their bitstreams during the next meeting cycle using the VTM 9.0 and/or VTM 9.1 Volunteers are requested to review the updated conformance specification, for updates to the recommendations for the bitstreams, including the following:

* All files in the zip archive should be in the top level, without a subfolder.
* The .md5 file should contain only the MD5sum value and no additional characters.
* The minimum level that the bitstream conforms to should be used.
* A VTM config file should be included in the .zip file if an unmodified VTM version is used, and the command line used should be included in the .txt file. If a modified version of the VTM is used, the VTM config file should not be included.

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

The AHG5 chairs and JVET chairs can be reached at [jvet-conformance@lists.rwth-aachen.de](mailto:jvet-conformance@lists.rwth-aachen.de). Participants should not subscribe to this list but may send emails to it. That reflector is not intended for JVET discussions – just for facilitating logistics details being worked out offline with the chairs.

The status at the time of preparation of this report is as follows:

* 99 bitstream categories have been identified
* A total of 429 bitstreams have been provided, 372 of which have been made available, representing 39 of the 99 categories, with remaining ones in the process of confirmation and/or refinement based on feedback
* Volunteers have been identified to generate 92 of the 99 categories
* Volunteers are needed for the following categories:
  + 10-bit 4:4:4 with no 4:4:4 specific coding tools enabled
  + 8-bit 4:0:0 in Main 10 profile
  + 8-bit 4:2:0 in Main 10 profile
  + 8-bit 4:2:2 in Main 4:4:4 10 profile
  + 10-bit 4:0:0 in Main 10 profile
  + 8-bit 4:4:4 in Main 4:4:4 10 profile
  + 10-bit 4:2:0 in Main 4:4:4 10 profile
* Bitstream volunteers are now requested to provide descriptions for inclusion in the conformance specification Section 6.6. “Specification of the test bitstreams”

There is an issue with verification of the spatial scalability conformance bitstreams because the VTM 8.0 software is not able to output selected output layer sets.

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). The ftp and http sites for downloading bitstreams are

* <ftp://ftp3.itu.int/jvet-site/bitstream_exchange/VVC>
* <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVC/>

The ftp site for uploading bitstream file is as follows.

* <ftp://ftp3.itu.int/jvet-site/dropbox/> (user id: avguest, passwd: Avguest201007)

If using FileZilla, the following configuration is suggested:



One particularly related contribution was noted:

* JVET-Q0479 Updates to conformance testing for versatile video coding

The AHG recommends the following:

* Review related input contributions
* Discuss and refine the list of conformance bitstreams and the conformance specification
* Identify contributors for all identified bitstreams
* Review submitted bitstreams and consider if the flexibility of the tested tool is sufficiently exercised
* Discuss possible implementation in the VTM software the capability to output target output layer sets

It was commented that it is desirable for the bitstreams to be specifically designed to exercise the tested features without having excessively large test sequences or excessively many bitstreams.

It was noted to be particularly desirable to have cross-checking with independent implementations and bitstreams generated by independent implemtations.

[JVET-R0006](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10060) JVET AHG report: 360° video coding tools, software and test conditions (AHG6) [J. Boyce, Y. He, K. Choi, J.-L. Lin, Y. Ye]

The document summarizes activities on 360-degree video content conversion software development between the 17th (7–17 Jan. 2020) and the 18th (15 – 24 Apr. 2020) JVET meetings.

Brief summary for the activities:

* The 360Lib-10.1 software package released on Mar. 19, 2020 included following changes:
* Support three guard band padding types and enable boundary guard band padding for generalized cubemap projection format (from JVET-Q0343).
* Software fix for minimum CU size (from JVET-Q0468);

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

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

The released version of 360Lib-10.1 can be found at:

* <https://jvet.hhi.fraunhofer.de/svn/svn_360Lib/tags/360Lib-10.1/>

360Lib-10.1 testing results can be found at:

* [ftp.ient.rwth-aachen.de/ahg/testresults/360Lib-10.1](ftp://ftp.ient.rwth-aachen.de/ahg/testresults/360Lib-10.1)

360Lib bug tracker

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

The first table below is for the projection formats comparison using VTM-8.0 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-8.0.

The second table below is for PERP coding comparison between VTM-8.0 and HM-16.16.

The third table below is to compare PHEC coding with VTM-8.0 with and CMP coding with HM-16.16.

**VTM-8.0 PHEC vs PERP (PERP as anchor)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **PHEC over PERP (VTM-8.0)** | | | | | |
|  | **End-to-end WS-PSNR** | | | **End-to-end S-PSNR-NN** | | |
|  | Y | U | V | Y | U | V |
| Class S1 | -11.77% | -6.95% | -7.46% | -11.70% | -6.86% | -7.42% |
| Class S2 | -5.37% | -1.42% | -1.28% | -5.36% | -1.32% | -1.21% |
| **Overall** | -9.21% | -4.74% | -4.99% | -9.16% | -4.64% | -4.94% |

**VTM-8.0 PERP vs HM-16.16 PERP (HM-16.16 PERP as anchor)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **VTM-8.0 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 | -25.27% | -41.98% | -44.32% | -25.26% | -42.00% | -44.29% |
| Class S2 | -34.78% | -43.66% | -45.82% | -34.77% | -43.69% | -45.86% |
| **Overall** | -29.07% | -42.65% | -44.92% | -29.06% | -42.67% | -44.92% |

**VTM-8.0 PHEC vs HM-16.16 CMP (HM-16.16 CMP as anchor)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **VTM-8.0 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 | -29.74% | -43.64% | -45.62% | -29.64% | -43.62% | -45.59% |
| Class S2 | -37.50% | -45.95% | -47.89% | -37.50% | -45.94% | -47.91% |
| **Overall** | -32.84% | -44.56% | -46.53% | -32.78% | -44.55% | -46.52% |

There are 4 input contributions related to 360° video, as listed below. One contribution proposes a new functionality, and three contributions are related to reference wraparound.

* [JVET-R0151](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9795) AHG6/AHG12: Uncoded subpictures and potential applications [J. Sauer (RWTH Aachen]
* [JVET-R0184](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9828) AHG9/AHG12: On reference picture wraparound for subpictures [S. Paluri, Hendry, S. Kim (LGE)]
* [JVET-R0223](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9867) AHG16: On DMVR and wraparound motion compensation [J. Luo, J. Chen, Y. Ye (Alibaba)]
* [JVET-R0425](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10087) Crosscheck of JVET-R0223 (AHG16: On DMVR and wraparound motion compensation) [Y.-H. Lee, J.-L. Lin (MediaTek)]

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

[JVET-R0007](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10061) JVET AHG report: Coding of HDR/WCG material (AHG7) [A. Segall, E. François, W. Husak, S. Iwamura, D. Rusanovskyy]

This document summarizes the activity of AHG7: Coding of HDR/WCG Material between the 17th meeting in Brussels, BE (7–17 January 2020) and the 18th meeting by teleconference (15–24 April 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. 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 March 23, 2020. A summary of the performance is provided below, and more detailed information may be found in the included XLS data.

VTM 8.0 versus VTM 7.0

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | | | | | |
|  | **Over VTM-7.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -7.59% | 0.15% | 0.25% | -12.22% | -22.12% | 0.26% | -13.48% | -22.94% | 104% | 125% |
| Class H2 |  |  |  |  |  | 0.16% | -14.70% | -15.00% | 104% | 128% |
| **Overall** | -7.59% | 0.15% | 0.25% | -12.22% | -22.12% | 0.22% | -13.93% | -20.05% | 104% | 126% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access** | | | | | | | | | |
|  | **Over VTM-7.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -8.81% | -0.18% | 0.01% | -12.80% | -26.47% | 0.05% | -13.94% | -26.39% | 110% | 110% |
| Class H2 |  |  |  |  |  | -0.23% | -18.80% | -19.22% | 111% | 119% |
| **Overall** | -8.81% | -0.18% | 0.01% | -12.80% | -26.47% | -0.05% | -15.71% | -23.78% | 110% | 113% |

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 | -41.13% | -26.63% | -26.13% | -56.61% | -51.95% | -23.45% | -52.54% | -45.14% |  |  |
| Class H2 |  |  |  |  |  | -21.16% | -47.43% | -48.90% |  |  |
| **Overall** | -41.13% | -26.63% | -26.13% | -56.61% | -51.95% | -22.62% | -50.68% | -46.50% |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access** | | | | | | | | | |
|  | **Over HM-16.18** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -31.39% | -31.44% | -31.13% | -46.08% | -38.43% | -28.09% | -41.03% | -30.85% |  |  |
| Class H2 |  |  |  |  |  | -28.53% | -56.27% | -58.58% |  |  |
| **Overall** | -31.39% | -31.44% | -31.13% | -46.08% | -38.43% | -28.25% | -46.57% | -40.93% |  |  |

In addition to evaluating the performance of VTM 8.0, 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.

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 | 16.01% | 0.96% | 0.87% | 14.45% | 18.89% | 150% | 101% | 148% | 102% |
| DQ | 0.10% | 1.37% | 1.46% | 0.19% | 0.26% | 95% | 107% | 96% | 105% |
| CCLM | 18.72% | 2.34% | 2.14% | 46.68% | 52.49% | 101% | 101% | 101% | 101% |
| MTS | 1.15% | 1.30% | 1.29% | 0.99% | 0.86% | 87% | 95% | 86% | 101% |
| ALF | 10.21% | 2.75% | 2.17% | 18.51% | 37.46% | 95% | 89% | 96% | 92% |
| MRLP | 0.20% | 0.32% | 0.30% | 0.16% | 0.01% | 99% | 102% | 99% | 101% |
| IBC | -0.08% | -0.34% | -0.32% | -0.11% | -0.11% | 141% | 102% | 183% | 101% |
| ISP | 0.04% | 0.63% | 0.72% | -0.28% | -0.26% | 90% | 99% | 85% | 99% |
| LMCS | 1.04% | 0.89% | 4.28% | 1.58% | 4.62% | 99% | 97% | 97% | 97% |
| BDPCM | 0.01% | 0.02% | -0.03% | -0.12% | -0.16% | 101% | 99% | 106% | 101% |
| MIP | 0.47% | 0.75% | 0.59% | 0.40% | 0.10% | 93% | 99% | 89% | 101% |
| LFNST | 0.90% | 0.93% | 0.82% | 1.25% | 2.31% | 106% | 98% | 103% | 101% |
| JCCR | 0.22% | 0.52% | 0.55% | 0.37% | -1.69% | 99% | 100% | 98% | 102% |
| SAO | 0.92% | 0.07% | 0.00% | 1.09% | 2.31% | 100% | 97% | 100% | 98% |
| CCALF | 7.40% | -0.16% | -0.17% | 13.29% | 33.96% | 97% | 98% | 99% | 99% |

Simulation Results for RA (Class H1)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | VTM RA |  |  |  |  |
| Abbreviation | DE100 | PSNR-L | BDR-wY | BDR-wU | BDR-wV | Tester EncTime | Tester DecTime | XChecker EncTime | XChecker DecTime |
| CST | 13.45% | 0.55% | 0.48% | 10.56% | 14.53% | 104% | 101% | 105% | 103% |
| DQ | -0.32% | 1.54% | 1.48% | -1.15% | -0.75% | 101% | 94% | 100% | 104% |
| CCLM | 15.06% | 1.16% | 1.04% | 35.92% | 39.48% | 100% | 99% | 100% | 102% |
| MTS | 0.78% | 1.10% | 1.08% | 1.03% | 1.18% | 99% | 96% | 95% | 102% |
| ALF | 11.48% | 2.08% | 1.72% | 17.60% | 45.54% | 93% | 92% | 95% | 95% |
| Affine | 0.91% | 1.13% | 1.12% | 0.59% | 0.61% | 79% | 101% | 79% | 102% |
| SbTMVP | 0.41% | 0.37% | 0.39% | 0.36% | 0.38% | 101% | 99% | 98% | 97% |
| AMVR | 0.95% | 0.76% | 0.78% | 1.26% | 1.73% | 88% | 101% | 86% | 104% |
| GPM | 0.65% | 0.40% | 0.45% | 0.99% | 1.10% | 97% | 101% | 98% | 104% |
| BDOF | 0.72% | 0.93% | 1.00% | 0.38% | 0.33% | 96% | 102% | 97% | 101% |
| CIIP | -0.02% | 0.14% | 0.17% | -0.15% | -0.04% | 97% | 101% | 98% | 103% |
| MMVD | 0.34% | 0.31% | 0.29% | 0.21% | 0.39% | 91% | 100% | 90% | 103% |
| BCW | 0.66% | 0.24% | 0.21% | 0.46% | 0.70% | 94% | 106% | 94% | 104% |
| MRLP | 0.21% | 0.21% | 0.17% | -0.11% | 0.27% | 100% | 105% | 100% | 102% |
| IBC | 0.16% | -0.07% | 0.02% | 0.23% | 0.53% | 104% | 101% | 108% | 103% |
| ISP | -0.12% | 0.43% | 0.46% | -0.15% | 0.26% | 99% | 99% | 96% | 102% |
| DMVR | 1.12% | 1.09% | 0.95% | 1.28% | 1.24% | 100% | 97% | 101% | 99% |
| SBT | 0.13% | 0.17% | 0.38% | 0.00% | 0.28% | 96% | 102% | 96% | 100% |
| LMCS | -1.17% | 0.26% | 4.55% | 0.76% | 3.42% | 98% | 98% | 101% | 100% |
| SMVD | 0.15% | 0.14% | 0.16% | 0.15% | 0.26% | 100% | 99% | 96% | 101% |
| BDPCM | 0.00% | 0.03% | 0.01% | -0.13% | 0.12% | 104% | 101% | 101% | 103% |
| MIP | 0.32% | 0.53% | 0.38% | 0.40% | 0.19% | 100% | 98% | 98% | 103% |
| LFNST | 0.38% | 0.59% | 0.47% | 0.91% | 1.89% | 98% | 97% | 97% | 102% |
| JCCR | -0.36% | 0.35% | 0.37% | -0.71% | -1.12% | 100% | 97% | 100% | 102% |
| SAO | 0.94% | -0.03% | -0.08% | 1.13% | 2.37% | 100% | 100% | 99% | 100% |
| PROF | 0.25% | 0.26% | 0.28% | 0.15% | 0.22% | 95% | 105% | 95% | 101% |
| CCALF | 9.12% | -0.47% | -0.48% | 14.56% | 41.31% | 101% | 97% | 101% | 102% |

Class H2 (HLG)

Simulation Results for AI (Class H2)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | AI |  |  |  |  |
| Abbreviation | BDR-wY | BDR-wU | BDR-wV | Tester EncTime | Tester DecTime | XChecker EncTime | XChecker DecTime |
| CST | 0.60% | 12.89% | 19.26% | 162% | 104% | 158% | 104% |
| DQ | 1.69% | 0.64% | 0.72% | 99% | 104% | 99% | 106% |
| CCLM | 1.81% | 26.99% | 16.96% | 102% | 100% | 101% | 100% |
| MTS | 1.87% | 2.62% | 2.14% | 87% | 97% | 86% | 99% |
| ALF | 2.70% | 18.58% | 20.81% | 97% | 89% | 94% | 91% |
| MRLP | 0.03% | -0.06% | -0.13% | 98% | 101% | 97% | 101% |
| IBC | -0.11% | 0.04% | 0.04% | 209% | 100% | 183% | 100% |
| ISP | 0.31% | -0.61% | -0.26% | 86% | 100% | 84% | 100% |
| LMCS | 0.06% | -0.90% | -0.74% | 99% | 101% | 97% | 100% |
| MIP | 0.72% | 0.83% | 0.35% | 91% | 100% | 89% | 101% |
| LFNST | 0.53% | 1.40% | 1.58% | 110% | 101% | 107% | 100% |
| JCCR | 0.28% | 0.82% | 5.64% | 99% | 101% | 97% | 101% |
| SAO | 0.06% | 0.27% | 0.66% | 100% | 97% | 98% | 98% |
| CCALF | -0.12% | 16.12% | 16.65% | 98% | 97% | 99% | 98% |

Simulation Results for RA (Class H2)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | VTM RA |  |  |  |  |
| Abbreviation | BDR-wY | BDR-wU | BDR-wV | Tester EncTime | Tester DecTime | XChecker EncTime | XChecker DecTime |
| CST | 0.22% | 7.47% | 13.71% | 103% | 99% | 106% | 105% |
| DQ | 1.72% | 0.94% | 0.77% | 102% | 103% | 105% | 108% |
| CCLM | 0.84% | 24.41% | 18.56% | 100% | 101% | 104% | 106% |
| MTS | 1.15% | 1.47% | 0.88% | 96% | 101% | 98% | 104% |
| ALF | 3.40% | 26.85% | 28.54% | 97% | 91% | 96% | 97% |
| Affine | 0.72% | 0.51% | 0.43% | 77% | 99% | 80% | 102% |
| SbTMVP | 0.36% | 0.29% | 0.33% | 101% | 100% | 104% | 104% |
| AMVR | 0.72% | 1.04% | 1.22% | 84% | 101% | 86% | 106% |
| GPM | 0.65% | 0.77% | 0.76% | 97% | 101% | 101% | 106% |
| BDOF | 0.60% | 0.29% | 0.27% | 96% | 99% | 99% | 103% |
| CIIP | 0.21% | -0.18% | -0.35% | 98% | 100% | 101% | 105% |
| MMVD | 0.20% | 0.32% | 0.27% | 91% | 101% | 93% | 105% |
| BCW | 0.22% | 0.15% | 0.14% | 95% | 102% | 97% | 107% |
| MRLP | 0.03% | -0.03% | -0.25% | 101% | 101% | 102% | 106% |
| IBC | 0.11% | 0.00% | -0.46% | 109% | 101% | 109% | 105% |
| ISP | 0.23% | 0.24% | 0.11% | 97% | 101% | 99% | 105% |
| DMVR | 0.86% | 1.08% | 1.09% | 100% | 97% | 103% | 100% |
| SBT | 0.31% | -0.14% | -0.15% | 97% | 101% | 99% | 105% |
| LMCS | 0.96% | 0.69% | 0.64% | 99% | 103% | 99% | 100% |
| SMVD | 0.19% | 0.15% | 0.20% | 97% | 101% | 96% | 105% |
| BDPCM | 0.02% | 0.05% | -0.10% | 102% | 100% | 104% | 105% |
| MIP | 0.50% | 0.62% | 0.19% | 97% | 100% | 101% | 105% |
| LFNST | 0.48% | 0.96% | 1.12% | 97% | 101% | 100% | 104% |
| JCCR | 0.17% | 0.53% | 6.62% | 100% | 101% | 103% | 105% |
| SAO | 0.06% | 0.34% | 1.61% | 100% | 99% | 103% | 104% |
| PROF | 0.33% | 0.19% | 0.33% | 95% | 99% | 96% | 104% |
| CCALF | -0.12% | 22.93% | 24.40% | 100% | 104% | 103% | 105% |



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



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



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

There were noted to be three contributions particularly related to HDR video coding.

|  |  |  |
| --- | --- | --- |
| JVET-R0259 | AHG7: On CCALF filtering of chroma sample location type-2 content | M.G. Sarwer, Y. Ye, J. Luo (Alibaba) |
| JVET-R0365 | Proposals on VVC extension for higher fidelity video | T. Suzuki, M. Ikeda, Y. Yagasaki (Sony), T. Toma, K. Abe (Panasonic), M. Shima (Canon) |
| JVET-R0446 | Crosscheck of JVET-R0256 (AHG7: On CCALF filtering of chroma sample location type-2 content) | F. Pu (Dolby) |



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



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



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

The AHG recommended to review all input contributions.

[JVET-R0008](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10062) 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 Wednesday 15 April 0530 UTC (GJS & JRO).

This document summarizes the activity of AHG08: Layered coding and resolution adaptivity, between the 17th JVET meeting in Brussels, BE (7–17 January 2020) and the 18th meeting by teleconference (15–24 April 2020).

A joint ad hoc group meeting of AHGs 8, 9 and 12 was held by teleconference in the timeframe between April 6 and April 13, involving 16 sessions of two hours each. The report from the joint AHG meeting sessions can be found in [JVET-R0339](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/18_Alpbach/wg11/JVET-R0339-v11.zip).

A kickoff message was sent to the reflector on Feb 2nd, 2020. Other email traffic labelled as relevant for AHG8 were scheduling related.

For a record of the deliberations during the joint AHG meeting please refer to [JVET-R0339](http://phenix.it-sudparis.eu/jvet/doc_end_user/documents/18_Alpbach/wg11/JVET-R0339-v11.zip).

The AHG recommends reviewing the remaining contributions and acting on them and on the recommendations of the joint AHG meeting.

[JVET-R0009](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10063) 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, P. Wu]

This AHG report was discussed Wednesday 15 April 0535 UTC (GJS & JRO).

This AHG report summarizes the activities of the AHG on High-level syntax (HLS) between the 17th JVET meeting in Brussels, BE (7–17 January 2020) and the 18th JVET meeting held by teleconference (15–24 April 2020).

There were no AHG9 e-mail discussion held on the e-mail reflector ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de)).

It is reported that the estimated number of input contributions related to high-level syntax has increased from 188 at the 17th JVET meeting to 253 at this 18th meeting.

An estimation of the review progress of HLS contributions suggests that there is just about sufficient time to handle all HLS input documents in time.

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

Four days of HLS AHG teleconference meetings were held prior to the main JVET meeting. These meetings were held on April 6, 7, 8 and 13. The meeting notes are available in document [JVET-R0339](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9983), which reports that during those four days, approximately 87 (34%) of the 253 contributions were reviewed. That resulted in 38 recommendations for adoption, 1 editor action item, and 11 revisits.

Note that the April series of teleconference meetings consist of 4 HLS AHG meeting days, 2 HLS-only days, and 8 regular JVET meeting days. This is 14 days in total which may be just about sufficient given that there are some revisits and some meeting sessions are JVET or MPEG plenary sessions.

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

[JVET-R0010](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10064) JVET AHG report: Encoding algorithm optimization (AHG10) [A. Duenas, A. Tourapis, S. Ikonin, A. Norkin, R. Sjöberg, J. Le Tanou, J.-M. Thiesse]

The document summarizes the activities of the AHG on Encoding algorithm optimizations between the 17th meeting in Brussels, BE (7-17, January 2020) and the 18th meeting conducted by teleconference (15-24 April 2020)

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

* JVET- R0164: Mean-scaled SATD for VTM encoder
  + Providing a small coding gain -0.12 %, -0.29 % and -0.37 % for AI, RA and LD-B configurations, respectively (-0.57 % for RA in class A1)
* Simplifications of CCALF
  + JVET- R0327: One-pass CCALF
  + JVET- R0328: ALF and CCALF encoder parallel design

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

[JVET-R0011](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10065) JVET AHG report: Screen content coding (AHG11) [S. Liu, J. Boyce, A. Filippov, Y.-C. Sun, J. Xu]

This document summarizes the activity of AHG11: Screen Content Coding between the 17th Meeting in Brussels, BE (7–17 January 2020) and the 18th meeting by teleconference (15–24 April 2020).

The AHG used the main JVET reflector, jvet@lists.rwth-aachen.de, with [AHG11] in message headers. There were a few emails exchanged through jvet reflector, mainly for discussion of screen content test conditions in non-4:2:0 formats (as in JVET-Q2013) and the corresponding VTM software configuration setup.

In total there were noted to be 26 SCC related technical contributions identified so far, among which there were 3 IBC related technical contributions, 10 Palette related technical contributions, 7 Transform Skip related technical contributions and 5 BDPCM related technical contributions identified for this meeting.

Input documents related to AHG11 are summarized as follows. Some of these contributions may be discussed in the context of other AHGs.

* IBC related contributions (3)
  1. JVET-R0175, AhG9: An SPS Flag for IBC-AMVR [K. Naser, M. Kerdranvat, T. Poirier, A. Robert (InterDigital)]
  2. JVET-R0311, [AHG2] Fix cu\_skip\_flag signalling for IBC [H. Jang, J. Nam, N. Park, S. Kim, J. Lim (LGE)]
  3. JVET-R0403 On the boundary strength derivation of IBC coded blocks [B. Ray, G. Van der Auwera, M.Karczewicz (Qualcomm)]
* Palette related contributions (11)
  1. JVET-R0145, AHG 11/15: On the use of limited EGk signaling [J. Gan, C. Rosewarne (Canon)]
  2. JVET-R0146, AHG11: Context coded bin limits for palette coding [J. Gan, C. Rosewarne (Canon)]
  3. JVET-R0229, AHG11: Fixed number of reuse flags for palette mode [R.-L. Liao, Y. Ye, M. G. Sarwer (Alibaba)]
  4. JVET-R0240, AHG11: On maximum palette size and palette predictor size [Y.-H. Chao, T. Hsieh, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm)]
  5. JVET-R0309, [AHG16] Clean-up on palette predictor update for local dual tree [H. Jang, J. Nam, S. Yoo, N. Park, S. Kim, J. Lim (LGE)]
  6. JVET-R0310, [AHG16] Clean-up by removing parsing dependency for palette [H. Jang, J. Nam, S. Yoo, N. Park, S. Kim, J. Lim (LGE)]
  7. JVET-R0320, AHG11: Maximum QP for escape value in palette coding [J. Xu, L. Zhang, W. Zhu, K. Zhang (Bytedance)]
  8. JVET-R0333, AHG11: Mismatches related to palette prediction [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]
  9. JVET-R0334, AHG11: Simplification of palette mode for local dual tree cases [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]
  10. JVET-R0379, Palette mode support in VVC main profile [Y. Ye, R.-L. Liao, M. G. Sarwer (Alibaba), Y.-H. Chao, W.-J. Chien, J. Chen, M. Karczewicz (Qualcomm), P. Onno, C. Gisquet, G. Laroche (Canon), H.-J. Jhu, Y.-W. Chen, X. Xiu, X. Wang (Kwai)]
* Transform Skip related contributions (7)
  1. JVET-R0045, AHG15: cleanup for signalling of minimum QP of transform skip [J. Li, K. Abe (Panasonic)]
  2. JVET-R0049, AHG9: HLS on disabling TSRC [S.-T. Hsiang, C.-W. Hsu, Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]
  3. JVET-R0083, AHG14: Residual coding constraints for transform skip blocks [A. Nalci, H.E. Egilmez, M. Coban, V. Seregin, M. Karczewicz (Qualcomm), M. G. Sarwer, Y. Ye, J. Luo (Alibaba)]
  4. JVET-R0116, AHG11/AHG14: On sign data hiding of transform skip block [M. G. Sarwer, Y. Ye, J. Luo (Alibaba), A. Nalci, H. E. Egilmez, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)]
  5. JVET-R0141, Disabling Dependent Quantization and Sign Data Hiding in Transform Skip blocks [T. Hashimoto, E. Sasaki, T. Aono, T. Ikai (Sharp)]
  6. JVET-R0317, AHG9: On slice transform skip residual coding method signaling [M. Coban, V. Seregin, Y. He, A. Nalci, M. Karczewicz (Qualcomm)]
  7. JVET-R0325, AHG14: Disabling dependent quantization and sign bit hiding for transform skip mode [T.-C. Ma, X. Xiu, Y.-W. Chen, H.-J. Jhu, X. Wang (Kwai Inc.)]
* BDPCM related contributions (5)
  + JVET-R0154, AHG9/16: On sign data hiding for BDPCM blocks [S. Yoo, J. Choi, J. Lim, S. Kim (LGE)]
  + JVET-R0219, Alternative block size conditions for BDPCM [K. Unno, K. Kawamura, S. Naito (KDDI)]
  + JVET-R0319, The interaction between LFNST and BDPCM [M. Koo, M. Salehifar, J. Lim, S. Kim (LGE)]
  + JVET-R0353, AHG14: On Interaction between ACT and BDPCM [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]
  + JVET-R0354, AHG14: BDPCM for Inter/IBC-predicted residuals [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

The AHG recommended:

* To review all related contributions.
* To continue investigating SCC coding tool performance, complexity and interactions between themselves and with other coding tools.
* To continue evaluating new test materials or variations of current test material and testing conditions.

[JVET-R0012](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10066) JVET AHG report: High-level parallelism and coded picture regions (AHG12) [S. Deshpande, B. Choi, M. M. Hannuksela, R. Sjöberg, R. Skupin, W. Wan, B. Wang, Y.-K. Wang]

This AHG report was discussed Wednesday 15 April 0540 UTC (GJS & JRO).

The document summarizes activities of AHG on High-level parallelism and coded picture regions between the 17th and the 18th JVET meetings.

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

In the JVET email reflector, a kick-off message was sent.

There were no other emails on the reflector specifically focusing on AHG12.

There were JVET HLS AHG meetings for AHG8, AHG9, AHG12 on 6-8 and 13 April 2020. Report of that meetings is available in [JVET-R0339](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9983).

Input documents (total 54) related to AHG12 are listed in the AHG report. These documents are classified into following categories. Additional categorization can be found in [JVET-R0339](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9983) (Agenda and report of the category 1 AHG pre-meeting of the 18th JVET meeting).

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

[JVET-R0013](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10067) JVET AHG report: Tool reporting procedure and testing (AHG13) [W.-J. Chien, J. Boyce, Y.-W. Chen, R. Chernyak, K. Choi, R. Hashimoto, Y.-W. Huang, H. Jang, R.-L. Liao, S. Liu]

This document summarizes the activity of AHG13: “Tool reporting procedure” between the 17th meeting in Brussels, BE (7–17 Jan. 2020) and the 18th Meeting by teleconference (15–24 April 2020). Tool on/off experimental results vs. VTM anchor are provided for the tools specified in JVET-Q2005.

The initial version of JVET-Q2005 “Methodology and reporting template for tool testing” was provided on February 25th.

All tests described in JVET-Q2005 were conducted. VTM tool tests were conducted on VTM-8.0 software with VTM configuration by switching off or on specific tool either in configuration files or macros.

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

Tools included in the VTM were listed and tested (with a tool off test vs VTM Anchor).

The DQ tool off test was conducted by disabling DQ and enabling Sign Data Hiding.

Palette mode testing was conducted with test sequences and test conditions defined in the CTC for non-4:2:0 colour format JVET-Q2013.

ACT was also tested with test sequences and test conditions defined in JVET-Q2013 while coding parameters were set as the same as RGB SCC, i.e. --IBC=1 --HashME=1 --BDPCM=1 --PLT=1 --ColorTransform=0 --DualITree=0.

The results of the tests are summarized in the tables below. The attached spreadsheet provides additional data. Table 7 shows tool test results across several VTM versions. The method of computing combined BD-Rate\_YUV is similar to the suggested method in JVET-Q2016. Instead of computing PSNR\_YUV for each frame and then averaging frame PSNR\_YUVs for a sequence, PSNR\_YUV is directly calculated from average PSNR\_Y, PSNR\_U, and PSNR\_V. The difference of the two methods is due to neglectable rounding error. 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-8.0/>

There were no bit rate or PSNR differences between testers and cross-checkers.

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

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **AI** |  |  |  |
| **Acronym** | **BDR-Y** | **BDR-U** | **BDR-V** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| CST | 0.42% | 8.85% | 8.57% | 149% | 101% | 152% | 102% |
| DQ\* | 1.71% | 1.40% | 1.29% | 96% | 103% | 93% | 100% |
| CCLM | 1.66% | 13.54% | 14.02% | 100% | 100% | 99% | 98% |
| MTS | 1.32% | 0.96% | 1.02% | 86% | 101% | 85% | 99% |
| ALF | 2.20% | 12.23% | 11.98% | 90% | 91% | 98% | 92% |
| MRLP | 0.32% | 0.15% | 0.11% | 100% | 100% | 98% | 100% |
| IBC | 0.63% | 0.69% | 0.72% | 52% | 100% | 55% | 100% |
| ISP | 0.50% | 0.30% | 0.29% | 85% | 98% | 85% | 97% |
| LMCS | 0.95% | 0.54% | 0.87% | 99% | 98% | 98% | 97% |
| MIP | 0.63% | 0.19% | 0.17% | 90% | 102% | 90% | 101% |
| LFNST | 0.99% | 1.98% | 2.21% | 110% | 100% | 110% | 100% |
| JCCR | 0.63% | 0.41% | 0.51% | 97% | 101% | 99% | 102% |
| SAO | 0.00% | 0.14% | 0.19% | 101% | 98% | 100% | 98% |
| CCALF | -0.14% | 9.13% | 8.15% | 99% | 97% | 100% | 98% |

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

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 | 0.12% | 3.35% | 3.79% | 101% | 100% | 102% | 100% |
| DQ\* | 1.57% | 1.03% | 0.67% | 100% | 102% | 93% | 95% |
| CCLM | 1.06% | 10.61% | 11.45% | 99% | 100% | 99% | 100% |
| MTS | 0.75% | 0.60% | 0.53% | 94% | 99% | 89% | 95% |
| ALF | 4.40% | 18.37% | 18.15% | 96% | 87% | 98% | 89% |
| Affine | 2.99% | 2.15% | 2.08% | 82% | 97% | 82% | 98% |
| SbTMC | 0.44% | 0.37% | 0.37% | 101% | 99% | 102% | 99% |
| AMVR | 1.40% | 2.08% | 2.23% | 84% | 102% | 84% | 100% |
| GPM | 0.66% | 1.04% | 1.10% | 97% | 102% | 97% | 101% |
| BDOF | 0.76% | 0.37% | 0.28% | 98% | 98% | 98% | 98% |
| CIIP | 0.27% | 0.02% | 0.00% | 98% | 100% | 98% | 100% |
| MMVD | 0.52% | 0.45% | 0.51% | 94% | 101% | 93% | 100% |
| BCW | 0.39% | 0.42% | 0.42% | 93% | 98% | 95% | 101% |
| MRLP | 0.14% | 0.00% | 0.02% | 100% | 100% | 100% | 100% |
| IBC | -0.03% | 0.12% | 0.14% | 91% | 100% | 92% | 101% |
| ISP | 0.28% | 0.27% | 0.28% | 96% | 100% | 96% | 99% |
| DMVR | 0.80% | 1.14% | 1.13% | 100% | 96% | 100% | 96% |
| SBT | 0.41% | -0.08% | -0.03% | 95% | 100% | 90% | 96% |
| LMCS | 1.41% | 1.09% | 0.91% | 95% | 100% | 94% | 98% |
| SMVD | 0.26% | 0.27% | 0.24% | 97% | 101% | 96% | 101% |
| MIP | 0.33% | 0.35% | 0.38% | 96% | 101% | 97% | 100% |
| LFNST | 0.70% | 0.78% | 1.08% | 95% | 100% | 96% | 100% |
| JCCR | 0.59% | 0.29% | -0.07% | 98% | 100% | 99% | 100% |
| SAO | 0.07% | 0.17% | 0.26% | 100% | 98% | 100% | 99% |
| PROF | 0.45% | 0.15% | 0.11% | 99% | 100% | 96% | 101% |
| CCALF | -0.14% | 12.54% | 12.60% | 94% | 93% | 100% | 99% |

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

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 | 0.01% | 1.93% | 1.96% | 100% | 99% | 99% | 99% |
| DQ\* | 1.60% | 0.60% | 0.16% | 100% | 104% | 93% | 97% |
| CCLM | 0.00% | 3.15% | 2.81% | 100% | 101% | 99% | 96% |
| MTS | 0.53% | 0.26% | 0.04% | 98% | 100% | 93% | 96% |
| ALF | 4.06% | 23.59% | 18.29% | 95% | 89% | 95% | 88% |
| Affine | 2.95% | 2.25% | 2.39% | 73% | 92% | 74% | 91% |
| SbTMC | 0.69% | 1.07% | 0.76% | 101% | 94% | 100% | 95% |
| AMVR | 0.59% | 1.06% | 0.86% | 86% | 99% | 86% | 101% |
| GPM | 1.50% | 1.83% | 1.64% | 94% | 103% | 95% | 102% |
| CIIP | 0.37% | 0.54% | 0.57% | 98% | 101% | 97% | 99% |
| MMVD | 0.46% | 0.52% | 0.49% | 95% | 98% | 96% | 100% |
| BCW | 0.24% | 0.37% | 0.37% | 96% | 97% | 97% | 100% |
| MRLP | 0.03% | 0.05% | 0.03% | 99% | 98% | 100% | 100% |
| IBC | -0.01% | -0.20% | -0.09% | 85% | 97% | 87% | 101% |
| ISP | 0.04% | 0.15% | -0.08% | 100% | 101% | 99% | 100% |
| SBT | 0.58% | -0.07% | -0.20% | 92% | 100% | 87% | 95% |
| LMCS | 0.88% | -0.07% | -0.08% | 94% | 97% | 94% | 98% |
| MIP | 0.18% | 0.40% | 0.53% | 95% | 100% | 104% | 98% |
| LFNST | 0.33% | 0.88% | 0.96% | 92% | 100% | 107% | 98% |
| JCCR | 0.13% | 1.81% | 2.12% | 100% | 102% | 99% | 98% |
| SAO | 0.07% | 0.71% | 1.04% | 100% | 98% | 101% | 100% |
| PROF | 0.27% | 0.35% | 0.26% | 99% | 100% | 98% | 99% |
| CCALF | -0.16% | 16.94% | 13.04% | 94% | 94% | 100% | 99% |

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

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 | 15.11% | 15.04% | 15.03% | 54% | 98% | 54% | 99% |
| IBC Class TGM | 46.91% | 44.57% | 44.58% | 63% | 99% | 62% | 99% |
| BDPCM ClassF | 0.92% | 0.81% | 0.76% | 98% | 101% | 106% | 102% |
| BDPCM ClassTGM | 1.39% | 1.58% | 1.54% | 100% | 102% | 97% | 100% |
|  |  |  |  | **RA** |  |  |  |
| IBC Class F | 12.30% | 12.36% | 12.51% | 87% | 98% | 86% | 100% |
| IBC Class TGM | 22.21% | 21.63% | 22.04% | 90% | 102% | 89% | 103% |
| BDPCM ClassF | 0.72% | 0.63% | 0.60% | 99% | 101% | 103% | 103% |
| BDPCM ClassTGM | 0.82% | 0.99% | 0.99% | 100% | 101% | 101% | 102% |
|  |  |  |  | **LD** |  |  |  |
| IBC Class F | 6.19% | 5.98% | 6.41% | 87% | 192% | 85% | 99% |
| IBC Class TGM | 11.45% | 11.79% | 12.06% | 87% | 104% | 86% | 103% |
| BDPCM ClassF | 0.48% | 0.77% | -0.39% | 99% | 100% | 102% | 104% |
| BDPCM ClassTGM | 0.44% | 0.35% | 0.34% | 99% | 102% | 102% | 101% |

Simulation results of coding tools for color space 4:4:4 (VTM anchor) were pending, due to a problem with this case that required a late correction in the software. These results were provided soon *after* the meeting, as follows:

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** |
| Palette\*\* | 14.12% | 15.57% | 16.78% | 98% | 108% | 99% | 111% |
| ACT, RGB SCC\*\*\* | 7.33% | 2.16% | 3.13% | 100% | 106% | 96% | 103% |
| ACT, RGB Camera\*\*\* | 13.04% | 0.24% | 5.23% | 75% | 103% | 74% | 101% |
|  |  |  |  | **RA** |  |  |  |
| Palette\*\* | 9.76% | 12.12% | 13.54% | 99% | 102% | 99% | 102% |
| ACT, RGB SCC\*\*\* | 11.91% | 4.53% | 5.58% | 92% | 101% | 91% | 100% |
| ACT, RGB Camera\*\*\* | 24.21% | 3.59% | 9.89% | 86% | 104% | 83% | 100% |
|  |  |  |  | **LD** |  |  |  |
| Palette\*\* | 5.13% | 7.52% | 8.51% | 96% | 100% | 98% | 103% |
| ACT, RGB SCC\*\*\* | 17.83% | 7.33% | 8.24% | 94% | 103% | 93% | 103% |
| ACT, RGB Camera\*\*\* | 37.69% | 6.84% | 17.32% | 89% | 103% | 93% | 103% |

\*\* Test was conducted with test sequences and test condition defined in JVET-Q2013.

\*\*\* Test was conducted Test sequences and test condition are defined in JVET-Q2013, while coding parameters are set as, i.e. --ColorTransform=0 --DualITree=0.

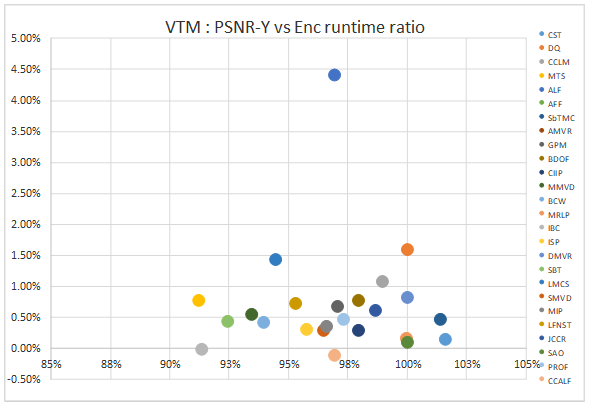
Luma sample usage and memory bandwidth results of VTM tool “off” test. (VTM anchor)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | AI |  | RA |  |  | LDB |  |
| Acronym | Sample usage | Sample usage | Ave mem BW | Max mem BW | Sample usage | Ave mem BW | Max mem BW |
| CCLM | 48.21% | 3.73% |  |  | 0.78% |  |  |
| ALF | 99.00% | 70.60% |  |  | 67.26% |  |  |
| Affine |  | 18.28% |  |  | 27.56% |  |  |
| SBTMC |  | 10.75% |  |  | 13.38% |  |  |
| AMVR |  | 5.45% |  |  | 2.56% |  |  |
| GPM |  | 2.50% |  |  | 6.15% |  |  |
| BDOF |  | 44.75% |  |  |  |  |  |
| CIIP |  | 0.88% |  |  | 1.48% |  |  |
| MMVD |  | 7.05% |  |  | 8.61% |  |  |
| BCW |  | 9.91% |  |  | 8.25% |  |  |
| MRLP | 6.40% | 0.58% |  |  | 0.23% |  |  |
| DMVR |  | 39.97% |  |  |  |  |  |
| SBT |  | 2.60% |  |  | 4.28% |  |  |
| SMVD |  | 2.83% |  |  |  |  |  |
| MIP | 23.64% | 5.14% |  |  | 2.40% |  |  |
| LFNST | 9.79% | 0.78% |  |  | 0.35% |  |  |
| JCCR | 11.02% | 0.53% |  |  | 0.12% |  |  |
| SAO | 31.67% | 7.16% |  |  | 8.08% |  |  |

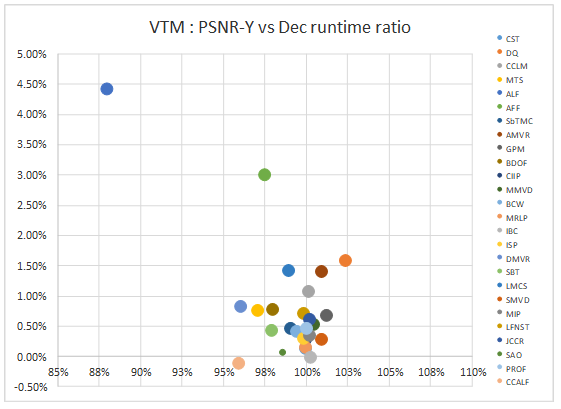
Test results of VTM tool “off” test on various VTM versions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **VTM RA** |  |  |  |
| **Abbreviation** | **VTM3** | **VTM4** | **VTM5** | **VTM6** | **VTM7** | **VTM8** |
| CST | 0.72% | 1.08% | 1.22% | 0.96% | 0.88% | 0.80% |
| DQ\* | 1.41% | 1.39% | 1.27% | 1.27% | 1.28% | 1.41% |
| CCLM | 3.94% | 4.01% | 3.84% | 3.57% | 3.60% | 3.26% |
| MTS | 1.25% | 0.82% | 0.37% | 0.68% | 0.70% | 0.71% |
| ALF | 3.61% | 3.71% | 4.78% | 4.65% | 4.63% | 7.06% |
| Affine | 2.43% | 2.47% | 2.39% | 2.82% | 2.80% | 2.80% |
| SbTMC | 0.52% | 0.43% | 0.40% | 0.48% | 0.43% | 0.43% |
| AMVR | 0.97% | 1.11% | 1.13% | 1.60% | 1.59% | 1.56% |
| GPM | 0.43% | 0.43% | 0.40% | 0.39% | 0.44% | 0.74% |
| BDOF | 1.02% | 0.63% | 0.67% | 0.67% | 0.66% | 0.66% |
| CIIP | 0.43% | 0.51% | 0.32% | 0.24% | 0.23% | 0.22% |
| MMVD | 0.81% | 0.52% | 0.59% | 0.52% | 0.51% | 0.51% |
| BCW | 0.48% | 0.45% | 0.46% | 0.43% | 0.41% | 0.40% |
| MRLP | 0.24% | 0.18% | 0.17% | 0.18% | 0.14% | 0.12% |
| ISP |  | 0.24% | 0.12% | 0.20% | 0.30% | 0.28% |
| DMVR |  | 0.80% | 0.87% | 0.87% | 0.89% | 0.88% |
| SBT |  | 0.33% | 0.34% | 0.31% | 0.31% | 0.31% |
| LMCS |  | 0.64% | 0.61% | 0.97% | 1.36% | 1.32% |
| SMVD |  | 0.26% | 0.24% | 0.27% | 0.26% | 0.26% |
| MIP |  |  | 0.28% | 0.32% | 0.37% | 0.34% |
| LFNST |  |  | 0.75% | 0.60% | 0.74% | 0.75% |
| JCCR |  |  | 0.28% | 0.35% | 0.32% | 0.41% |
| SAO | 0.80% | 0.63% | 0.16% | 0.13% | 0.12% | 0.10% |
| PROF |  |  |  | 0.41% | 0.39% | 0.38% |
| CCALF |  |  |  |  |  | 2.30% |

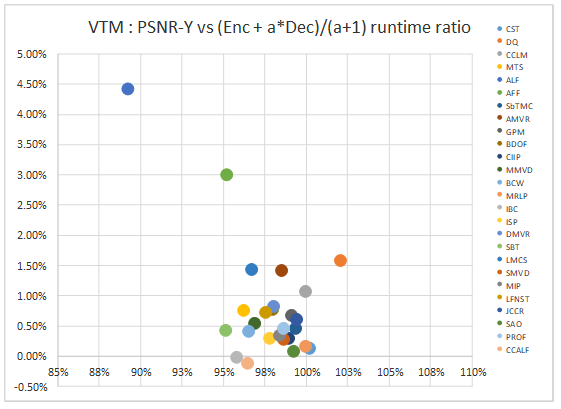
\* Test was conducted by disabling DQ and enabling Sign Data Hiding.



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)

One contribution was noted to be particularly related:

* JVET-R0468 AHG13: On RGB common test condition [Y.-H. Chao, W.-J. Chien, M. Karczewicz (Qualcomm), X. Xiu, Y.-W. Chen, X. Wang (Kwai)]

The AHG recommended the following:

* Consider the reported tool test results during tool adoption decision making
* Review non-420 common test condition for RGB contents
* Refine list of tested tools and test methodology for the next meeting cycle

[JVET-R0014](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10068) JVET AHG report: Lossless and near-lossless coding (AHG14) [T. Nguyen, T.-C. Ma, M. Ikeda, H. Jang, X. Zhao]

This document reports the activity of AHG 14 on lossless and near-lossless coding tools between the 17th JVET meeting in Brussels and the 18th Meeting via Teleconference.

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 3th February 2020. No technical emails have been exchanged related to the AHG. The output document JVET-Q0214 was produced that specify the lossless CTC.

The results for VTM-8.0 against VTM-7.0 for the 4:2:0 test set are as follows.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | **Random Access** | | |
| **ratio** | | bit-rate savings | **ratio** | | bit-rate savings |
| VTM7 | VTM8 | VTM7 | VTM8 |
| Class A1 | 2.2 | 2.4 | -6.62% | 2.2 | 2.4 | -7.20% |
| Class A2 | 1.6 | 1.8 | -10.44% | 1.7 | 1.9 | -8.52% |
| Class B | 2.2 | 2.3 | -6.31% | 2.3 | 2.5 | -4.65% |
| Class C | 1.9 | 2.1 | -7.17% | 2.4 | 2.6 | -6.12% |
| Class D | 1.9 | 2.1 | -8.96% | 2.8 | 2.9 | -6.18% |
| Class E | 2.8 | 3.1 | -9.15% |  |  |  |
| Class F | 5.3 | 5.8 | -7.57% | 33.7 | 35.4 | -5.45% |
| TGM | 11.8 | 12.4 | -4.63% | 107.1 | 109.0 | -1.85% |
| **Overall** | **2.1** | **2.3** | **-7.71%** | **2.2** | **2.4** | **-6.33%** |
| Enc Time[%] | 95% | | | 109% | | |
| Dec Time[%] | 98% | | | 105% | | |

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | **Random Access** | | |
| **ratio** | | bit-rate savings | **ratio** | | bit-rate savings |
| HM-16.20 | HM-16.20 Rext | HM-16.20 | HM-16.20 Rext |
| Class A1 | 2.2 | 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 VTM-7.0 relative [Update for VTM 8] to HEVC Main/Main10 are as follows.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | **Random Access** | | |
| **ratio** | | bit-rate savings | **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 VTM-7.0 relative to HEVC RExt [Update for VTM 8] are as follows.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | **Random Access** | | |
| **ratio** | | bit-rate savings | **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**  **[TSRC]** | **6.55%** | **2.3** | **2.2** | **5.18%** |
| Enc Time[%] | 3285% | | | 1270% | | |
| Dec Time[%] | 185% | | | 151% | | |

Related contributions were noted:

* JVET-R0083 AHG14: Residual coding constraints for transform skip blocks
* JVET-R0084 AHG14: On signalling for lossless coding
* JVET-R0110 AHG14: Mixed lossy/lossless coding of VTM reference software
* JVET-R0116 AHG11/AHG14: On sign data hiding of transform skip block
* JVET-R0140 AHG14: Max BT/TT size restriction for lossless coding encoder configuration
* JVET-R0143 AHG14: Configuration parameter to enable TSRC for lossless coding
* JVET-R0144 AHG14: On lossless operation with RRC
* JVET-R0169 AHG14: Report of CABAC skip mode results on VTM-8.0
* JVET-R0271 AHG9/AHG14: High-level constraints of dependent quantization and sign data hiding
* JVET-R0325 AHG14: Disabling dependent quantization and sign bit hiding for transform skip mode
* JVET-R0353 AHG14: On Interaction between ACT and BDPCM
* JVET-R0354 AHG14: BDPCM for Inter/IBC-predicted residuals

The AHG recommended to review all related contributions and discuss mixed lossy/lossless conditions.

It was suggested to also consider the SCM as an anchor for SCC coding, and noted that VVC is, in some ways, less complex than HEVC SCC due to its IBC design.

[Break until 0837 UTC]

[JVET-R0015](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10069) JVET AHG report: Quantization control (AHG15) [R. Chernyak, E. François, C. Helmrich, S. McCarthy, A. Segall]

This document summarizes the activity of AHG15: Quantization control between the 17th meeting in Brussels, BE (7–17 Jan 2020) and the 18th Meeting (teleconference, 15-24 April 2020).

The regular JVET e-mail reflector was used for discussions ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de)) with [AHG15] in message headers. There were no emails besides AHG kickoff message sent to the JVET reflector during the AHG period.

*Category 1 AHG pre-meeting of the 18th JVET meeting*

The following AHG15 related contributions were identified as related to Quantization control signalling section of Category 1 AHG pre-meeting. Notes from the Category 1 pre-meeting are available in JVET-R0339.

1. [JVET-R0050](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9694), AHG9: HLS on dependent quantization and sign data hiding, S.-T. Hsiang, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)
2. [JVET-R0068](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9712), AHG8/AHG9/AHG12: Miscellaneous HLS topics, Y.-K. Wang, L. Zhang, Z. Deng, J. Xu, K. Zhang, K. Fan (Bytedance)
3. [JVET-R0073](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9717), AHG9: Some cleanups on QP delta signaling, Z. Deng, L. Zhang, Y.-K. Wang, J. Xu, K. Zhang (Bytedance)
4. [JVET-R0076](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9720), AHG9/AHG15: Chroma QP mapping table cleanups, J. Xu, L. Zhang, Y.-K. Wang, K. Zhang, Z. Deng (Bytedance)
5. [JVET-R027](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9916)2, AHG9: On chroma QP offsets in picture header, K. Misra, J. Samuelsson, S. Deshpande, F. Bossen, A. Segall (Sharp)
6. [JVET-R0302](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9946) AHG12: On signalling of chroma QP, L. Li, X. Li, B. Choi, S. Wenger, S. Liu (Tencent)

*Category 2 AHG pre-meeting of the 18th JVET meeting*

The following AHG15 related contributions were identified as related to Quantization control section of Category 2 AHG pre-meeting and they were discussed in session 2.5 Tue 14 April 0520-0630. Notes from the Category 2 pre-meeting are available in JVET-R0340.

1. [JVET-R0055](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9699), AHG15: On referencing a non-existent scaling list, C.-Y. Lai, O. Chubach, C.-Y. Chen, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)
2. [JVET-R0127](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9771), AHG15: On scaling list prediction, A. K. Ramasubramonian, B. Ray, G. Van der Auwera, M. Karczewicz (Qualcomm)
3. [JVET-R0166](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9810), AHG15: Issue on chroma scaling matrix for 4:4:4, K. Abe, T. Toma (Panasonic)
4. [JVET-R0326](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9970), AHG15: On Chroma Quantization Matrix Signalling, H. Zhang, X. Li, G. Li, L. Li, S. Liu (Tencent)

The following AHG15 related contribution was identified related to Transform skip section of Category 2 AHG pre-meeting and it was discussed in session 2.4 Thu 9 April 2320 - Fri 10 April 0115.

1. [JVET-R0045](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9689), AHG15: cleanup for signalling of minimum QP of transform skip, J. Li, K. Abe (Panasonic)

The following AHG15 related contribution was identified related to ACT section of Category 2 AHG pre-meeting.

1. [JVET-R0380](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10025), Scaling list for adaptive colour transform, S. Iwamura, S. Nemoto, A. Ichigaya (NHK), K. Naser, P. de Lagrange, F. Le Leannec, P. Bordes (InterDigital)

The AHG recommended to review all related contributions and continue investigating VVC Quantization control techniques.

Using adaptive rate control for QP signalling experiments was suggested in the discussion.

[JVET-R0016](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10070) JVET AHG report: Implementation studies (AHG16) [M. Zhou, J. An, E. Chai, K. Choi, S. Sethuraman, T. Hsieh, X. Xiu]

This document summarizes the activity of AHG16: Implementation studies, between the 17th JVET meeting in Brussels, BE (7–17 January 2020) and the 18th meeting by teleconference (15–24 April 2020).

The following three issues were suggested to need to be resolved:

* The newly adopted CCALF was identified to have a line buffer issue in 4:2:2/4:4:4 coding. For 4:2:2/4:4:4 chroma format, the luma deblocking is two lines behind the chroma deblocking, but the CCALF uses the collocated luma lines (after de-blocking and SAO) for processing, resulting in the need to buffer two chroma lines for each chroma component. JVET-R0233, JVET-R0291 and JVET-R0322 were submitted to address this cost issue.
* After the adoption of slice\_ts\_residual\_coding\_disabled\_flag at the last meeting, the transform skip can now be combined with the regular transform coefficients coding, but its interaction with the dependent quantization and sign data hiding was suggested to be a potential issue. Several proposals had been submitted that discuss this.
* The availability check of the upper-left neighbouring sample used in CCLM is discussed in some contributions. There is asserted to be a problem when the raster scan slice is in use, such that the upper-left neighbouring sample may still be unavailable even if both the left and top neighbours are available. JVET-R0314 and JVET-R0375 discuss this. In the discussion of the AHG report, there was discussion of whether this is really a possibility or not in the current design. Further discussion was needed about this during the meeting.

The following contributions were identified for the AHG.

* In-loop filters (9)
  + JVET-R0233, “AHG16: Line buffer problem of CC-ALF for 4:2:2 and 4:4:4 sequences”, N. Hu, V. Seregin, M. Karczewicz (Qualcomm)
  + JVET-R0291, “AHG16: On ALF attenuation near virtual boundaries”, F. Bossen (Sharp)
  + JVET-R0312, “AHG2/AHG16: A fix on chroma ALF virtual boundary position”, Y. Wang, L. Zhang, H. Liu, K. Zhang, Z. Deng (Bytedance)
  + JVET-R0322, “CCALF virtual boundary issue for 4:4:4 and 4:2:2 format”, X.W. Meng (PKU), X. Zheng (DJI), S.S. Wang, S.W. Ma (PKU)
  + JVET-R0208, “AHG16: Rounding correction for ALF virtual boundary processing”, A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)
  + JVET-R0313, “AHG2/AHG16: Cleanups of chroma ALF and CC-ALF on/off control”, Y. Wang, L. Zhang, H. Liu, K. Zhang (Bytedance)
  + JVET-R0128, “AHG16: On CCALF clipping” M. G. Sarwer, Y. Ye, J. Luo (Alibaba)
  + JVET-R0133, “AHG16: On Clipping values for Non-linear ALF “, T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)
  + JVET-R0289, “AHG16: On deblocking filter process”, N. Park, J. Nam, H. Jang, J. Lim, S. Kim(LGE)
* TSRC disabling/dependent quantization/sign data hiding (8)
  + JVET-R0050, “AHG9: HLS on dependent quantization and sign data hiding”, S.-T. Hsiang, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)
  + JVET-R0083, “AHG14: Residual coding constraints for transform skip blocks”, A. Nalci, H.E. Egilmez, M. Coban, V. Seregin, M. Karczewicz (Qualcomm), M. G. Sarwer, Y. Ye, J. Luo (Alibaba)
  + JVET-R0116, “AHG11/AHG14: On sign data hiding of transform skip block”, M. G. Sarwer, Y. Ye, J. Luo (Alibaba), A. Nalci, H. E. Egilmez, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)
  + JVET-R0141, “Disabling Dependent Quantization and Sign Data Hiding in Transform Skip blocks”, T. Hashimoto, E. Sasaki, T. Aono, T. Ikai (Sharp)
  + JVET-R0153, “AHG9/AHG16: On slice\_ts\_residual\_coding\_disabled\_flag”, J. Choi, S. Yoo, J. Heo, J. Choi, J. Lim, S. Kim (LGE)
  + JVET-R0154, “AHG9/16: On sign data hiding for BDPCM blocks”, S. Yoo, J. Choi, J. Lim, S. Kim (LGE)
  + JVET-R0271, “AHG9/AHG14: High-level constraints of dependent quantization and sign data hiding”, A. Nalci, M. Coban, M. Karczewicz (Qualcomm)
  + JVET-R0325, “AHG14: Disabling dependent quantization and sign bit hiding for transform skip mode”, T.-C. Ma, X. Xiu, Y.-W. Chen, H.-J. Jhu, X. Wang (Kwai Inc.)
* Intra prediction/CCLM bug fixes/LMCS (7)
  + JVET-R0280, “AHG16: Cleanup of intra reference sample filter selection”, J. Heo, H. Jang, J. Choi, J. Nam, M. Koo, J. Lim, S. Kim (LGE)
  + JVET-R0281, “AHG16: Cleanup MIP flag signaling”, J. Heo, H. Jang, J. Choi, J. Lim, S. Kim (LGE)
  + JVET-R0288, “AHG16: Reference samples for ISP”, F. Bossen (Sharp)
  + JVET-R0314, “AHG2/AHG16: Fixes on CCLM “, Y. Wang, K. Zhang, L. Zhang, H. Liu (Bytedance)
  + JVET-R0375, “AHG2/AHG16: CCLM bug fix in luma reference down-sampling “, L. Pham Van, G. Van Der Auwera, J. Chen, V. Seregin, M. Karczewicz (Qualcomm)
  + JVET-R0290, “AHG16: LMCS constraint cleanup”, F. Bossen (Sharp)
  + JVET-R0330, “AHG16: On clipping average luma value for chroma residual scaling factor derivation”, X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai)
* Palette (2)
  + JVET-R0309, “AHG16: Clean-up on palette predictor update for local dual tree.”, H. Jang, J. Nam, S. Yoo, N. Park, S. Kim, J. Lim (LGE)
  + JVET-R0310, “AHG16: Clean-up by removing parsing dependency for palette”, H. Jang, J. Nam, S. Yoo, N. Park, S. Kim, J. Lim (LGE)
* Implementation (3)
  + JVET-R0316, “AHG16: Normative constraints on BT and TT split under MER “, Y. Wang, K. Zhang, L. Zhang, H. Liu, Z. Deng (Bytedance)
  + JVET-R0224, “AHG16: Realization of RPR based real-time VVC decode and playback on ARM based mobile devices”, J. Shingala, A. Natesan, A. Chelawat (Ittiam)
  + JVET-R0390: “AHG16: VVC multi-thread decoder and performance analysis”, S. Gudumasu, T. Poirier, F. Urban, F. Hiron, P. de Lagrange (interdigital)
* Other AHG16-related contributions (1)
  + JVET-R0223, “AHG16: On DMVR and wraparound motion compensation”, J. Luo, J. Chen, Y. Ye (Alibaba)

The AHG recommended to review the input contributions (see JVET-R0340).

[JVET-R0017](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10071) JVET AHG report: Film grain synthesis (AHG17) [A. Norkin, A. Tourapis, D. Grois, P. de Lagrange, X. Li, S. McCarthy, R. Sjöberg]

The document summarizes the activities of the AHG on Film grain synthesis between the 17th meeting in Brussels, BE (7-17, January 2020) and the 18th teleconferencing meeting (15–24 April 2020).

The regular JVET e-mail reflector was to be used for discussions (jvet@lists.rwth-aachen.de). No e-mail related to AHG17 activity was sent to the JVET reflector during the AHG period.

The following input contributions have been identified as being related to the AHG.

* JVET-R0359 AHG17: Illustration of the film grain characteristics SEI message for VVC [S. McCarthy, F. Pu, T. Lu, P. Yin, W. Husak, T. Chen (Dolby)]
  + JVET-R0455 AHG17: Cross-check report of JVET-R0359 on Illustration of the film grain characteristics SEI message for VVC [P. de Lagrange, E. François (Interdigital)]
* JVET-R0384 Alternative film grain characteristics SEI message [A. Norkin (Netflix)]
  + JVET-R0456 Crosscheck of JVET-R0384 on Alternative film grain characteristics SEI message [A. Tourapis (Apple)]

The AHG recommends that the related input contributions be reviewed by JVET.

It was remarked that neither of the contributions includes an encoder implementation.

R0359 has software for inserting the SEI message in the encoder and for post-processing decoded video but not for grain analysis and film grain removal preprocessing. It was noted that a contribution corresponding to R0359 had been submitted to JCT-VC as JCTVC-AM0023.

It was asked whether the proposed alternative message described in R0384 could also be applicable to HEVC, and it was said that this would also be applicable. There was no contribution to JCT-VC about this alternative, which had not been tested for the HEVC context.

# Project development

## General (2)

[JVET-R0365](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10009) Proposals on VVC extensions for higher fidelity video [T. Suzuki, M. Ikeda, Y. Yagasaki (Sony), T. Toma, K. Abe (Panasonic), M. Shima (Canon)]

This was discussed in the closing plenary of 24 April at 1435 (GJS & JRO).

In the current discussion of profile in JVET, 4:2:0 10 bit and 4:4:4 10 bit profiles will be created in the version 1 of VVC. However due to the evolution of sensing technology, higher fidelity of image/video can be captured and HDR video is emerging to the market. At this moment, display can support 10 bit HDR video, e.g. HDR10; however C-MOSs sensors can capture higher fidelity of image/video, e.g. 12, 14, 16 bit video. Especially for high end production equipment, it is important to support higher bit depth than that of display side. This contribution proposes to investigate the extension to support such higher bit depth video and proposes to develop new profiles in version 2 of VVC.

See also JVET-R0351 with software support for higher bit depths.

ITU-R WP 6C incoming liaison statement to MPEG; it mentioned 12 bit video, which is supported in Rec. ITU-R BT.2100.

Several participants said this seems like very good input toward future work.

The technical issues for supporting this in VVC do not seem very challenging.

Some precision saturation had been reported for the transforms; see the notes for R0351. It was commented that just adjusting the forward transform may be helpful for this.

The subject is already within the scope of the agreed requirements expressed by the parent bodies. Additional study of specific requirements was encouraged.

It was commented that high throughput may be another direction for future work.

At the next meeting, plans toward v2 should be discussed with the parent bodies.

[JVET-R0383](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10028) MC-IF VVC interoperability survey and sub-profile registration [L. Litwic (Ericsson), J. Boyce (Intel), S. McCarthy (Dolby)]

This informational contribution was discussed in the closing plenary of 24 April at 1445 (GJS & JRO).

This input contribution provides an update on the Media Coding Industry Forum (MC-IF) and its activities related to VVC interoperability activities. In particular, the contribution presents information about the planned survey on VVC interoperability needs, and plans for a VVC sub-profile registration service.

The authors of this contribution represent companies who are members of the Media Coding Industry Forum (MC-IF), which has the following stated purpose: “*To further the adoption of MPEG Standards, initially focusing on VVC (Versatile Video Codec), by establishing them as well accepted and widely used standards for the benefit of consumers and the industry.”*

MC-IF plans to conduct a survey in order to facilitate the timely commercialization of Versatile Video Coding (VVC), the new international standard for video coding. MC-IF is interested in helping VVC implementers conduct interoperability testing efficiently so that VVC can be deployed into the market quickly. The purpose of this survey is to establish the need, interest and relevant timeline in order to create a work plan for potential interop activities and resources. Interop activities and services which will be included in this survey may be actioned subject to sufficient interest and contribution from MC-IF members.

The survey will be announced on the MC-IF web site: <https://www.mc-if.org/>.

Both MC-IF member and non-member organizations are welcome to respond to the survey.

MC-IF plans to offer a VVC sub-profile registration service to the industry, to encourage interoperability by ensuring that MC-IF registered sub-profiles are well-motivated, clearly specified, and published. The MC-IF profiling workgoup is developing a registration process document which describes the application procedure for any organization wishing to register a VVC sub-profile using an MC-IF terminal provider code for ITU-T T.35. (The registrant would not need their own terminal provider code.) MC-IF membership is not required to register an MC-IF VVC sub-profile.

The draft registration process document is available on the public MC-IF profiling workgroup page <https://www.mc-if.org/profiling-work-group>, at this link: [MC-IF Sub-profile Registration Process Draft](https://a7dce6fd-e8f0-45f7-b0b0-255c5c9a28e1.filesusr.com/ugd/0c1418_c85bbcbd194f453098812b91b1ae34c3.docx?dn=Sub%20profile%20registration%20process%20draft%20d).

It was reported that the publication of such sub-profiles would include the publication of conformance bitstreams. The review process was characterized as primarily a review of the clarity and completenees of the specification. The specification of sub-profiles may include additional provisions other than the settings of profile and contstraint flag indicators (e.g., additional constraints may be specified to require certain SEI messages to be present).

## Text and software development (1)

Contributions in this category were discussed Friday 24 Apr. morning in plenary (chaired by GJS and JRO).

[JVET-R0481](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10143) AHG2: Editorial input of integrated text for HLS adoptions [Y.-K. Wang (Bytedance), R. Sjöberg (Ericsson)] [late]

This was reviewed in the closing plenary of Friday 24 April at 1500 (GJS & JRO) and confirmed to appear to represent the actions of the meeting.

The integration of R0410 item 10 was suggested to potentially need some refinement.

Using the bug tracker was suggested for any issues noticed in the interpretation of recorded actions.

It was remarked that there is an issue in the conditions for signalling the mvd\_l1\_zero\_flag in the document relative to R0324. It was agreed to resolve the question after the meeting. See the post-meeting note on this subject in the discussion of JVET-R0410.

Review of editors’ notes in texts

* Decision (cleanup): Allow the value 6 for chroma sample location type indicators when present.
* Decision (cleanup): Add a byte to the decoded picture hash SEI message with a single\_component\_flag followed by 7 reserved zero bits. The width and height of each component are defined externally.
* For the decoded picture hash, the two’s complement issue is also found in HEVC. This should be further studied.
* Decision (cleanup): When used with a RWP SEI message, the generalized cubemap message shall have the same functionality as the “traditional” cubemap message (define by syntax element constraints)
* Decision (cleanup): (pt\_)display\_elemental\_periods\_minus1: specify as u(4).

## Test conditions (2)

Contributions in this category were discussed Monday 20 Apr. 1300–1340 in Track B (chaired by JRO).

[JVET-R0321](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9965) AHG3: Chroma QP table bug-fix and CTC update for RGB coding in VTM-8.0 [J. Xu, L. Zhang, W. Zhu (Bytedance), X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai)]

In VTM-8.0, when input video is in non-420 chroma format, one encoder configuration parameter UseIdentityTableForNon420Chroma is enabled which aims at using identical QPs for both luma and chroma components. This is done by manipulating the values of chroma QP table syntax elements in SPS. However, it was found that the currently used values of chroma QP table syntax could unintentionally lead to unequal luma and chroma QPs when the input QP is larger than 26. This contribution provides an encoder fix to appropriately set the equal chroma QP table for non-420 videos. Simulation results are summarized as follows:

For RGB SCC content, the average {G, B, R} BD-rate impacts of the proposed software fix are {−2.10%, 0.80%, 0.61%} and {−2.59%, 0.43%, 0.20%} for AI and RA configurations, respectively. For RGB natural content, the corresponding BD-rate changes are {−10.69%, 2.23%, 0.87%} and {−5.85%, 0.93%, −0.06%} for AI and RA configurations, respectively.

With the above results, it is suggested updating the current CTC for RGB coding.

Bug in software with significant impact on results in RGB The same issue is addressed in merge request 1492. As this has been fixed, there is no need for action. Important information how large the effect of this bug is.

[JVET-R0442](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10104) Crosscheck of JVET-R0321 (AHG3: Chroma QP table bug-fix and CTC update for RGB coding in VTM-8.0) [Y.-H. Chao (Qualcomm)] [late]

[JVET-R0468](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10130) AHG13: On RGB common test condition [Y.-H. Chao, W.-J. Chien, M. Karczewicz (Qualcomm), X. Xiu, Y.-W. Chen, X. Wang (Kwai)] [late]

This contribution proposes to disable chroma separate tree (--DualITree=0) for RGB sequences in the non-420 common test condition. The results of different combinations of ACT and chroma separate tree setting are presented in the document. From the results, enabling ACT and disabling chroma separate tree gives the best performance for RGB sequences for both natural and screen content.

Disabling chroma separate tree versus enabling chroma separate tree for ACT:

Natural content: -13.59%/0.83%/-5.35% G/B/R AI, -7.27%/-0.82%/-2.39% G/B/R RA, x.xx% LDB

Screen Content: -27.82% AI, -16.82% RA, x.xx% LDB

Currently, separate tree is disabled in CTC for screen content (both for YUV and RGB)

It is suggested in the contribution to disable separate tree in CTC for RGB 4:4:4. This allows usage of ACT which is likely the reason for the benefit. It is noted that the results above already are relative to the bug fix as per R0321.

It is asked why the BD gains are non-uniform over the three components. As per the Excel sheets, typically the rate increases, the SNR in G is increased more than in B and R.

Overall, there seems to be benefit in RD performance.

Decision (CTC): Change the conf setting for RGB coding of camera-captured content, single tree in I slices as suggested in JVET-R0468.

(For computer-generated content, single tree was already in use.)

## Verification test planning (3)

[JVET-R0461](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10123) AHG4: Candidate test sequences for verification tests [M. Wien (RWTH), V. Baroncini (VABTECH)] [late]

This document discussed the suitability of SDR test sequences in UHD resolution for usage in the VVC verification tests according to the draft verification test plan described in JVET-R2009. Available test sequences are collected and characterized by means of RD measurements based on HM16.20 in RA configuration and visual inspection. A number of about seven sequences is identified to be inspected further. A method is suggested to perform online viewing sessions in order to proceed in the selection process during the meeting. It is noted that the collection of sequences reported in this document only addresses the SDR UHD test case so far. Contributions and suggestions from JVET experts are solicited, including potential test sequences, but also support with VTM simulations.

Discussed Sunday 19 Apr. 0500–0620 in Track B (chaired by JRO). Follow-up discussion planned for Wednesday after MPEG plenary.

Verification Test should be done with at most 8 sequences per test case, this document proposes a pre-selection for UHD SDR. In SDR, there should be perhaps 5 UHD and 5 HD

Range of qualities should be selected such that at the highest point VVC would be quasi transparent, and HEVC would still have artifacts. Lowest point should be still somewhat acceptable quality for VVC.

It is suggested to have more (perhaps 5) points within that range.

For determining rate savings, it would be best to have same range of qualities for both codings. Another interesting aspect would be determining the improvement in quality at same rate. With having more points, both could be done at the same time.

Vittorio says that a dry run for SDR could be done by end of May. This would mean that a pre-selection of sequences and kind of remote expert viewing should be done during this meeting. This could of course not be done under optimum viewing conditions.

For VTM, we need 6 points: 26,30,..,46 (use 8.0)

For HM, we need QP 24,25,…,46

Tencent, Mediatek, Qualcomm, Sharp, Bytedance, Huawei, Ericsson, Alibaba, HHI, …

Volunteers for encoding and volunteers to participate in expert viewing to send email to Mathias and Vittorio. The procedure and requirements for expert viewing are described in the document.

Results expected to be available on Wednesday. Follow-up on Wednesday afternoon, Mathias and Vittorio will recommend how to conduct the expert viewing.

Further refinement of the first setup can be done after the meeting, e.g. by telco of AHG

It is suggested that for the dry run two VVC versions might be considered, one with ALF on, and one with ALF off.

Other aspects, such as HD selection, and update of the test plan to be further discussed on Wednesday.

Side activities for defining similar test cases for 360 and HDR between Vittorio/Mathias and the relevant people in that area. Y. Ye (360) and A. Segall (HDR) to take care.

Follow-up discussion Wed 22 1515-1620

SDR encodings are almost done, except one sequence still running.

RD plots were shown for HM with 7 sequences. Race night shows more flattening of PSNR vs. rate than other sequences (which however might appear less prominent if a log rate scale was used)

The dense chroma QP plots for HM show jumps (probably due to the chroma QP offset table). It is also noted that the quality of chroma with ALF on/off deviates more below QP 37 (which is probably due to the more disabled CCALF). This should also be considered when potentially adapting chroma QP offset table for VTM.

For quality improvement comparison at same rate, the lowest point should be selected such that VTM still has somewhat acceptable quality (as would be used by typical application), and HM would (hopefully) start looking ugly at the same rate. The highest point should be that VTM starts becoming transparent, and HM still shows artifacts.

For the rate comparison, the lowest/highest quality point selection should be identical, but as HM should have somewhat similar quality as VTM, the HM quality could be used as starting point.

Starting with rate comparison seems simpler.

The first step should be identifying the lowest/highest quality range we want to investigate, and map this with QPs for both codec. As we have a denser QP setting for HM, could be better starting with this.

Mathias and Vittorio to suggest a procedure for this, identify experts who would help with viewing (and give some hints for the selection of lowest/highest point. This should become part of the verification test plan.

HD sequence selection still tbd. Not for “dry run” yet.

Follow up discussion Friday 24 April JVET morning session (chaired by JRO)

An initial version of the verification test plan was presented and discussed.

It was pointed out that after first viewing performed offline by experts, it was found that VTM with QP46 might still be acceptable in some cases, might be useful to also investigate another higher QP point.

The set of candidate sequences for HDR still needs some refinement within the editing period of the verification test doc.

It was also discussed that HDR may be restricted to 4K sequences, as this is the typical case in consumer applications.

Potentially HDR on mobile devices as follow-up? May be a long term goal, similar to 360 with HMD (and probably simpler than that)

There should be no dry run with non-experts for HDR, just expert viewing activity.

For 360, it should be clarified if padding can be used for CMP-like formats, to avoid visibility of face boundaries. For fair comparison, this should be used for both codecs. Clarify if at all an implementation exists for such a mechanism in HEVC (per SEI message it should be possible), or if it could be mimicked but using 360lib.

[JVET-R0484](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10146) Report of 360 verification test planning side activity [V. Baroncini, J. Boyce, J.-R. Ohm, M. Wien, Y. Ye]

Was presented Wed. 22 1625-1650

This is the summary report of the 360 video verification test planning side activity, Tuesday April 21 15:15 – 16:25 UTC.

It was agreed to use 5 360 video sequences in the formal verification tests.

When doing initial simulations, it was agreed to use more sequences, and plot their R-D performance to get quality and rate range behaviour of each sequence.

SDR used QP 26-46, step size of 4 for VVC, and QP 26-46, step size of 1 for HEVC

It was agreed to use the same QP settings for 360 content in the preliminary round of simulations.

It was suggested that, after preliminary encoding is done, perform preliminary viewing of the content, and suggest viewports (one static and one dynamic).

It was commented that once bitstreams are available, generating viewport images is relatively easy.

It was agreed to separate encoding and viewport selection/generation into different tasks, with possibly different volunteers.

It was commented that SDR bitstreams have two settings, one ALF on and the other with ALF off.

It was agreed that we will keep ALF on for 360 video encoding in the preliminary round of simulations.

VVC CfP used dynamic viewports with 78.1×49.1 degrees of FOV and a resolution of 1920×1080.

It was asked if we consider HMD viewing, and commented that with HMD viewing, the same problem that we had before with people watching different content still exists. So HMD viewing may not be suitable.

It was agreed to use viewport viewing in verification tests.

It was suggested to describe the 360 test procedure in writing, including sequence selection, rate points, viewport selections, and timeline.

Agreed.

A complete inventory of 360 video sequences on our ftp repository ([ftp://ftp.ient.rwth-aachen.de](ftp://ftp.ient.rwth-aachen.de/)) can be found in Annex A. The following candidate list was selected based on their resolutions and discussed in this side activity.

Table 1 Candidate sequence list for preliminary simulation

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Sequence | Frame rate | Resolution | Provider | BD | Camera | CTC | Notes |
| 6 | skateboarding | 60 | 4096x2048 | GoPro | 8 | static | no |  |
| 12 | GT\_Sheriff | 30 | 4320x2160 | Nokia | 8 | static | no |  |
| 13 | basketball | 30 | 8192x4096 | GoPro | 10 | static | no |  |
| 16 | jam\_session | 30 | 8192x4096 | GoPro | 8 | static | no | “holes” in sky/ground |
| 17 | SkateboardTrick | 60 | 8192x4096 | GoPro | 8 | static | no |  |
| 18 | Train | 60 | 8192x4096 | GoPro | 8 | static | no | “holes” in sky/ground |
| 28 | BranCastle | 30 | 6144x3072 | GoPro | 8 | moving | no | shaky |
| 29 | Landing | 30 | 6144x3072 | GoPro | 8 | moving | no | Very fast |
| 30 | SkateBoardAtBridge | 30 | 6144x3072 | GoPro | 8 | moving | no |  |
| 31 | HarborBiking | 30 | 8192x4096 | InterDigital | 8 | moving | no |  |
| 32 | KiteFliteWalking | 30 | 8192x4096 | InterDigital | 8 | moving | no |  |

It was commented that having small “holes” in the sky and ground is not an issue if the content is otherwise suitable, because we could design viewports that avoid the “holes.”

During email discussion, it was mentioned that sequences #28 (BranCastle) and #29 (Landing) are shaky and/or contain very fast motion, making them uncomfortable to watch. This was confirmed during the discussion.

It was agreed to not consider sequences #28 and #29 due to undesirable content characteristics.

It was agreed to encode all remaining 9 sequences, numbered 6, 12, 13, 16, 17, 18, 30, 31, 32 in Table 1.

360 video CTC uses the following configurations as “anchor” and “test”:

* codec only comparison: VVC in PERP format vs HEVC in PERP format
* codec + projection comparison: VVC in PHEC format vs HEVC in cubemap (CMP) format

It was agreed to use the same configurations in the preliminary encoding round.

It was asked if also a VR display such as HMD would be used? This could hypothetically be done in a later phase, when a good method of judging the quality of experience of VR would exist. Not in short term, but could be written in the verification test plan as a longer-term goal.

It is also asked if any HDR-based 360 test material would be available. Not known.

[JVET-R0487](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10149) Report of HDR verification test planning side activity [A. Segall, M. Wien]

Presented Wed 22, 1650-1710

This is a summary report of the HDR video verification test planning side activity. The activity took place during the 18th JVET meeting and included a teleconference on Tuesday April 21 16:30 – 17:30 UTC.

The group considered if the HDR verification process should be aligned with the SDR verification process.

It was commented that the SDR verification process is currently targeting completion by October. Additionally, it was explained that the SDR schedule includes completing a dry run in July.

It was commented by one participant that it would be beneficial to have the HDR testing done sooner rather than later.

It was further suggested that the group should attempt to align with the SDR schedule. However, it was also commented that it was currently unclear if this could be accomplished given current local limitations and its impact on accessing display equipment.

The group agreed to align with the SDR schedule as a working direction, with an understanding that the work plan should include re-evaluating the schedule after initial testing.

The group considered if there is additional content that is available and could provide additional candidates for vierfication testing.

It was suggested by one participant that an initial target of 9-10 sequences would be ideal.

It was suggested by another participant to include an equal mixure of PQ and HLG content.

It was commented that JVET-E0121 provides som analysis of existing content that was not included in the CTC. Furthermore, another participating commented that JVET-E0086 also provided analysis for other content that could be available for verification testing.

It was further commented that SONY had genereoursly provided additional sequences that were not included in the CTC.

Action Item: Create a summary of content available on the FTP site and solicit input from others not participating in the side-discussion.

The group then discussed if the current CTC sequences are useful and still relevant for verification testing.

One participatnt commented that including the CTC sequences in the verification tests may not be desireable.

Another participant commented that the VTM may not be specifically tuned for the HDR CTC sequences and so could be considered if needed.

One participant commented that even if the VTM was not tuned for the HDR CTC sequences, it might still be desireable to not include them in a verification test.

The group then discussed what monitor (or monitors) should be used for the visual evaluation. And, specifically, if it would be acceptable to use a consumer level monitor for evaluation.

One participant noted that we shuld be aware of two different sources of artifacts. The first would be coding artifacts and the second would be chroma artifacts, where coding artifacts would denote artifacts similar to those typically found in SDR content and chroma artifacts would denote chroma degradations that may be HDR specific.

Multiple participants commented that using a less than 4k nit display should be acceptable.

The group then discussed two general categories of displays. These categories are consumare and professional displays.

As a working direction, the group agreed to perform initial evaluation and verification testing using a consumer HDR display. A preference for an OLED display was expressed.

From discussion in track B:

Using consumer displays is preferable, as this is the real application case of HDR.

It is pointed out that, if the HDR test would be performed in different labs, same displays/settings shouldbe used

With PQ, the content could violate the range of certain displays, some re-grading/tone mapping might be necessary. This needs to be done carefully.

Wed 22 1710 Review of previous test plan:

Might HD be tested just with LB configuration?

Mathias, Yan and Andrew should start an offline activity for updating the verification test plan, integrating relevant elements from R0484, R0487, naming the volunteers for sequence coding, listing sequences etc, defining a time line until the next meeting is the most important element that should be approved on Friday. This should include plans for teleconf meeting(s), dry run, and everything that is necessary before that. For SDR, HD part should be elaborated until the next meeting.

Wednesday 22 session ended 1730.

## Coding studies and tools on specific use cases (2)

[JVET-R0243](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9887) AHG9: 4:4:4 vs. 4:2:0 bit-rate in VTM [S. Keating, A. Browne, K. Sharman (Sony)]

This was discussed in AHG Session 1.5 (GJS, YKW, JRO & JB).

This contribution compares bit rates for 4:4:4 and 4:2:0 encoding. It is for information/discussion only.

Another contribution, JVET-R0244, proposes changes to the CpbVclFactor and MinCrScaleFactor for Main 4:4:4 10 profile. JVET-R0244 proposes to specify that the maximum bit-rate of 4:4:4 should be twice the maximum bit-rate of 4:2:0 (instead of 2.5 as currently specified, and as in AVC and HEVC).

Comments:

In some cases, unless low-pass filtering is applied, the bit rate is higher. However, on the other hand, low-pass filtering to chroma seems not good as it blurs the chroma.

Chroma QP offset or lambda adjustment are another ways of adjusting the bit-rate balance.

A reason for having some extra bit rate header room for 4:4:4 is that the quality expectation for 4:4:4 is higher, and the GOP length or intra refresh period may be shorter.

Sometimes there is RGB coding for 4:4:4, which is generally less efficient than YCbCr.

Discussion stopped here for AHG Session 1.5 Tuesday 7 April at 1500 UTC.

[JVET-R0376](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10021) Versatile Video Coding for VPCC [D. Mehlem, C. Rohlfing (RWTH)]

This contribution presents recently conducted experiments on the video-based point cloud compression (VPCC) test model TMC2 by exchanging the currently used HM HEVC coder implementation with the VTM VVC coder implementation. Experiments show, that compression results with VVC are significantly higher than with HEVC.

Contribution for information. Was presented in JVET separate plenary track Fri 24 April 0915 (chaired by JRO)

The contribution shows that VVC can be used instead of HEVC for VPCC, with a similar benefit in terms of rate saving as for conventional video.

## Test material (0)

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

## Conformance (2)

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

[JVET-R0254](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9898) AHG5: Conformance bitstreams with decoder conditions [M. Pettersson, R. Sjöberg, M. Damghanian, Z. Zhang, J. Enhorn, R. Yu, J. Ström (Ericsson)]

This was discussed Thursday 23 April at 0645 (GJS)

This contribution proposes the following:

1. To include conformance bitstreams with specific decoder conditions in the draft VVC conformance testing document. It is proposed that a description of the decoder conditions applied to produce the decoded pictures is provided for each such bitstream together with VTM decoder settings used to decode the bitstream.
2. To add DRAP conformance bitstreams to the list of conformance bitstreams in the draft VVC conformance testing document, either in the table with high-level syntax features or in a separate section containing conformance bitstreams that requires specific decoder conditions. It is proposed that the following decoder conditions would apply for a DRAP conformance bitstream:

* Skip all pictures with a POC value smaller than X, except for IRAP pictures, which are decoded but not output.
* Start decoding at the first IRAP or DRAP picture in decoding order with a POC value equal to or larger than X.

1. To modify the VTM decoder to support tuning in at a DRAP picture. The following modifications to VTM are proposed:

* Add a decoder option SEIDRAP that enables the decoder to tune in at DRAP pictures.
* When SEIDRAP is enabled and SkipFrames is set to a value X that is larger than 0, the decoder skips all pictures with a POC value smaller than X, except for IRAP pictures, which are decoded but not output and starts decoding at the first IRAP or DRAP picture in decoding order with a POC value equal to or larger than X.

The VTM does not currently support the “tuning in” functionality, which is an optional capability.

It was commented that the response of a decoder to this SEI message is not only optional but non-normative, so it was suggested that this is not really a conformance test.

A suggestion was to put bitstreams into a separate directory on the accessible ftp site but not make it part of the conformace test specification.

It was commented that it would be desirable to have many other such demonstration/showcase examples.

Another suggestion was to consider specifying “optionally normative” messages, perhaps as a separate standard, as contrasted with the usual concept that behaviour of a decoder (or receiving system) in response to an SEI is not normatively specified.

Having an informative section in the conformance test specification was suggested.

Issuing showcase examples as an informational JVET output, similar to the test model was suggested.

It was agreed to further study this in an AHG.

[JVET-R0405](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10050) Editors input on VVC conformance testing [J. Boyce, E. Alshina, K. Kawamura, I. Moccagatta, S. McCarthy, K. Sühring, W. Wan] [late]

This was discussed Thursday 23 April at 0700 (GJS)

[Add abstract]

Volunteers had been solicited offline.

Two more categories of volunteers were requested, both relating to 4:2:2: 8 bit and 10 bit conformance streams were requested.

Ikeda-san volunteered to provide 4:2:2 10 bit conformance streams.

Having low resolution bitstreams (or both high and low resolution bitstream) is often desirable when adequate for testing a feature.

Participants are requested to review the draft and see whether they believe the planned tests are adequate for testing the features.

## Implementation studies (AHG16) (3)

Contributions in this category were discussed Monday 20 Apr. 1340–1450 in Track B (chaired by JRO).

[JVET-R0224](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9868) AHG16: Realization of RPR based real-time VVC decode and playback on ARM based mobile devices [J. Shingala, A. Natesan, A. Chelawat (Ittiam)]

A feature rich real time implementation of VVC software decoding on ARM based mobile clients was demonstrated as part of JVET-Q0386. The optimized software decoder is now extended to support reference picture resampling (RPR) which can be a useful tool for various applications such as low delay adaptive streaming, video conferencing and spatial scalability. This contribution provides informative insights on implementation aspects and impact of RPR on the decoding speed of the optimized VVC software decoder.

The RPR optimized VVC decoder is realized as follows

RPR configuration1: 1080p with scaling ratio of 2

* Low delay B configuration
* Kimono 1080p24
* Input bit depth and Internal bit depth as 8-bit
* 4 tiles with uniform spacing
* Horizontal and Vertical Scaling Ratio of 2 (1080p <=> 540p)
* Switching interval of 1second

RPR configuration2: 1080p with scaling ratio of 1.5

* Low delay B configuration
* Kimono 1080p24
* Input bit depth and Internal bit depth as 8-bit
* 4 tiles with uniform spacing
* Horizontal and Vertical Scaling Ratio of 1.5 (1080p <=> 720p)
* Switching interval of 1second

ARM platform and software configuration

* VTM-7.0 based software decoder supporting all tools
* Critical decoder modules optimized for ARM NEON (128-bit SIMD) architecture
* Multi-threaded decoding using 4 cores of Cortex-A75 (/Cortex-A76) clocked at 2.5GHz
* Optimized for low delay (LDB) and random access (RA) configuration

It is pointed out that RPR could also be used for other configurations such as RA

It is pointed out that the switching between filters was challenging in the implementation.

All scaling ratios are supported, also more irregular ones.

[JVET-R0351](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9995) High bit depth coding [A. Browne, S. Keating, K. Sharman (Sony)]

This document presents the current capabilities of VVC when operating at a range of bit depths (8, 10, 12, 14 and 16 bit), and low QPs. Such testing is designed to show the correctness of VVC under the currently defined profiles and to identify problems which will need to be solved for higher bit profiles that may defined in a future version of VVC. This document identifies and tests a number of transforms where enhanced numerical accuracy can improve the results and extend the current operating range of VVC. It is proposed that the extended precision flag is kept in the reference software, VTM, as this will allow further study of high bit depths in version 2. Acceptance of a patch for a number of bugs encountered whilst studying VVC with high bit depths is proposed.

It is pointed out that for the DCT2, VTM had already implemented the data structures for high precision transforms of HEVC (extended precision flag), which are however not in the spec. Various bug fixes were necessary, but the proponents were able (as per results) to encode >10 bit content can be coded without incurring losses in the low QP range (it is noted that the results were generated with TS disabled, if it was enabled, such losses caused e.g. by overflows might not have occurred). Also corresponding high precision versions of the forward transform for DST/DCT variants and LFNST were implemented.

It is proposed to retain the high precision flag in the software for experimental purposes.

A merge request is announced that would provide the elements that were developed for higher precision transforms. The SW coordinator would requests for further cleanup.

It is noted that such a piece of software should be disabled by a macro and would be removed in the software specification to be submitted for standardization.

Decision (SW): Include code from JVET-R0351 in VTM SW for experimentation with coding >10 bit content.

[JVET-R0390](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10035) [AHG16] VVC multi-thread decoder and performance analysis [S. Gudumasu, T. Poirier, F. Urban, F. Hiron, P. de Lagrange (InterDigital)]

This contribution introduces a software based VVC decoder implementation using parallel processing. The design explores both task and data parallelization to distribute the decoding modules on general-purpose multiprocessor platform. The implementation is based on VTM8.0 without compromising on the coding efficiency or memory bandwidth; an average 85% and 80% decoding time reduction is reported for Class A and Class B sequences respectively with random access CTC test conditions on a 10-core processor.

Threads are operated in wavefront approach over CTU rows.

Percentage of processing that is needed for inter reconstruction and deblocking is substantially reduced compared to VTM.

For HD, 55-70 fps (depending on sequence) at QP37, 35-45 at QP22 (with 8 threads, where it saturates)

For UHD, it is slower, but more threads than 8 are still giving advantage.

The limitation of number of threads should be due to the wavefront processing, with a lag of 2 CTUs of size 128, 2x8x128 is approximately the width of an HD picture.

## Profile/level specification (5)

Also see the WG 11 US NB ballot comment on still picture profiles.

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

[JVET-R0370](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10014) Main 10 Still Picture and Main 4:4:4 10 Still Picture profiles for VVC version 1 [J. Chen, M. Karczewicz (Qualcomm), B. Bross (HHI), Y.-K. Wang (Bytedance), , H. Yang, E. Alshina (Huawei), S. Wenger, L. Li (Tencent)]

[JVET-R0392](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10037) VVC Version 1 Profiles [W. Wan (Broadcom), D. LeGall, A. Wells (Ambarella), H. Edward, G. Sines (AMD), D. Singer, A. Tourapis (Apple), S. Pejhan, M. Raulet (ATEME), P. Pahalawatta, E. Petajan (ATT Inc.), S. Davis (Charter Communications), D. Grois, Y. Syed (Comcast Cable), X. Ducloux, P. Haskell (Harmonic Inc.), J. Le Tanou (MediaKind), C. Hau (NBCUniversal), A. Luthra (Picsel Labs), T. Suzuki (Sony), E. Chai (Ubilinx]

[JVET-R0054](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9698) AHG12: On combination of wavefront parallel processing and tile partitioning [C.-M. Tsai, C.-W. Hsu, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

This contribution was initially discussed in AHG Session 1.2 Monday 6 April at 1700 UTC (GJS & YKW).

It was determined not to really be an HLS proposal.

In VVC Draft 8, parallel processing can be achieved by using wavefront parallel processing (WPP) or tile partitioning, and they are allowed to be simultaneously used within the same picture. The proponent asserts that disallowing the combination of WPP and tile partitioning would decrease the effort of decoder verification and remove functionality redundancy between WPP and horizontal tile partitioning. Two methods are proposed in this contribution.

* In Method 1, if WPP is used in the current picture, the number of tile rows in the current picture shall be equal to 1. As a result, the functionality redundancy between WPP and horizontal tile partitioning is removed, and the behaviour of CABAC context variable inheritance is also simplified.
* In Method 2, same as in most HEVC profiles (those other than the high-throughput profiles), WPP and tile partitioning are disallowed to be simultaneously used within the same picture. It is claimed that Method 2 is simpler than Method 1 and simplifies the decoder verification significantly.

The proposed restriction is motivated by verification effort. It is a functionality change and was suggested to be too substantial to be able to agree to in the AHG. One participant said that “method 1” would be undesirably restrictive in the case of rectangular slices with wavefronts.

Left open by the AHG.

[JVET-R0379](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10024) Palette mode support in VVC main profile [Y. Ye, R.-L. Liao, M. Sarwer (Alibaba), Y.-H. Chao, W.-J. Chien, J. Chen, M. Karczewicz (Qualcomm), P. Onno, C. Gisquet, G. Laroche (Canon), X. Wang (Kwai)]

[JVET-R0364](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10008) Information on cinematic aspect ratios in the context of JVET-Q0065 [S. McCarthy, W. Husak, P. Yin, T. Lu, F. Pu, T. Chen (Dolby)]

JVET-Q0065 proposed level constraints on maximum tile size such as to reduce line buffer memory requirements. JVET-Q0065 was adopted at the 17th JVET meeting, Brussels, BE; but further study was suggested regarding some cinematic aspect ratios. This contribution provides information on HD, UHD, and cinematic aspect ratios to resolve that further study. This contribution proposes that the level restrictions adopted in JVET-Q0065 are appropriate and sufficient for standards specifying aspect ratios for HD, UHD, and digital cinema use cases.

Was presented Monday 20 Apr. 1400 in Track B (chaired by JRO)

It is noted in the contribution that cinematic formats such as CinemaScope which have 2.39:1 aspect ratios are well supported by VVC level definitions.

Just for information – no need for action.

# Low-level tool technology proposals (114)

## AHG2/AHG3/AHG16: General coding tools (77)

### Inter and IBC prediction and MV coding (16)

Initially discussed in AHG session 1.8 Tuesday 14 April 1530-1720 (chaired by JRO), further discussed in track B Friday 17 April 1300-1505 (chaired by JRO)

[JVET-R0137](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9781) On mvd\_l1\_zero\_flag and NoBackwardPredFlag [T. Chujoh, E. Sasaki, T. Ikai (Sharp)]

Only first aspect (problem 1) on NoBackwardPredFlag and ColPic

In this contribution, some solutions for two problems of current VVC Draft 8 have been proposed. One problem is that there is no specification of the variables ColPic and NoBackwardPredFlag and the other problem is that mvd\_l1\_zero\_flag is specified in only picture header even if reference picture list structure can be changed on slice header. Two solutions for the first problem have been shown Option 1 is that the variable ColPic as the almost same as that of HEVC is defined and a new variable IdenticalDirectionalFlag which is replaced to previous NoBackwadPredFlag is specified by using the decoding process for symmetric motion vector difference reference indices. Option 2 is that the variables ColPic and NoBackwadPredFlag as the almost same as that of HEVC are defined. Also, two solutions for the second problem have been shown. Option 1 is that the change of enabling condition of symmetric motion vector difference and mvd\_l1\_zero\_flag by the variable IdenticalDirectionalFlag and option 2 is that mvd\_l1\_zero\_flag is specified in the picture header or in the slice header by the syntax element rpl\_info\_in\_ph\_flag exclusively. Neither proposal changes the results of the CTC.

The proposal is filling an existing hole regarding the definition of collocated picture and NoBackwardPredFlag.

The definition proposed for collocated picture seems appropriate (just transferring the HEVC method which is also matching with software). In terms of the NoBackwardPredFlag, the proposed option 1.1 seems to deviate from the SW implementation, option 1.2 also but with less change.

It is recommended to fill the gap in the spec by transferring the corresponding text from HEVC as much as possible, while matching with the decoding process as implemented in SW. The difference compared to HEVC is e.g. related to processing of long term pictures. It was asked to be further discussed with HLS experts what the issues are – was again discussed Monday Apr. 20 1635

The following is suggested:

- definition of collocated picture could be transferred from HEVC “as is”

- for aspect of backward pred flag, “each picture aPic” should be changed to “each active picture aPic”, otherwise the text could be transferred

- deviations in terms of different definition of long term reference picture have not been verified.

Decision: The missing definitions in the decoding process need to be included in the text. The concepts proposed in JVET-R0137 option 1.2 to be used as a basis for that – left to the discretion of editor to resolve potential additional issues, and align with the exact behaviour in reference SW.

[JVET-R0212](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9856) On modes in geometric partitioning [C. Hollmann, D. Liu, R. Yu, J. Ström (Ericsson)]

In this contribution three methods to reduce the number of modes for geometric partitioning are presented. These methods are claimed to reduce the number of modes from 64 to 50, 38 and 32, respectively. It is further claimed that these methods have a minor impact on the compression efficiency. It is also asserted that the number of combinations that are required to be tested during verification testing is reduced by up to 50%.

* Method 1 (50 modes): 0.03% RA, 0.00% LDB, 700 combinations to test (-22%)
* Method 2 (38 modes): 0.05% RA, 0.01% LDB, 532 combinations to test (-40%)
* Method 3 (32 modes): 0.07% RA, 0.06% LDB, 448 combinations to test (-50%)

The main intent is reducing the number of combinations for conformance testing.

The issue of testing a large number of combinations in geo was already discussed in the last meeting, and the adopted solution was agreed to be a good compromise.

No action was taken on this.

[JVET-R0385](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10030) Crosscheck of JVET-R0212 (On modes in geometric partitioning) [K. Zhang (Bytedance)] [late]

[JVET-R0213](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9857) Modifications of motion storage in geometric partition mode [R. Yu, D. Liu, C. Hollmann, J. Ström (Ericsson)]

In the current VVC, for a geometric partition mode (GPM) coded block, the block is split into two partitions with a splitting line defined by an angle and a distance. Each partition is associated with a uni-motion. The prediction sample for each partition is generated using the uni-motion. For the prediction samples near the splitting line, a blending operation is carried out to reduce discontinuity.

The motion storage process for the GPM coded block stores three types of motion. The three types of motion are the two uni-motions associated with each partition and a third motion which is a combination of the two uni-motions. The third motion is also referred to as type2 motion. Each 4x4 subblock within the GPM coded block stores one of the three types of motion. The type2 motion is stored within 4x4 subblocks that are within the blending area. It is asserted that since the blending area is narrow in general the storage of the type2 motion will be unnecessary.

This contribution proposes to remove the storage of type2 motion for GPM coded blocks. In other words, only the two uni-motions are stored. It is claimed that with the modification, one absolute operation and one comparison operation for each 4x4 subblock can be saved if the motion storage map is computed on the fly. It is also claimed that the determination process for the type2 motion can also be removed. It is further claimed that the specification text for the motion storage for GPM can be significantly cleaned up. The modification was implemented in the VTM-8.0 and the BD-rate impact is reported to be -0.01% for RA and 0.01% for LDB. It is proposed to adopt the modification considering that the BD-rate impact is negligible.

There is no real problem to be solved, several experts pointed out that similar methods had been proposed earlier in the context of the triangular partitioning mode. Some concern was also expressed with regard to possible impact on subjective quality with regard to blending.

No action was taken on this.

[JVET-R0389](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10034) Crosscheck of JVET-R0213 (Modifications of motion storage in geometric partition mode) [Z. Deng (Bytedance)] [late]

[JVET-R0223](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9867) AHG16: On DMVR and wraparound motion compensation [J. Luo, J. Chen, Y. Ye (Alibaba)]

In VVC draft 8, when wrap around motion compensation is enabled, the bilinear interpolation in DMVR motion search process also uses wrap-around clipping operation. In this contribution, it is proposed to apply regular clipping operation during DMVR motion search, and apply wrap-around clipping operation only for regular interpolation during the final motion compensation process. It is asserted that this simplifies the motion search process in DMVR. Experiment results reportedly show that the BD rate difference is -0.01%, -0.01%, -0.02% for end-to-end WS-PSNR for Y, U and V respectively. Informal subjective viewing was conducted and no visible difference was observed.

Results with 360 video PERP.

It was commented that the implementation seems to become more complicated, as an additional reference area fetch would become necessary for DMVR.

No action was taken on the proposal.

There is another aspect in the proposed text that the DMVR text could be simplified, e.g. in terms of that the combination with RPR would never be used. Decision: Editorial improvement left to editor. (Initial recommendation of AHG meeting was later converted into Decision in track B)

[JVET-R0425](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10087) Crosscheck of JVET-R0223 (AHG16: On DMVR and wraparound motion compensation) [Y.-H. Lee, J.-L. Lin (MediaTek)] [late]

[JVET-R0282](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9926) GEO with MMVD [K. Panusopone, S. Hong, L. Wang (Nokia)]

This contribution proposes to harmonize GEO with MMVD such that MVD can be applied to derive MV of a GEO partition. The proposed method first determines base MV using current GEO MV calculation, then computes MVD for each base MV following method like MVD calculation for MMVD. Simulation results show the proposed method has BD-rate of approximately -0.25%, -0.36%, -0.49% for RA, and -0.51%, -0.66%, -0.97% for LB, respectively, compared to VTM-8.0 anchor.

Encoding time increase is roughly 30% for RA, and over 30% for LB. This is not an attractive tradeoff.

No action.

[JVET-R0407](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10054) Crosscheck of JVET-R0282: GEO with MMVD [K. Reuzé (??)] [late]

[JVET-R0292](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9936) Fixes for 4-tap interpolation filtering [K. Andersson, R. Yu, Z. Zhang, J. Ström (Ericsson)]

Only one aspect related to inter:

* 4-tap interpolation filter for chroma motion compensation
* 4-tap interpolation filter for intra angular prediction

It is asserted that the current 4-tap interpolation filters which are used both for intra angular prediction and chroma motion compensation have significant phase misalignments compared to the ideal phases of the interpolation filters. For ten of the interpolation filters the phase misalignments are as large as the expected phase differences between two interpolation filters of adjacent fractional positions. This contribution proposes 4-tap interpolation filters that fixes the phase misalignments of the current 4-tap interpolation filters.

The fixes were reported to be tested under VTM-8.0 CTC. The impact on coding efficiency is reported for Luma/Cb/Cr as follows:

-0.05%/-0.03%-0.06% for AI, -0.02%/-0.05%/-0.15% for RA and -0.11%/-0.24%/-0.30% for LDB.

The impact of only fixing the 4-tap interpolation filters for intra is reported to be:

-0.05%/-0.03%-0.06% for AI, -0.04%/-0.04%/-0.02% for RA and -0.06%/0.01%/-0.09% for LDB.

Other experts commented that the problem of phase mismatch is known to them and expressed that an alignment might be desirable.

It is asked if the energy gain of the filters is close to unity over the different filters from the set?

It was also asked if there could be visual impact? For coded video, proponents did not observe differences, but they did not check the prediction.

It is confirmed that the 16 bit precision is retained.

It is pointed out that the variation of magnitude responses among the different filters of the set may be of concern (this also relates to the energy gain question). Is it better or worse in that compared to the current filters?

Was further reviewed along with the related contribution R0293 on Friday 17 April.

From here discussion in track B

Results on energy gain are shown in V4. The proposed filters have an average of mean energy of 0.76, while the existing filters have 0.78. It is also pointed out that for the existing filters the energy gain continuously decreases from phase 1/32 to 16/32, which is less consistent for the new filters it is not the case. However, another expert mentions that it is also relevant how this is distributed over the frequency, and low frequencies are more important.

No consensus was reached if the phase misalignment is a problem that needs to be solved. The new proposed filters according to the proponents do not have impact on the visual quality (so they don’t solve a subjective quality problem, which is typically important in the design of interpolation filters).

There is also no technical problem with the existing filters, and in terms of energy gain (which is also important according to some experts’ opinions) are less homogeneous.

No action.

[JVET-R0474](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10136) Crosscheck of JVET-R0292 (Fixes for 4-tap interpolation filtering) M. Winken (HHI)] [late]

[JVET-R0293](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9937) Fixes for 6-tap interpolation filtering for affine motion compensation [K. Andersson, R. Yu, Z. Zhang, J. Ström (Ericsson)]

It is asserted that the some of the current 6-tap interpolation filters for affine motion compensation have significant phase misalignments compared to the expected phases of the interpolation filters. This contribution proposes modifications of the filters for the fractional positions 4/16, 5/16, 6/16, 10/16, 11/16 and 12/16, and it is claimed that this fixes the phase misalignments of the current filters.

The modifications were reported to be tested under VTM-8.0 CTC. The impact on coding efficiency is reported to be -0.01%/-0.09% for RA/LDB. The modifications were reported to also be tested for the non-CTC) affine test set which was used to determine the performance of proposals in the past affine CEs. The impact on coding efficiency on that test set is reported to be -0.20% for RA.Presented Fri 17 April

It is mentioned that phase is less important in motion comp, amplitude/energy preservation more important. It is also mentioned that even the 8-tap filters are not optimum in phase. New results in v4 include the energy gain, which show that it is slightly lower for 6/16 filter than for the current filter, whereas for the other two (4/16 and 5/16) it is slightly higher.

It was also asked if the visual effect of the filters was investigated. The proponent says that no difference was visible.

No action (see further notes under R0292).

[JVET-R0475](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10137) Crosscheck of JVET-R0293 (Fixes for 6-tap interpolation filtering for affine motion compensation) [M. Winken (HHI)] [late]

[JVET-R0311](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9955) [AHG2] Fix cu\_skip\_flag signaling for IBC [H. Jang, J. Nam, N. Park, S. Kim, J. Lim (LGE)]

In VVC draft 8, when all of the below conditions are satisfied, cu\_skip\_flag is signalled to indicate whether IBC prediction mode with skip or not although IBC is not allowed in this case.

* ModeType is not equal to MODE\_TYPE\_INTRA
* CU size is larger than 64x64
* sps\_ibc\_enabled\_flag is equal to 1

It is asserted that the problem is caused by the fact that modeType is not defined as MODE\_TYPE\_INTRA for a CU which is in I\_SLICE despite disallowing inter prediction mode for CU in I-Slice. It is reported at #440 and several different solutions were suggested. But it has been not solved yet. Therefore this contribution suggests the three solutions to solve this problem.

1. Update modeType as MODE\_TYPE\_INTRA for a CU which is in I-SLICE
2. Update modeType as MODE\_TYPE\_INTRA for a CU which is larger than 64x64 and is in I-SLICE
3. Add I\_SLICE condition for checking modeType.

It is agreed that there is an issue to be resolved, as the software works as intended but the restriction is missing in the spec text. All three variants proposed in R0311 reflect the behaviour of the software.

Decision (BF): Adopt (editors to select the most appropriate expression)

[JVET-R0357](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10001) Geometric prediction mode with motion vector difference [K. Zhang, L. Zhang, Z. Deng, H. Liu, Y. Wang (Bytedance)]

In this contribution, Geometric prediction mode with Motion Vector Difference (GMVD) is proposed. With GMVD, the MV of a geometric partition in a GPM-coded block is refined as a sum of a MV derived from a merge candidate and a signalled MVD. The MVD is signalled in the same way as MMVD, wherein indices of a direction and a distance are coded. Simulation results are reported as below:

RA: -0.17%, 103%, 99%

LB: -0.32%, 104%, 99%

The peak BD-rate savings in CTC are reported to be 0.53% and 0.76% under RA and LB configurations, respectively.

It is mentioned that a similar approach had been proposed in the last meeting (JVET-Q0315). The current proposal is a more unified approach, not modifying the existing MMVD. However, it is necessary to modify the syntax parsing in GPM, as it is necessary to invoke MMVD twice for two MV differences (can also be for only one of the two partitions), and also modify the decoding process in adding the offset to the GPM MVs.

It is also pointed out that the syntax may miss a condition upon MMVD disabled at high level.

It is confirmed that the approach follows the dependency on picture resolution as MMVD.

The purpose is compression benefit, and the tradeoff (3% encoder runtime vs. <0.2% gain in RA) does not seem attractive. Stability of the design has priority at this stage.

No action.

[JVET-R0429](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10091) Cross-check of JVET-R0357: Geometric prediction mode with motion vector differences [C. Hollmann (Ericsson)] [late]

[JVET-R0366](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10010) Simplified disLut for GPM [Y.-Z. Ma, Q.-H. Ran, R.-P. Qiu, H.-X. Wang, J.-Y. Huo, F.-Z. Yang (Xidian Univ), S. Wan (NPU), Y.-F. Yu, Y. Liu (OPPO)]

In VVC Draft 8, for CUs coded by geometric partitioning mode (GPM), a look-up table disLut is used for weight value derivation and motion vector storing type derivation. This contribution proposes to simplify the table disLut, by changing each value to half. With the proposed simplification, 1 bit could be saved for each value in the table and the intermediate variables, and the derivation of weight value and motion vector storing type keep mathematically equivalent at the same time.

The coding performance is identical with that of VTM8.0. The experimental results are as below:

For RA configuration: 0.00 %, 0.00%, and 0.00%.

For LB configuration: 0.00 %, 0.00%, and 0.00%.

This is purely editorial. A hardware implementation could anyway make this (as there are only even values in the table), whereas for software it may be more straightforward to use table as is.

No action.

[JVET-R0447](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10109) Crosscheck of JVET-R0366 (Simplified disLut for GPM) [Y.-W. Chen (Kwai Inc.)] [late]

[JVET-R0367](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10011) Adjustment of shiftHor calculation in GPM [Y.-Z. Ma, Q.-H. Ran, R.-P. Qiu, M.-L. Zhang, J.-Y. Huo, F.-Z. Yang (Xidian Univ), S. Wan (NPU), Y.-F. Yu, Y. Liu (OPPO)]

In VVC8, a variable is derived to indicate the partitioning line shift direction (horizontal or vertical) in each CU using geometric partitioning mode (GPM). Given some GPM modes with specific angle being utilized for CUs with specific height/width ratio, the shift intervals between candidate partitioning lines are too narrow to be identified from each other. However, the interval can be increased by simply adjusting the shift direction in these cases. In this contribution, a quite simple modification is proposed in calculation method, with which the selected shift direction always lead to wider intervals between the partitioning lines.

The experimental results are as below:

For RA configuration: -0.04%, -0.04%, and -0.07%;

For LDB configuration: -0.04 %, -0.04%, and -0.01%.

It is claimed that the proposed method would be more consistent. However, there is nothing broken, and the benefit in compression is marginal. Stability of the design is more important at this moment.

No action.

[JVET-R0448](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10110) Crosscheck of JVET-R0367 (Adjustment of shiftHor calculation in GPM) [Y.-W. Chen (Kwai Inc.)] [late]

[JVET-R0368](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10012) GPM merge list construction modification [Y.-Z. Ma, Q.-H. Ran, R.-P. Qiu, J.-Y. Huo, F.-Z. Yang (Xidian Univ), S. Wan (NPU), Y.-F. Yu, Y. Liu (OPPO)]

In this contribution, a new method is proposed to derive the geometric partitioning mode (GPM) unidirectional merge candidate list. In this method, regular merge candidate list is re-used by selecting the unique available candidates in it.

The experimental results are as below:

For RA configuration: -0.07 %, -0.11%, and -0.08%.

For LB configuration: x.xx %, x.xx%, and x.xx%.

Target is compression benefit, which is low. Not clear if there are more comparisons between motion vectors necessary. According to proponent, more comparsions are necessary.

Stability of the design is more important at this moment.

No action.

[JVET-R0422](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10084) Crosscheck of JVET-R0368 (GPM merge list construction modification) [H. Chen, H. Yang (Huawei)] [late]

[JVET-R0369](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10013) Combination of JVET-R0367 and JVET-R0368 for GPM [Y.-Z. Ma, Q.-H. Ran, R.-P. Qiu, J.-Y. Huo, F.-Z. Yang (Xidian Univ), S. Wan (NPU), Y.-F. Yu, Y. Liu (OPPO)]

No need for presentation. See notes on R0367 and R0368 above.

[JVET-R0423](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10085) Crosscheck of JVET-R0369 (Combination of JVET-R0367 and JVET-R0368 for GPM) [H. Chen, H. Yang (Huawei)] [late]

[JVET-R0175](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9819) AHG9: An SPS Flag for IBC-AMVR [K. Naser, M. Kerdranvat, T. Poirier, A. Robert (InterDigital)]

This was discussed in Track A on 21 April at 1500 UTC and the notes were moved here since this proposes a low-level change.

AMVR can be used for regular blocks, affine block and IBC blocks. For affine blocks there is a separate flag for AMVR enabling.

This contribution proposes to add an SPS flag to control IBC-AMVR to provide consistent HLS design and to offer further encoder flexibility.

The proposal is to add a flag sps\_ibc\_amvr\_enabled\_flag, conditioned on “sps\_ibc\_enabled\_flag && sps\_amvr\_enabled\_flag”.

The asserted benefit is for the encoder to have greater flexibility over what to implement.

It was commented that this introduces a decoder change at the CU level, and a low-level change is undesirable.

No action was taken for that reason.

Discussion stopped here in JVET Track A on 21 April at 1515 UTC.

### Intra prediction and mode coding (10)

Contributions in this category were discussed Friday 14 Apr. 1520–1730 in Track B (chaired by JRO).

[JVET-R0280](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9924) AHG16: Cleanup of intra reference sample filter selection [J. Heo, H. Jang, J. Choi, J. Nam, M. Koo, J. Lim, S. Kim (LGE)]

In current VVC draft, the intra mode checking process is used to select intra reference sample filters. If the current intra mode is an angular mode with integer slope, a 3-tap [1 2 1]/4 reference sample filter is applied. Since the 4-tap [16 32 16 0]/64 smoothing filter for integer sample position is the same as the 3-tap reference sample filter for an angular mode with integer slope, the 3-tap reference sample filter used in the reference sample generation process can be replaced by the 4-tap smoothing filter used in the interpolation process. Therefore, this contribution proposes to remove the intra mode checking process, which process is redundant, and directly determine intra reference sample filters. The experimental results show that the proposed method provides the coding performance changes of 0.00%, 0.00%, and -0.05% BD-rate in AI, RA, and LD configuration, respectively. Encoding and decoding run-times are not changed.

Was previously proposal in Q0292, but the new contribution modifies the text description.

Benefit would be removal of 40 lines in clean software (not VTM). Too late in process to make micro changes. Stability of design has higher priority.

No action.

[JVET-R0432](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10094) Crosscheck of JVET-R0280 (AHG16: Cleanup of intra reference sample filter selection) [F. Bossen (Sharp)] [late]

[JVET-R0281](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9925) AHG16: Cleanup MIP flag signaling [J. Heo, H. Jang, J. Choi, J. Lim, S. Kim (LGE)]

The CABAC context model for matrix-based intra prediction (MIP) flag signaling depends on the mode information and availability of the left and above blocks. Method 1 proposes not to consider the upper block, when the current CU is at the upper boundary of each CTU. Method 2 proposes to consider only the left block. Method 3 proposes not to consider all neighbouring blocks. The proposed methods remove the required memory usage for line buffer for MIP flag. Moreover, the Method 1 can also achieve a unification on limiting the use of information of the upper block at the CTU boundary in intra coding. The experimental results show that the proposed method 1 provides the coding performance changes of 0.00% and -0.01% BD-rate in AI and RA configuration, respectively. Method 2 provides the coding performance changes of 0.00% and -0.01% BD-rate in AI and RA configuration, respectively. Method 3 provides the coding performance changes of 0.01% and 0.00% BD-rate in AI and RA configuration, respectively. Encoding and decoding run-times are not changed.

Cross-checker reports that the method would not introduce any problems. However, it also does not solve any existing problem. The simplification of the implementation is not critical, and benefit not large enough to justify a change of the design.

No action.

[JVET-R0435](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10097) Crosscheck of JVET-R0281 (AHG16: Cleanup MIP flag signalling) [J. Pfaff (HHI)] [late]

[JVET-R0288](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9932) AHG16: Reference samples for ISP [F. Bossen (Sharp)]

It is asserted that during the 15th JVET meeting it was incorrectly determined that the text included in VVC draft 6 and its corresponding software is equivalent to aspect 1 of JVET-O0364 that was intended to be adopted. It is proposed to include aspect 1 of JVET-O0364 (as originally proposed) in the final VVC specification such as to facilitate implementations that use a single reference sample buffer for all blocks within a CU that exercises the ISP mode.

Cross-checker confirms that the software and spec text were thoroughly checked and are aligned.

There is probably some “ugliness” in the current design, and the proposal would simplify the software implementation (avoiding unnecessary duplicate padding). On the other hand, there is nothing broken with the current design, and in hardware it does not seem to be a problem. In the interest of stability of the low level design, no action should be taken.

[JVET-R0399](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10044) Crosscheck of JVET-R0288 (AHG16: Reference samples for ISP) [S. De-Luxán-Hernández (HHI)] [late]

[JVET-R0314](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9958) AHG2/AHG16: Fixes on CCLM [Y. Wang, K. Zhang, L. Zhang, H. Liu (Bytedance)]

In this contribution, two aspects are proposed to fix issues of CCLM in the current VVC text.

Aspect #1: Fix the availability check of above-left neighbouring luma samples by considering the raster-scan slice case.

Aspect #2: Fix two mismatches to align the text with the VTM-8.0 software for neighbouring sample checking orders and padding methods.

It is noted that aspect #1 is no longer relevant with the current HLS design of raster-scan slices.

Aspect #2: the first Mismatch (ordering of left/above neighbours) was filed as ticket #1012. The second mismatch (usage of luma samples for CCLM) was filed as ticket #1011.

The existence of the mismatch was confirmed by other experts. It is agreed that in regard of this specific mismatch the text should be aligned with software.

The same issue is raised in R0375

It is noted that other issues probably exist in context of CCLM, and document R0452 is setting up a collection (which already cvers R0375). Could be done as BoG work.

Decision (mismatch/aligntext): Adopt JVET-R0314 aspect #2.

[JVET-R0350](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9994) MIP for all channels in the case of 4:4:4 and single tree [J. Pfaff, B. Stallenberger, P. Merkle, M. Schäfer, P. Helle, T. Hinz, H. Schwarz, D. Marpe, T. Wiegand (HHI)]

In this document, for 4:4:4 chroma-format and single tree, it is proposed that on a chroma intra-block for which the chroma-intra mode is the DM mode and for which the luma intra-mode is a MIP mode, the chroma intra prediction signal is to be generated using this MIP mode. No change of the MIP-matrices or the MIP-modes themselves is proposed. The proposed method does not propose any change for content which is non-4:4:4 or non-single-tree.   
Experimental results of -0.25%/-0.23%/-0.22% and of -0.15%/-0.13%/-0.07% for 4:4:4 natural content in YUV and of -1.81%/-0.61%/-1.00% and -1.28%/-0.38%/-0.55% for 4:4:4 natural content in RGB (GBR-numbers) are reported for the AI and RA configurations respectively. For 4:4:4 screen content, experimental results of -0.49%/-0.40%/-0.37% and -0.35%/-0.28%/-0.30% for RGB (GBR-numbers) and of -0.09%/-0.06%/-0.01% and -0.04%/-0.04%/-0.11% for YUV are reported for the AI and RA configurations respectively.  
During the discussion of the category 2 AHG pre-meeting on Tuesday, April 14th 2020, it was suggested that contributions related to 4:4:4 content should generate results that include the proposed bug-fix of the CTC for 4:4:4 content of document JVET-R0321. These results are included in version 2 of this document, where for RA, they are not complete yet and will be uploaded in a future version. The software that includes the proposed method as well as the changes needed for the update of the CTC is included in version 2 of this document.

The proposal indicates that the combination ACT/MIP which was disabled in the last meeting works when MIP is applied on all three components.

It is asserted that the proposal would not have any impact on 4:2:0, and that the matrices of MIP are not changed. It would also not be used in dual-tree case.

Many experts supported the adoption of this proposal, as it is asserted as a useful enabling of an existing tool, and would not require low-level re-design.

Decision (comp-eff): Adopt JVET-R0350, only for 4:4:4, no change to 4:2:0 decoding.

[JVET-R0356](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10000) CCLM-related bugfixes for the VVC specification draft [A. Filippov, V. Rufitskiy, E. Alshina (Huawei)]

Included in R0452

[JVET-R0375](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10019) AHG2/AHG16: CCLM bug fix in luma reference down-sampling [L. Pham Van, G. Van Der Auwera, J. Chen, V. Seregin, M. Karczewicz (Qualcomm)]

In the current VVC text and VTM, the availability check of above-left neighbouring luma samples (avaiTL) in CCLM mode is derived using the availability of the left and above blocks. However, this check is not always correct in raster-scan slice case. This contribution proposes to not use the top-left neighbouring samples in CCLM mode. The experimental results shown that the impact of the proposed fix in terms of coding performance is negligible with an average (Y, U, V) Bd-rate reported as follows: (*v2: update results, v3: fix typos*)

AI: 0.00%, 0.00%, 0.02% and (EncT, DecT) of (100%, 100%).

RA: -0.01%, -0.09%, -0.03% and (EncT, DecT) of (100%, 100%).

The proposed fix of the VVC bug tracker ticket #796 is also provided in the attached specification text, together with the proposed bug fix.

Aspect not included in R0452 was reviewed: Raster-scan slices (as called aspect #1 in R0314). Obviously, there is no problem. No action on this necessary.

All other aspects are included in R0452. See notes there

[JVET-R0434](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10096) Crosscheck of JVET-R0375 (AHG2/AHG16: CCLM bug fix in luma reference down-sampling) [J. Pfaff (HHI)] [late]

[JVET-R0391](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10036) Simplification on CCLM [L. Li, X. Li, S. Liu (Tencent)]

In the last meeting, simplification of CCLM which perform repetitive padding for those unavailable luma samples and apply the same 6-taps filter to generate down-sampled luma samples is adopted. In this proposal, further simplification on CCLM is proposed which perform repetitive padding to generate above down-sampled luma samples when it is CTU boundary. It is asserted the line buffer is not increased.

Aspect 1: a spec bugfix for CCLM is introduced for ticket #796. This aspect is already included in the JVET-R0452 CCLM: common text for spec bugfixes.

Aspect 2: the proposed simplification on CCLM is described. The results show 0.00% (AI), 0.00%(RA) impact under CTC, and show 0.00% (AI), 0.00% (RA) when sps\_chroma\_vertical\_collocated\_flag is set to 1. With proposed one-line change, the number of down-sample filter used in CCLM is reduced, and half page of spec text can be removed.

For aspect 1, see notes under R0452.

For aspect 2, different opinions were expressed. While one expert mentions that the reducing of number of filters is an advantage, other were not convinced that the additional padding that is introduced is a good tradeoff.

Not obvious that this low-level change is justified. No action.

[JVET-R0449](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10111) Crosscheck of JVET-R0391 (Simplification on CCLM) [Y.-W. Chen (Kwai Inc.)] [late]

[JVET-R0452](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10114) CCLM: common text for spec bugfixes [L. Li, X. Li, S. Liu (Tencent), A. Filippov, V. Rufitskiy, E. Alshina (Huawei)] [late]

This document provides a common CCLM text to fix several spec bugs in the current VVC specification. Several tickets have been reported in VVC bug tracker. It is asserted that the behavior of VTM-8.0 is correct, and spec should be aligned with SW.

Following aspects are proposed to change regarding VVC Draft 8:

Aspect 1: Wrong upper bounds of numTopRight and numLeftBelow (ticket #1002)

Aspect 2: Undefined luma neighbour samples are used in down-sample process (ticket #796)

Aspect 3: Remove unused one-dimensional filter coefficients array F1. (leftover from last meeting’s adoption JVET-Q0500)

It is proposed to change the spec and and aligning it with the software.

It is mentioned that the second mismatch pointed out in R0314 relates to aspect 2 here (tickets #1011 and #796 are somewhat overlapping), but R0314 covers yet another aspect.

This aspect was agreed in principle. Proponents of R0452, R0375 and R0314 were asked to sort out the editorially best solution and come with a combined text. The first mismatch of R0314 (relating to ticket #1012) is not included in R0452, and should also become part of the combined text.

v6 of the document was later provided with an integrated text, presented Monday 20 April 1650. It was generally agreed that this is a step in the correct direction to resolve the SW/text mismatch. It was however pointed out that still cases could occur with contradicting numSampL/numSampT from (353-356) versus availability checks, which could result in unassigned values (in particular whenever negative x in combination with positive y comes up). Also, the mismatch in terms of 4:2:2 (see below under R0471) is missing.

This was agreed by proponents, and further fixes were confirmed to be necessary. [Ed. Confirmed to be unnecessary, or confirmed to be necessary?]

[JVET-R0471](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10133) On CCLM [F. Bossen (Sharp)] [late]

Contributions JVET-R0314 and JVET-R0375 propose changes to the CCLM process to address ill-defined cases that can arise when the top-left CTU is not available while the left and top CTUs are available. An alternative set of changes is proposed, which is asserted to be simpler and to have no impact on behaviour under common test conditions (CTC). Additionally, numerous issues are identified in the CCLM text and changes are proposed to resolve these.

Experts are asked studying the additional aspects that this document raises (beyond those already confirmed in R0314 and R0452). It was agreed by other experts (including proponents of R0452, R0375 and R0314) who had inspected the text that the additional aspects are justified. The additional aspects are wrong definitions of behaviour of defining filters for 4:2:2 case, and the possible contradiction numSampL=0 and availability=true (or same with numSampT).

The proponents of R0452 were asked to include the missing additional items where the spec is not aligned with the text into their version (on top of the version in R0452v6.zip). It is asserted that this should then only be an editorial difference between R0452 and R0471, the normative decoder behaviour should be exactly identical. Editors should then decide which of the two versions would be more appropriate, clean and understandable.

It is further confirmed again that both contributions shall only reflect aligning the text with the software behaviour.

Discussion in track B stopped here Mon. 20 Apr. 1730.

A new version of R0452 was presented Tue. 21 Apr. 0715 (uploaded as R0452v7.zip). The proponent of R0471 points out that there is still an inconsistency in the cross-shaped filter in the 422 case.

In this context, it is also pointed out that in the last meeting it was confirmed that any variable has to be properly initialized in the spec text, even if in a certain cornercase condition it would only be multiplied by zero.

It was reported in a follow-up discussion Wed Apr. 22 0600 that in the meantime two additional issues were found where the text deviates from the software in the context of CCLM. An update of R0471 (v2) integrates a proposed solution to fix this. Both issues are obvious errors (on a typo in a variable, and one a missing mult by chroma sample position scaling). There are some more editorial changes in R0471v2. The two errors would be straightforward to integrate into R0452 as well.

For R0452, a v8 exists that fixes the issues disussed on Tue. Apr. 21.

The proponents of R0452 included the two additional error corrections (as from above R0471v2) and uploaded a new version. For R0471v2, no objection was raised until Friday 24 April 0715 that something wrong with that document, therefore it is concluded that everything is correct in solving the problem. As both solutions of resolving the text mismatch are technically equivalent, the editor (B. Bross) was asked to decide which text modifications should be implemented.

From JVET session Friday 24 April 0715

Decision (mismatch/aligntext): The editor suggests that the main difference is about how the filters are defined, and he believes it is cleaner to define them directly, using separate equations for the two shapes. Left to the discretion of the editor. As there are no technical differences, remaining issues can be sorted out during spec editing, and if there would still be a misalignment with software, probably this will be pointed out in tickets or new reports made by next meeting.

### Loop filtering (23)

#### Deblocking filter (9)

Initially reviewed in AHG session 2.2 Thu 9 April 1520-1705 UTC (chaired by JRO) except noted differently

[JVET-R0130](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9774) Cleanup of tC value derivation process for deblocking filter [S. Iwamura, S. Nemoto, A. Ichigaya (NHK)]

This contribution proposes cleanup of tC value derivation process for deblocking filter. In the current draft specifications, tC table is defined for 10-bit video instead of 8-bit video as done in HEVC. In order to adapt various bit depth, tC is modified depending on the input bit depth. However, this bit-depth adaptation is not correctly described in the spec text, such that deblocking filter can be performed for block boundaries with lower QP when the input bit depth is equal to 9. To avoid this undesirable deblocking filter, this proposal introduces an offset depending on the input bit depth to tC derivation process. It is asserted that this modification only affects input bit depth of 9 and does not affect CTC results.Presented in Track B Sun 19 Apr. 0720

The case only happens for 9 bit, where for low QP tc would end up with a value of 1, which means that deblocking is not turned off for low QP.

This is a clear oversight when the tc mapping was changed to 10 bit default, which is asserted to be a bug fix. The change at low level is minor, and does not have any effect on the common bit depth cases suc as 8, 10 and beyond.

Decision (BF/text&SW): Adopt JVET-R0130.

[JVET-R0134](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9778) AHG2: Mismatch related to deblocking of subblock motion edges [B. Heng, M. Zhou, W. Wan (Broadcom)]

This contribution asserts that there is a mismatch between the VVC draft text and VTM sotware related to deblocking of coding subblock boundaries. Within a subblock motion CU, the length of the deblocking filter used depends on the distance the nearest transform edge. However, when this neighbouring transform edge aligns with a virtual boundary, the behavior of the text and software differ.

Specifically, the VTM software treats the neighbouring transform edge as a transform edge, regardless of whether it aligns with a virtual boundary or not. While the VVC draft text ignores the neighbouring transform edge altogether if it aligns with a virtual boundary. This difference will cause the text and software to use different filter lengths for subblock motion edges, and therefore they will produce different results.

This contribution proposes to modify the text to match the software behavior to resolve this mismatch. Proposed text changes are provided.

Presented Thu 9 April 1733 (chaired by JRO).

There is a ticket #857 which also identifies this issue (as well as other issues). This was partially resolved by submitting a software patch. The new contribution points out that after that we have still a mismatch between text and software. Text appears to be appropriate.

The AHG meeting recommended that the proposed text changes should be adopted.

This also would resolve ticket #857 as far as the text is concerned.

Confirmed in track B Tue 21 Apr.

Decision (mismatch/aligntext): Adopt JVET-R0134, align text with software

[JVET-R0168](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9812) Issue on bS derivation of deblocking filter [K. Abe, T. Toma (Panasonic)]

This contribution points out the mismatch between VVC text and VTM on bS derivation process of deblocking filter. In VVC text, bS is set equal to 1 for the boundary between IBC and inter block on both luma edge and chroma edge. On the other hand, in VTM, bS is set equal to 1 for the boundary between IBC and inter block only on luma edge. The proponent of this contribution thinks there are two solutions, solution1: fix VTM to align to VVC text, solution2: fix VVC text to align to VTM. This contribution shows the difference of coding performance and text changes for both solutions.

No ticket yet.

It is mentioned by the proponents that solution 1 would have small impact on coding results, therefore they would better suggest aligning the text with software.

Several experts expressed support for solution 2, as also in the past it had been agreed that MV differences should not be checked for chroma deblocking.

AHG Recommendation (mismatch/aligntext): The proposed text changes should be adopted. There may however be some interaction with a related issue in R0228, where palette mode is also considered. See further notes under R0437.

[JVET-R0372](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10016) Crosscheck of JVET-R0168 (Issue on bS derivation of deblocking filter) [T. Hashimoto, T. Ikai (Sharp)]

[JVET-R0228](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9872) AHG11: Bugfix to deblocking filter boundary strength setting for palette [R.-L. Liao, Y. Ye, M. G. Sarwer (Alibaba)]

In VVC draft 8, the deblocking filter boundary strength is set according to the coding modes of two neighbouring blocks along a deblocking edge. However, it is reported that, when one of neighbouring blocks is coded in palette and the other is coded in IBC or inter mode, the boundary filtering strength is not clearly defined in the spec. It is also reported that in VTM-8.0, this ambiguity partially exists as well, and can cause the software mismatch in encoder and decoder in some cases. In this contribution, it is proposed to clearly define the boundary filtering strength for the aforementioned case by setting it to one of 1 or 2. It is reported that, as compared to VTM-8.0 with palette off, the overall coding performance impact for {Y, U, V} in 4:4:4 color format is:

* VTM8:{-6.25%,-6.42%,-6.26%}for AI,{-5.04%,-6.81%,-6.86%}for RA,{-3.18%,-4.39%,-4.60%}for LB
* bS = 1:{-6.25%,-6.42%,-6.26%}for AI,{-5.03%,-6.82%,-6.87%}for RA,{-3.20%,-4.34%,-4.16%}for LB
* bS = 2:{-6.25%,-6.42%,-6.26%}for AI,{-5.02%,-6.76%,-6.81%}for RA,{-3.14%,-4.26%,-4.41%}for LB

For class F in 4:2:0 color format, the overall coding performance impact for {Y, U, V} is:

* VTM8:{-1.24%,-0.43%,-0.47%}for AI,{-1.29%,-0.47%,-0.56%}for RA,{-0.56%,-0.24%,-1.24%}for LB
* bS = 1:{-1.24%,-0.43%,-0.47%}for AI,{-1.29%,-0.48%,-0.51%}for RA,{-0.61%,-0.14%,-0.76%}for LB
* bS = 2:{-1.24%,-0.43%,-0.47%}for AI,{-1.32%,-0.53%,-0.52%}for RA,{-0.60%,-0.38%,-0.98%}for LB

For class SCC in 4:2:0 color format, the overall coding performance impact for {Y, U, V} is:

* VTM8:{-6.50%,-5.18%,-4.94%}for AI,{-3.78%,-2.45%,-2.42%}for RA,{-1.22%,-0.59%,-0.66%}for LB
* bS = 1:{-6.50%,-5.18%,-4.94%}for AI,{-3.76%,-2.42%,-2.43%}for RA,{-1.23%,-0.57%,-0.60%}for LB
* bS = 2:{-6.50%,-5.18%,-4.94%}for AI,{-3.76%,-2.36%,-2.39%}for RA,{-1.28%,-0.68%,-0.69%}for LB

In terms of subjective quality, no significant visual difference was observed in all three cases based on the informal subjective viewing conducted.

It I agreed during the discussion that the spec text does not clearly define the bS in case where palette is used at the other side of the block. For the case of not using local dual tree, the VTM mode of operation is clearly defined. For this case, it is agreed that the text should be aligned with the software (setting Bs=1 when the other side is a palette block, and operated in single tree mode). For local dual tree, more investigation is necessary to understand if the SW is covering all possible cases.

AHG recommendation (mismatch/aligntext): The proposed text change on more clearly specifying bS in case of palette and single should be adopted. There may however be some interaction with a related issue in R0168, which requires text alignment. This is covered in R0437 – see further notes there.

Further offline study was performed for the case of local dual tree, and it was confirmed that this also requires fixing the VTM. The software patch is also included in R0437 (does not change CTC, only when one side is palette).

[JVET-R0440](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10102) Crosscheck of JVET-R0228 (AHG11: Bugfix to deblocking filter boundary strength setting for palette) [Y.-H. Chao (Qualcomm)] [late]

[JVET-R0289](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9933) [AHG16] On deblocking filter process [N. Park, J. Nam, H. Jang, J. Lim, S. Kim (LGE)]

In Ticket #899, it was claimed that there is a mismatch between VVC draft 8 and VTM8.0 on deblocking filter process when CU size is greater than maximum transform block size and cu\_coded\_flag is equal to 0.

In VVC draft 8, implicit TU tiling is applied even though cu\_coded\_flag is equal to 0 for inter prediction mode. These internal transform block boundaries within the CU is considered as transform block boundary in deblocking filter process. However, in the VTM8.0, the above case is treated as a TU which has the same size as CU therefore there is no internal transform block boundary. Although the mismatch has already resolved by the ticket #899, this cause misalignment in terms of filter length on the each block boundary with same property.

In this proposal, to fix abovementioned behavior two solutions are suggested.

* Method1: Implicit TU tiling is restricted when cu\_coded\_flag is equal to 0.
* Method2: Implicit TU tiling is retained but edges inside a CU are not treated as transform edge when cu\_coded\_flag is equal to 0.

Since Ticket #899 is reverted by Method 1 and deblocking filter process is fixed to be performed same as VTM8.0 by Method 2, the experimental results for both solutions are same as results of VTM8.0.

In revision 1, it is added the simulation results based on Ticket #899 bugfix.

After the fix of ticket #899, there is no mismatch between text and software.

The suggested solution 1 would revert the solution of the ticket, and require additional checks.

Also the solution 2 would be requiring additional logic.

There is no problem with the current design, no need for action.

[JVET-R0395](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10040) Crosscheck of JVET-R0289 ([AHG16] On deblocking filter process) [R.-L. Liao (Alibaba)] [late]

[JVET-R0300](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9944) Additional fix for long luma deblocking decisions [K. Andersson, J. Enhorn (Ericsson)]

The contribution proposes to fix the long deblocking decision such that all lines of respective 4 samples boundary segment are checked to avoid over filtering of lines 1 and 2 due to decision based only on line 0 and line 3. It is asserted that the proposal ensures that the deblocking filtering is robust and that the fix does not increase worst case complexity for deblocking decisions.

The BD rate impact for luma for CTC SDR:

AI: 0.00%, RA: -0.01%, LDB: -0.05%, LDP: -0.01%.

The BD rate impact for CTC HDR:

AI: DE: 0.01% PSNRL: 0.00% wPSNRY: 0.00%, PSNRY: 0.00%

RA: DE: -0.04% PSNRL: -0.03% wPSNRY: -0.02%, PSNRY: 0.00%

Similar encoding and decoding time as the anchor.

The number of operations increases, but is still less than worst case for deblocking.

The target is rather a corner case, it is reported that the effect was visible in the sequence slide editing. Other experts mentioned that deblocking for screen content is a very special case, where an encoder might want to align parameters.

Not obvious that there is need for action on this issue.

[JVET-R0476](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10138) Crosscheck of JVET-R0300 (Additional fix for long luma deblocking decisions) [B. Ray (Qualcomm)] [late]

[JVET-R0279](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9923) AHG9: On decoupling luma deblocking parameters [K. Misra, F. Bossen, J. Samuelsson, S. Deshpande, A. Segall (Sharp Labs of America)]

In the current VVC draft, the deblocking activation and clipping threshold values (beta and tc) are common for the luma long filters and luma strong filters. This contribution proposes that the threshold values for each type of filtering be separate. This is achieved by signaling separate beta offset and tc offset for luma long filters and luma strong filters. The proposed modification enables the decoupling of activation and clipping control thresholds for the two types of filtering. The proposed change is asserted to be a desirable improvement over the signalling in the current VVC draft.

Question: Is there evidence that this is needed? Can it be expected that the values would be so different?

It also requires some additional logic at low level, switching the offset values between two different options.

No action.

[JVET-R0403](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10048) On the boundary strength derivation of IBC coded blocks [B. Ray, G. Van der Auwera, M.Karczewicz (Qualcomm)] [late]

When both sides of the boundary are IBC coded, the boundary strength derivation requires whether the difference between the vertical or horizontal components of the block vectors are greater or equal than 8 units of 1/16 luma samples. However, as IBC always uses integer pixel(s) block vector resolution, the condition can be corrected to check whether the block vectors are equal or not, thus the comparison with the threshold (8 units of 1/16 luma samples) can be avoided.

Reviewed Sun. 19 Apr

This appears purely editorial, as IBC vectors are integer, and measuring them in 1/16 sample units appears unnecessary.

It is however noted that the BVs may be stored in units of 1/16 samples in the same memory as MVs. It is to be checked what the phrase “block vectors used in prediction” means. If the BVs described in the prediction process are expressed in 1/16 sample units, the change would be wrong.

Decision: Left to the discretion of editor to take action.

[JVET-R0454](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10116) Cross-check of JVET-R0403 (On the boundary strength derivation of IBC coded blocks) [K. Andersson (Ericsson)]

[JVET-R0437](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10099) Combination of JVET-R0168 and JVET-R0228 on deblocking filter boundary strength setting [R.-L. Liao, Y. Ye, M. G. Sarwer (Alibaba), K. Abe, T. Toma (Panasonic)] [late]

Reviewed Sun 19 Apr.

Combined text of two contributions that had been recommended for adoption in the AHG pre-meeting.

This includes fixes for both single and dual tree, and also SW BF for dual tree.

It is confirmed during the discussion that a case where luma is palette and chroma is IBC is excluded. The other way round is possible, luma IBC with chroma palette is allowed.

By inspection of the text it appears that the rules related to BDPCM are not changed. This may however be dependent on orde of condition checks. Experts who have concerns about this should clarify offline.

Decision (BF/text and SW): Adopt JVET-R0437

#### Adaptive loop filter (6)

Initially reviewed in AHG session 2.2 Thu 9 April 1705-1720 and session 2.3 2100- UTC (chaired by JRO)

[JVET-R0133](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9777) AHG16: On Clipping values for Non-linear ALF [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

In VVC WD, clipping values for Non-linear ALF filtering process are defined in a lookup table, as a form of “2N” depending on BitDepth and clipIdx, where N is an integer value. When BitDepth is equal to 16 and clipIdx is equal to 0, clipping values become 216; Thus, the lookup table needs up to 17 bits per element.

This contribution proposes to replace the clipping values in a form of “2N” to a form of “2N - 1”; Any clipping values are kept within 16 bits and can be derived by simple logical operation without the lookup table. It is asserted that the proposed method has negligible bdrate changes of (0.00%,0.00%, 0.00%) for AI, (0.00%, -0.05%, 0.01%) for RA and (0.01%, -0.06%, -0.17%) for LDB under CTC.

In v2, results of IBDI equal to 8/12 are attached.

It is observed that:

* For IBDI=8, average bdrate changes are (0.02%, 0.10%, 0.11%) for AI, (0.03%, -0.19%, -0.21%) for RA and (0.02%, -0.40%, -0.44%) for LB.
* For IBDI=12, average bdrate changes are (0.00%, -0.01%, 0.01%) for AI, (0.00%, -0.03%, 0.07%) for RA and (0.05%, 0.03%, 0.04%) for LB.

Presented Thu April 9 1705 UTC (chaired by JRO)

The advantage would only apply to case of profiles beyond 15 bit, where the cost of lookup table storage seems almost irrelevant

There was a contribution in Gothenburg (JVET-O0188) which proposed the same approach. It was not adopted by that time

Several experts expressed that this change is not needed, as in the only case that would require 17 bit implementation clipping would have no effect and could be skipped.

No action.

[JVET-R0467](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10129) Crosscheck of JVET-R0133 (AHG16: On Clipping values for Non-linear ALF) [M. G. Sarwer (Alibaba)]

[JVET-R0208](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9852) AHG16: Rounding correction for ALF virtual boundary processing [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)]

In VTM-8.0, to avoid extreme padding for the sample rows which are immediately adjacent to the adaptive loop filter (ALF) virtual boundary, the correction value applied during the filtering is quantized by a larger value 1024 (210) instead of 128(27). However the rounding value used during the filtering is still 64. The current proposal proposes a fix by changing the rounding value to 512 when the quantization value used in the ALF filtering is 1024.

The objective results, over VTM8.0 Anchor for CTC configuration are as follows:

Config. Y U V EncT DecT

AI 0.00% 0.01% 0.01% 100% 99%

RA 0.01% -0.01% 0.00% 100% 100%

LDB 0.01% 0.02% -0.07% 100% 102%

LDP 0.01% -0.25% -0.14% 100% 103%

By modifying filters at virtual boundaries per adoption of Q0150 solution 2, the rounding operation in case of shift 10 is no longer doing the nearest integer rounding. This appears as an inconsistency rather than a bug. This issue had been detected during software integration. Proponents of Q0150 also support this change. It is agreed that the change is minor and there is no harm that it would introduce any problems.

R0231 method 1 and R0291 target the same problem, basically the same solution but different specification text. There may be more elegant ways of expressing the change than suggested in R0208, which introduces another column in the table 45/46, e.g. by an equation.

The AHG meeting recommended that the rounding operation in case of the modified filter at virtual boundary should be aligned, and that editors should decide the best way of expressing it in text.

Was confirmed in track B Tue 21 Apr. 21

Decision (cleanup/text+software): Adopt JVET-R0208. The rounding operation in case of the modified filter at virtual boundary should be aligned. Editors should decide the best way of expressing it in the spec. text.

[JVET-R0231](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9875) AHG2: Rounding offsets for adaptive loop filter [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

Virtual boundary (VB) processing is adopted to VVC to avoid line buffer increment for adaptive loop filter (ALF) and cross component adaptive loop filter (CC-ALF). Symmetrical sample padding is applied when VB processing is applied to ALF and CC-ALF. In some cases, extreme padding for the closest row on each side of a VB may introduce visual artifacts. In VVC, to account for that in ALF when ALF is applied to samples on the rows adjacent to a VB, filter strength is reduced by increasing the right shift for ALF filtering. However, the rounding offset of the right shift is not changed and is kept the same for all values of the right shift. In addition, the filter strength for samples on the rows adjacent to a virtual boundary is not changed in CC-ALF. In this contribution, at first, the rounding offset is changed for different right shift values for ALF. In another aspect, the filter strength is reduced when applying CC-ALF to the samples on the rows adjacent to a VB. Compared to VTM-8.0, the average BD-rate for the proposed methods is as follows:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Results over VTM-8.0** | **All Intra** | | | **Random Access** | | | **Low Delay B** | | | **Low Delay P** | | |
|  | **Y** | **U** | **V** | **Y** | **U** | **V** | **Y** | **U** | **V** | **Y** | **U** | **V** |
| Method 1 | 0.00% | 0.01% | 0.01% | 0.01% | -0.01% | 0.00% | 0.01% | 0.02% | ‑0.07% | 0.01% | ‑0.25% | ‑0.14% |
| Method 2 | 0.00% | 0.05% | 0.05% | 0.00% | ‑0.01% | 0.00% | -0.05% | 0.00% | ‑0.09% | -0.01% | ‑0.31% | 0.20% |
| Method 3 | 0.00% | 0.07% | 0.07% | 0.01% | 0.01% | 0.04% | -0.04% | 0.09% | 0.05% | 0.01% | -0.32% | -0.17% |

Method 1 is identical to R0208.

Method 2 applies the modified boundary processing of Q0150 to CCALF

Method 3 combines methods 1 and 2.

It is asked if there is evidence that a similar problem of artifacts is present in CCALF which was shown in ALF in context of the Q0150 adoption. Currently, there is no such evidence.

The main argument is for design consistency. ALF and CCALF could share the table 45, but otherwise equations would be different. In implementations, different logic would likely be used.

Benefit not obvious – no action on Method 2/3.

[JVET-R0479](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10141) Crosscheck of JVET-R0231 (AHG2: Rounding offsets for adaptive loop filter) [F. Bossen (Sharp)] [late]

[JVET-R0291](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9935) AHG16: On ALF attenuation near virtual boundaries [F. Bossen (Sharp)]

It was verbally reported during AHG session that all issues raised in this document are also covered by other contributions (R0208, R0231, R0233, R0312). No need for further presentation.

[JVET-R0444](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10106) Crosscheck of JVET-R0291 (AHG16: On ALF attenuation near virtual boundaries) [N. Hu (Qualcomm)] [late]

[JVET-R0299](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9943) Additional fix for ALF virtual boundary processing [K. Andersson, J. Ström, Z. Zhang, J. Enhorn (Ericsson)]

At the last previous meeting, a low complexity fix for ALF virtual horizontal CTU boundary was adopted from JVET-Q0150. An alternative approach proposed in the same contribution was rejected since the increase of two luma line buffers and two chroma line buffers for each component was undesirable. This contribution proposes a combination of the two approaches in JVET-Q0150 as follows: Filtering of a row just above the virtual horizontal CTU boundary is performed as currently using the low complexity technique, i.e., not using samples below the virtual horizontal CTU boundary. When filtering a row just below the virtual horizontal CTU boundary on the other hand, this contribution proposes to change the filtering process so as to let it use also one row just above the virtual horizontal CTU boundary. This combined approach is asserted to further reduce visual artifacts from virtual horizontal CTU boundary processing. Proposal 1 of this contribution only changes the ALF filtering. It is claimed that the memory cost for proposal 1 is 60% of one 10-bit line buffers for luma samples and 60% of one 10-bit line buffer for each chroma channel for chroma samples. Proposal 2 of this contribution combines proposal 1 with an approach that avoids filtering across the virtual boundary also for SAO when filtering samples just below the virtual boundary, by employing padding. Samples just above the virtual boundary are SAO-filtered as currently. It is claimed that proposal 2 comes at no memory cost in terms of line buffers over the current draft of VVC.

The claimed benefit of the proposal is suppression of coding artifacts from virtual horizontal CTU boundary processing. The BD rate impact for luma for CTC is as follows:

Proposal 1: AI: -0.01%, RA: -0.03%, LDB: -0.09%

Proposal 2: AI: -0.01%, RA: -0.xx%. LDB: -0.xx%

Similar encoding and decoding times as the anchor are reported.

It is claimed that the method improves over the method from Q0150 adopted by last meeting, but requires approx. 0.6 additional line buffer (by using buffer jointly with SAO).

It is however pointed out that SAO does not need to store sample values, so it would be more like 1 line buffer.

The proposal would require a substantial amount of changes, and the additional subjective benefit over the Q0150 method may not be too large.

No action.

[JVET-R0312](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9956) AHG2/AHG16: A fix on chroma ALF virtual boundary position [Y. Wang, L. Zhang, H. Liu, K. Zhang, Z. Deng (Bytedance)]

In current VVC, luma and chroma ALF virtual boundaries are always set to four and two lines above the bottom luma CTB and chroma CTB boundaries, respectively. Such a design works well for 4:2:0 colour format since the height of a chroma CTB is half of that of a luma CTB. However, for 4:2:2 and 4:4:4 colour formats in which heights of a luma CTB and a chroma CTB are equal, it is asserted that the design could result in misaligned ALF virtual boundaries for luma and chroma samples. This contribution proposes to align ALF virtual boundaries of luma and chroma components for 4:2:2 and 4:4:4 colour formats. The simulation results for 4:4:4 colour format screen sequences, 4:4:4 and 4:2:2 natural sequences following the common test conditions are summarized as follows:

Dual tree on:

AI: {0.00%, -0.01%, 0.00%}; RA: {-0.02%, -0.02%, -0.03%}; LDB: {0.02%, -0.01%, 0.08%}

Dual tree off:

AI: {0.00%, 0.00%, 0.00%}; RA: {0.02%, 0.02%, -0.02%}; LDB: {0.01%, 0.07%, 0.05%}

Natural sequences:

YUV 4:4:4, AI: {0.00%, -0.02%, -0.04%}; RA: {0.01, -0.07%, 0.03%}; LDB: {}

YUV 4:2:2, AI: {0.00%, 0.00%, -0.02%}; RA: {0.01, -0.11%, -0.08%}; LDB: {0.00%, -0.15%, 0.01%}

It is proposed that for the cases of 4:4:4 and 4:2:0 the virtual boundary height should be aligned for luma and chroma.

It is pointed out that in terms of quality this may not be needed, as luma and chroma have different characteristics.

The motivation is about improving pipelining.

From the discussion, it is not fully clear if this would have consequences on the interaction with deblocking and SAO in the pipeline. There are different opinions on that.

Contribution 233 method is identical. See further discussion there.

[JVET-R0363](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10007) Crosscheck of JVET-R0312 (AHG2/AHG16: A fix on chroma ALF virtual boundary position) [C.-M. Tsai (MediaTek)] [late]

#### CCALF (6)

Contributions initially presented in AHG session 2.6 Tuesday 14 April 0715-0815 except otherwise noted.

[JVET-R0128](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9772) AHG16: On CCALF clipping [M. G. Sarwer, Y. Ye, J. Luo (Alibaba)]

In VVC CCALF process, an 8-tap filter is applied to luma sample to generate a residual correction for the chroma samples. At first, an offset value is generated from the luma samples and then the offset value is clipped. Then, the clipped offset value is added to the chroma sample to generate filtered output. Another clipping operation is performed to generate final filtered sample. This contribution proposes to remove the first clipping operation (i.e. clipping the offset value before sum) from the CCALF process. Following results are reported as compared to VTM-8.0.

* AI : 0.00% (Y), 0.00% (Cb), 0.00% (Cr)
* RA : 0.00% (Y), 0.00% (Cb), 0.00% (Cr)
* LB : 0.00% (Y), 0.00% (Cb), 0.00% (Cr)

In v2, the results of HDR sequences are added.

It is reported that the first clipping is never triggered in CTC.

One reason for introducing this clipping was saving memory for intermediate storage of luma data for later use in CCALF. There is also a conformance stream designed to check if the decoder implements the clipping.

No action.

[JVET-R0443](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10105) Crosscheck of JVET-R0128 (AHG16: On CCALF clipping) [N. Hu (Qualcomm)] [late]

[JVET-R0230](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9874) AHG2: Syntax clean-up for cross component adaptive loop filter [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

In VVC draft 8, cross component adaptive loop filter (CC-ALF) is adopted to refine chroma components by using luma samples. Filter coefficients of CC-ALF are signalled in adaptation parameter sets (APSs). In an APS, a Cb (Cr resp.) CC-ALF filter set with up to 4 filters could be signalled and a filter from this Cb (Cr resp.) filter set could be applied to a Cb (Cr resp.) coding tree block. On the other hand, in an APS, a chroma adaptive loop filter (ALF) filter set with up to 8 filters could be signalled and a filter from this chroma filter set could be applied to a chroma coding tree block. In this contribution, CC-ALF filters are unified for the two chroma components. Cb and Cr components share the same CC-ALF filter set in an APS, which is the same method used in a regular chroma ALF. Under common test conditions, compared with VTM-8.0, the average BD rate of the proposed method is

* AI: 0.03%(Y), -0.17%(U), -0.20%(V)
* RA: 0.01%(Y), -0.10%(U), 0.06%(V)
* LDB: -0.04%(Y), -0.16%(U), -0.04%(V)
* LDP: -0.06%(Y), -0.09%(U), 0.21%(V)

The intent of the proposal is unifying CCALF with ALF, using the same APS ID for Cb and Cr at slice.

There is nothing wrong with the current spec, and the proposal might give up some flexibility.

No action.

[JVET-R0466](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10128) Crosscheck of JVET-R0230 (AHG2: Syntax clean-up for cross component adaptive loop filter) [M. G. Sarwer (Alibaba)]

[JVET-R0233](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9877) AHG16: Line buffer problem of CC-ALF for 4:2:2 and 4:4:4 sequences [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)]

In VVC draft 8, cross component adaptive loop filter (CC-ALF) is adopted to refine chroma components by using luma samples. To get an offset for a chroma sample, CC-ALF is applied to luma samples (after applying luma sample adaptive offset) where the centre of the filter is the co-located luma sample of the current chroma sample.

To reduce the line buffer requirement for adaptive loop filter (ALF) and CC-ALF, virtual boundary (VB) processing is applied to both ALF and CC-ALF. The position of a VB is 4 lines of luma samples and 2 lines of chroma samples above a horizontal coding tree unit (CTU) boundary. When ALF or CC-ALF is applied, a current to-be-filtered sample above (below resp.) a VB can not use samples below (above resp.) the VB.

However, when CC-ALF is applied to 4:2:2 and 4:4:4 video sequences, in some cases, when current to-be-filtered chroma sample is above a VB, its co-located luma sample is below the VB, which conflicts the design of VB.

In this contribution, three methods are proposed to solve the problem. Compared to VTM-8.0, the average BD-rate for the proposed methods is as follows:

Results over VTM-8.0 All Intra Random Access Low Delay B Low Delay P

Y U V Y U V Y U V Y U V

Method 1 0.00% 0.00% 0.01% 0.01% -0.03% 0.02% 0.01% -0.06% 0.01% -0.02% -0.02% -0.04%

Method 2 0.00% 0.02% 0.06% 0.02% 0.04% 0.11% 0.00% 0.03% 0.08% -0.06% 0.00% 0.04%

Method 3 0.00% -0.01% -0.02% 0.00% -0.06% -0.03% 0.01% -0.07% -0.05% -0.02% -0.04% -0.13%

Discussed in session 2.3 Thu 9 Apr 2225-2300UTC (chaired by JRO)

Method 3 is conceptually identical with R0312. The problem is that in case of 4:4:4 and 4:2:2 the processing of chroma in CCALF can only be started when the VB processing of luma at co-located positions has been finished. As a consequence, two additional line buffers are required for each chroma component (above the 2 lines of chroma VB).

The problem only arises due to CCALF, but as the VB definition of ALF and CCALF is identical, cannot be separated. Method 3 is not saving any line buffers, but just redefines the height of the chroma VB.

It is not obvious (different opinions) that method 3 has a clear benefit. It claims to be more consistent between luma and chroma VB processing for 444 and 422, but on the other hand is less consistent with 420 chroma in those cases.

Methods 1 and 2 are saving the additional chroma line buffers in 444 and 422. Method 1 proposes to use luma samples from line above which are not co-located. Method 2 skips CCALF for the two rows where the additional line buffers would be necessary. Both methods would require some additional logic. It is not known whether they might impose subjective artifacts. Likely, the second method seems preferable in both aspects.

It is noted that R0322 solution 1 also proposes method 2 (with slightly different results)

It is mentioned that for 444 (which requires more memory anyway) the four additional line buffers might not be too critical.

Furher discussion Tue Apr 21 0630

No further evidence was brought if the line buffers are critical or not. However, as the change suggested in method 2 is minor, and it is also reported that it does not have impact on visual quality, many experts supported to adopt this method.

Decision (complexity red.): Adopt JVET-R0233 method 2, disable CCALF at two lines between luma and chroma virtual boundaries for saving line buffers in 444 and 422 cases.

[JVET-R0387](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10032) Crosscheck of JVET-R0233 (AHG16: Line buffer problem of CC-ALF for 4:2:2 and 4:4:4 sequences) [Y. Wang (Bytedance)] [late]

[JVET-R0259](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9903) AHG7: On CCALF filtering of chroma sample location type-2 content [M. G. Sarwer, Y. Ye, J. Luo (Alibaba)]

It is asserted that the CCALF filter shape is not optimal for chroma sample location type-2 content. Accordingly, this contribution proposes three cross shaped CCALF filters. Following results are reported.

For chroma sample location type-2 content,

9 tap 5x5 cross shaped filter:

* AI : 0.01% (Y), -0.77% (Cb), -0.81% (Cr)
* RA: 0.07% (Y), -1.99% (Cb), -1.95% (Cr)
* LB: 0.19% (Y), -5.85% (Cb), -9.09% (Cr)

13 tap 7x7 cross shaped filter:

* AI : 0.05% (Y), -1.40% (Cb), -1.34% (Cr)
* RA: 0.04% (Y), -2.85% (Cb), -3.22% (Cr)
* o LB: 0.10% (Y), -7.28% (Cb), -11.34% (Cr)

8 tap 5x4 cross shaped filter:

* AI : 0.00% (Y), -0.35% (Cb), -0.39% (Cr)
* RA: 0.05% (Y), -1.43% (Cb), -1.52% (Cr)
* o LB: 0.17% (Y), -4.10% (Cb), -7.06% (Cr)

When the proposed cross-shape filters are applied on chroma sample location type-0 content, it is reported that some coding gain can also be achieved:

9 tap 5x5 cross shaped filter:

* AI : 0.02% (Y), -0.26% (Cb), -0.68% (Cr)
* RA: 0.01% (Y), -0.39 % (Cb), -0.48 % (Cr)
* LB: -0.04 % (Y), -1.06 % (Cb), -1.19 % (Cr)

13 tap 7x7 cross shaped filter:

* AI : 0.04% (Y), -0.82% (Cb), -1.16% (Cr)
* RA: 0.00% (Y), -1.30% (Cb), -1.28% (Cr)
* o LB: -0.02% (Y), -3.25% (Cb), -2.80% (Cr)

8 tap 5x4 cross shaped filter:

* AI : 0.01% (Y), -0.09% (Cb), -0.55% (Cr)
* RA: -0.01% (Y), -0.19% (Cb), -0.31% (Cr)
* o LB: -0.01% (Y), -0.55% (Cb), -0.91% (Cr)

It is commented that the current filter shape could allow asymmetric tuning of coefficients regarding type 2 content.

Filters beyond 8-tap would be more complex than current design. Buffer requirements would not be increased. In hardware, also the 8-tap filter could be less regular.

Gains are mainly observed in HDR (where HDR H1 is the only type 2 sampling). Compared to the gain of CCALF in those sequences, the additional gain is approximately one tenth of that (or even less for the 8-tap filter).

Gains are largest in LB, which may not be the primary use case of CCALF.

It was asked for visual quality. It is reported by proponents that they inspected visual quality and did not find problems, nor differences compared to current CCALF.

It is commented that this is a quite substantial low level modification with the main intent of compression improvement, which only applies for certain type of content.

No action.

[JVET-R0446](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10108) Crosscheck of JVET-R0259 (AHG7: On CCALF filtering of chroma sample location type-2 content) [F. Pu (Dolby)] [late]

[JVET-R0313](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9957) AHG2/AHG16: Cleanups of chroma ALF and CC-ALF on/off control [Y. Wang, L. Zhang, H. Liu, K. Zhang (Bytedance)]

In current VVC, chroma ALF and CC-ALF are disabled implicitly when luma ALF is disabled at SPS/PH/SH as it is unlikely that chroma ALF/CC-ALF would be used when luma ALF is disabled. Such a design could benefit power consumption. However, luma ALF, chroma ALF and CC-ALF are controlled independently at CTU level. Therefore, for a slice, it is still possible that chroma ALF/CC-ALF is enabled in some CTUs, even luma ALF is disabled for all CTUs, which conflicts with the original intention. In this contribution, it is proposed to disable chroma ALF/CC-ALF implicitly when luma ALF is disabled for a CTU to keep the design consistent for all video processing units. Simulation results reportedly show that BD-rate changes are {0.00%, 0.02%, 0.04%}, {-0.01%, 0.18%, 0.14%}, and {-0.09%, 0.56%, 0.04%} with AI, RA, and LDB configurations under CTC, respectively.

It is commented that the reason of coupling the enabling at high level is rather an encoder choice, and it is not necessary to transfer that to the low level. The consistency argument is not necessarily applicable here.

No justification for a low level change. There is nothing conceptually broken. No action.

[JVET-R0445](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10107) Crosscheck of JVET-R0313 (AHG2/AHG16: Cleanups of chroma ALF and CC-ALF on/off control) [N. Hu (Qualcomm)] [late]

[JVET-R0322](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9966) CCALF virtual boundary issue for 4:4:4 and 4:2:2 format [X.W. Meng (PKU), X. Zheng (DJI), S.S. Wang, S.W. Ma (PKU)]

In this contribution, the CCALF virtual boundary issue for 4:4:4 and 4:2:2 format is addressed. Specifically, the current processing chroma sample and its collocated luma sample may belong to different Coding Virtual Blocks (CVB, the block between two neighbouring horizontal virtual boundaries) for 4:2:2 and 4:4:4 chroma format, which means that these chroma samples have to be stored until deblocking and SAO of collocated luma samples are done. This will cause extra hardware overhead.

In this proposal, a bug in CCALF covariance calculation process in VTM-8.0 is reported and fixed, firstly. Then, three methods are proposed to solve the virtual boundary issue.

Aspect 1: Bug fix of VTM-8.0 (YUV422 natural sequances)

* AI: 0.00% 0.00% 0.00%;
* RA: 0.00% -0.09% -0.01%;
* LDB: 0.02% -0.01% 0.07%

Aspect 2: Solution1 (Disable CCALF when a chroma sample and its collocated luma sample belong to different CVBs.)

* YUV444:   
  AI: 0.00% 0.01% 0.07%; RA: 0.04% -0.04% 0.18%; LDB 0.03% -0.09% -0.01%
* YUV422:   
  AI: 0.00% 0.04% 0.09%; RA: 0.00% 0.06% 0.07%; LDB: 0.01% 0.07% 0.12%

Aspect 2: Solution 2 (For 4:2:2 and 4:4:4 chroma format, a chroma sample and its reference luma sample are forced to belong to the same CVB)

* YUV444:   
  AI: 0.00% 0.01% 0.05%; RA: 0.05% -0.01% 0.02%; LDB 0.02% -0.12% -0.06%
* YUV422: AI: 0.00% 0.05% 0.08%; RA: 0.00% 0.04% 0.13%;

Aspect 2: Solution3 (For 4:2:2 and 4:4:4 chroma format, the location of chroma VB is changed from 2 lines to 4 lines above a CTU boundary)

* YUV444:   
  AI: 0.00% -0.02% -0.04%; RA: 0.01% -0.07% 0.03%; LDB 0.04% -0.04% -0.16%
* YUV422:
* AI: 0.00% 0.00% -0.02%; RA: 0.01% -0.11% -0.08%; LDB 0.00% -0.15% 0.01%

Was presented in track B Sun 19 Apr. 0810 (chaired by JRO)

Aspect 1 is an obvious bug in VTM8 encoder (not filed as ticket so far)

Aspect 2: Same solutions as in R0233 – see notes there.

Decision (BF/SW): Adopt JVET-R0322 aspect 1

[JVET-R0463](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10125) Crosscheck of JVET-R0322 (CCALF virtual boundary issue for 4:4:4 and 4:2:2 format) [G. Li (Tencent)] [late]

#### Luma mapping with chroma scaling (3)

Initially discussed in AHG session 2.6 Tuesday 14 April 0825-0845

[JVET-R0290](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9934) AHG16: LMCS constraint cleanup [F. Bossen (Sharp)]

It is asserted that the expression of constraints on LMCS parameters is needlessly convoluted. An alternative definition of constraints is proposed. While the proposed constraints are not strictly equivalent to the ones in VVC draft 8, no impact on coding efficiency is observed under common test conditions. It is asserted that the proposed constraint is much more straightforward.

The proposal would simplify the expression of the encoder restriction, but give up some flexibility of LMCS. No need to change a decoder implementation, though perhaps a decoder could be simplified by knowing the range is more restricted. There are however divergent opinions on this.

No urgent need of doing this change, nothing is broken, and it gives up some flexibility.

No action on this proposal

It is noted that conformance bitstreams should be made available which exercise the entire range of the current spec.

[JVET-R0330](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9974) AHG16: On clipping average luma value for chroma residual scaling factor derivation [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai)]

In VVC draft 8, the average of neighbouring reconstructed luma samples above and left to one 6464 region is used to calculate the chroma residual scaling factor for the coding units (CUs) inside the region. In the chroma sample reconstruction process 8.7.5.3 in VVC draft 8, one clipping operation is applied to clip the luma average to the full range of the internal bit-depth when deriving the chroma residual scaling factor. Additionally, the same clipping operation is also applied when generating chroma samples even if the chroma residual samples are zeros, i.e., chroma CBF is zero. It is asserted that those two clipping operations are redundant. For a cleaner design, this contribution proposes to remove those unnecessary clipping operations from the current VVC specification. Simulation results reportedly show that the proposed modification provides bit-exact BD-rate performance.

Agreed that the secondary clipping is not needed, as it does not have any effect.

The AHG meeting recommended to remove the clipping from text, up to editor. Cleanup of software should be done for alignment with the text.

Confirmed in track B Tue. 21 Apr.

Decision (ed + SW cleanup): Remove the clipping from text, up to editor to do it consistently. Cleanup of software should also be done for alignment with the text.

[JVET-R0402](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10047) Crosscheck of JVET-R0330 AHG16: On clipping average luma value for chroma residual scaling factor derivation [J. Chen (Alibaba)] [late]

[JVET-R0393](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10038) AHG9: On LMCS for GDR [L. Wang, S. Hong, K. Panusopone, M. M. Hannuksela (Nokia)]

According to VVC Draft 8, it is asserted that the use of LMCS will cause leaks for GDR, so that exact-match at recovery point becomes unguaranteed for GDR. To fix the asserted problem associated with using LMCS for GDR, this contribution proposes to add a constraint to disable chroma residual scaling of LMCS for pictures within a GDR period.

Encoders can satisfy the proposed constraint by disabling either LMCS entirely or just the chroma residual scaling part of LMCS for the pictures within a GDR period. In the performed simulations, the impact on overall coding performance by the proposal is 0.76% for disabling LMCS within the GDR periods and 0.46% for disabling chroma residual scaling of LMCS within the GDR periods.

Alternative proposal is to fix the problem with LMCS for GDR at CU level without changes in syntax and/or semantics. For a current CU in clean area, if use of chroma residual scaling of LMCS requires any reconstructed pixels in dirty area, this contribution proposes to disable chroma residual scaling of LMCS for the current CU. This alternative proposal has almost no impact on overall coding performance (only 0.01%).

Presented in Track B Sun 19 Apr. 0830 (chaired by JRO)

It is noted that in the HLS discussions, it was already recommended to resolve the issue by adding a note of disabling CS at picture level when using GDR.

No support for introducing a low-level change.

No action on “alternative proposal”

### Transforms and transform signalling (16)

Contributions in this category were discussed Saturday 18 Apr. 0715–0920 in Track B (chaired by JRO).

[JVET-R0345](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9989) Unified primary transform kernel for ISP mode [J.-Y. Huo, W.-H. Qiao, H.-X. Wang, Y.-Z. Ma, F.-Z. Yang (Xidian Univ.), S. Wan (NPU), Y.-F. Yu, Y. Liu (OPPO)]

In VVC Draft, for CUs coded as ISP mode, when lfnst\_idx is equal to 1 or 2, the primary transform kernels are DCT-2, while when lfnst\_idx is 0, an implicit transform scheme is applied and DST-7 or DCT-2 may be applied as the primary transform kernels. It is proposed to use a unified primary transform kernel, DCT-2, for ISP mode when sps\_lfnst\_enabled\_flag is equal to 1. It is asserted that the proposed scheme can reduce the complexity in both encoder and decoder with little loss.

The experimental results are as below:

* For AI configuration: 0.06%, 0.13%, and 0.12%, with 99% EncT, 100% DecT;
* For RA configuration: 0.02 %, 0.02%, and 0.08%, with 99% EncT, 99% DecT.

It is commented that this is not clearly simplifying, as the transforms are available anyway, and the additional implicit check is minor. There is also some small compression loss.

No action.

[JVET-R0457](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10119) Crosscheck of JVET-R0345 (Unified primary transform kernel for ISP mode) [X. Zhao (Tencent)] [late]

[JVET-R0056](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9700) LFNST complexity reduction [T.-D. Chuang, M.-S. Chiang, Z.-Y. Lin, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

In VVC Draft 8, the low frequency non-separable transform (LFNST) is applied to luma only and not applied to chroma when the current coding unit (CU) is coded in single tree structure to reduce the LFNST complexity. However, in dual tree structure, the LFNST still can be applied to all three colour components, so the worst case LFNST complexity is not reduced. In this contribution, two methods are proposed to reduce the worst case LFNST complexity by only applying the LFNST to at most one colour component per CU. In the method-1, the chroma LFNST is disabled. The LFNST index is moved after the first nonzero luma transform block (TB). In the method-2, for chroma tree, the LFNST is only applied to the transformed coefficient of the first nonzero chroma TB. The LFNST index is moved after the first nonzero luma TB in single tree and luma tree, and moved after the first nonzero chroma TB in chroma tree. The results reportedly show 0.14%/1.18%/1.35% Y/Cb/Cr BD-rate under AI and 0.08%/0.28%/0.37% Y/Cb/Cr BD-rate under RA for method-1. For method-2, the results reportedly show 0.04%/0.38%/0.60% Y/Cb/Cr BD-rate under AI and 0.02%/0.13%/0.27% Y/Cb/Cr BD-rate under RA. It is asserted that 33% (for 4:2:0) / 66% (for 4:4:4) and 17% (for 4:2:0) / 33% (for 4:4:4) worst case LFNST complexity is reduced by method-1 and method-2, respectively, and issues of processing latency and coefficient buffering for LFNST in hardware decoding are solved.

Several hardware implementation experts expressed that they don’t see a complexity problem with LFNST. There is no good reason to justify the loss in compression.

No action.

It is mentioned that the aspect of signalling LFNST index when it would never be used is also included in other proposals.

[JVET-R0426](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10088) Crosscheck of JVET-R0056 (LFNST complexity reduction) [T.-C. Ma (Kwai Inc.)] [late]

[JVET-R0057](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9701) LFNST redundant syntax removal [T.-D. Chuang, M.-S. Chiang, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

In VVC Draft 8, the low frequency non-separable transform (LFNST) is applied to luma only and not applied to chroma when the current coding unit (CU) is coded in single tree structure. The LFNST index can be signalled when there is at least one nonzero AC coefficient in the current CU or the intra subblock partition (ISP) mode is used and when there is no nonzero coefficient in the LFNST zero-out region. At the same time, in case of single tree, chroma coefficients are also used to check both existence of nonzero AC coefficient in the current CU and existence of nonzero coefficient in the LFNST zero-out region. Therefore, a redundant LFNST index may be signalled in two following cases: case-1, when luma has nonzero DC and all-zero AC coefficients, and at least one of the chroma components has at least one nonzero AC coefficient in the non-zero-out region of a single tree coded CU; or in case-2, when luma has all-zero coefficients, and at least one of the chroma components has at least one non-zero AC coefficient in the non-zero-out region of a single tree coded CU. This contribution proposes two methods to reduce the syntax redundancy. In method-1, only luma coefficients are used for checking existence of nonzero AC coefficient in single tree, and it is asserted the syntax redundancy in both cases is removed. In method-2, the LFNST index is only signalled when luma has at least one nonzero coefficient in single tree, and it is asserted the syntax redundancy in case-2 is removed. Results reportedly show -0.01% and -0.01% luma BD-rates under RA for method-1 and method-2, respectively.

It is mentioned that in method 1 it might also be necessary to check the last position (not only DC).

There is nothing broken with the current design. The redundant signalling may appear ugly, but apparently the effect on bit rate is minor, and to avoid it, it is necessary to introduce one more check condition.

No good reason for this low-level change.

No action.

[JVET-R0427](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10089) Crosscheck of JVET-R0057 (LFNST redundant syntax removal) [T.-C. Ma (Kwai Inc.)] [late]

[JVET-R0167](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9811) Issue on LFNST index signaling condition [K. Abe, T. Toma (Panasonic)]

This contribution points out the issue of LFNST index signaling. According to the existing VVC specification, chroma LFNST is disabled for the single tree partition mode, and LFNST latency can be reduced by removing the dependency of luma block on chroma block. However, the availability of LFNST index of luma block still depends on chroma transform\_skip\_flag, even though LFNST is never applied to chroma block in single tree partition mode. This contribution proposes to remove the checking of chroma transform\_skip\_flag in LFNST index signaling of luma block in single tree partition mode. It can improve the consistency of LFNST conditions and allow the encoder to make more appropriate LFNST selections for luma block. The simulation results reportedly show that the proposed method can simplify LFNST conditions with -0.01% BD-rate gain for RA on VTM-8.0, and -0.01% BD-rate gain for LDB on VTM-8.0 with enabling LFNST.

Other experts raise concern that by making this change, the buffer problem that was resolved by the last meeting would come back.

It is not clear why the suggested change would reduce the latency.

It is mentioned that without understanding the impact in detail, it might be dangerous to introduce further problems. The conditions were introduced in the last meeting to solve the buffering/latency issues in inverse transform in context of chroma TS.

No action.

[JVET-R0424](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10086) Crosscheck of JVET-R0167 (Issue on LFNST index signalling condition) [T. Tsukuba (Sony)] [late]

[JVET-R0174](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9818) LFNST index signaling [C. Rosewarne, J. Gan (Canon)]

With the adoption of JVET-Q0784 LFNST is only able to be applied in the luma channel for slices using a shared coding tree. When applied, the chroma TBs must use DCt-2. In WD8 and VTM-8.0 the signalling of lfnst\_idx is conditioned on the last significant position of the TBs in the CU, i.e. luma and chroma TBs for shared coding trees. Since the chroma TBs are using DCT-2, there is no need to check their last position for the purpose of suppressing lfnst\_idx. This contribution proposes to restrict last significant coefficient checking for lfnst\_idx suppression to the luma channel only for CUs in shared coding trees. BD-rate impact under RA is 0.01%, 0.01%, 0.03%, no effect in AI (dual tree used instead) or LDB (LFNST disabled).

It is mentioned that the condition that is suggested to be removed by this proposal was introduced by purpose to avoid buffering issues.

No action.

[JVET-R0458](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10120) Crosscheck of JVET-R0174 (LFNST index signaling) [Y. Kidani, K. Unno, K. Kawamura (KDDI)] [late]

[JVET-R0176](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9820) On chroma LFNST [C. Rosewarne, J. Gan (Canon)]

With the adoption of JVET-Q0784 LFNST is only able to be applied in the luma channel for slices using a shared coding tree. This results in LFNST application in chroma only applicable to chroma branches of separate coding trees, which are only possible in Intra slices (occurring once every IntraPeriod in random access configuration). To reduce the computational burden of LFNST, this contribution proposes to remove LFNST from chroma altogether. As a consequence, the lfnst\_idx can be moved to just after the luma residual last significant position, for latency benefit. BD-rate effect for AI is 0.27%, 1.24%, 1.42%, and for RA is 0.16%, 0.37%, 0.48% for Y, Cb, and Cr channels, respectively. With the number of luma intra modes for full RDO increased by 2 for each block size, the results are: AI is 0.13%, 1.20%, 1.40%, RA is 0.08%, 0.29%, 0.47% for Y, Cb, Cr channels, respectively.

There is not latency or complexity problem with current design. The current design probably has some ugliness, but implementation does not seem to be a problem. The proposal introduces loss which is not a good tradeoff versus the benefit of removing some of the ugliness.

No action.

[JVET-R0400](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10045) Crosscheck of JVET-R0176 (On chroma LFNST) [S. De-Luxán-Hernández (HHI)] [late]

[JVET-R0234](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9878) Removal of redundant LFNST index signalling [H. E. Egilmez, A. Nalci, V. Seregin, W.-J. Chien, M. Karczewicz (Qualcomm)]

(insert abstract)

Same as R0057 method 1. See notes there. No action.

[JVET-R0360](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10004) Crosscheck of JVET-R0234 (Removal of redundant LFNST index signalling) [Z.-Y. Lin (MediaTek)] [late]

[JVET-R0235](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9879) Removal of LFNST for chroma components [H. E. Egilmez, A. Nalci, V. Seregin, W.-J. Chien, T. Hsieh, M. Karczewicz (Qualcomm)]

See under R0358. See notes there. No action

[JVET-R0361](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10005) Crosscheck of JVET-R0235 (Removal of LFNST for chroma components) [Z.-Y. Lin (MediaTek)] [late]

[JVET-R0236](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9880) Latency reduction in transformation process with TU-level signalling [H. E. Egilmez, A. Nalci, V. Seregin, W.-J. Chien, T. Hsieh, M. Karczewicz (Qualcomm)]

See under R0358. See notes there. No action

[JVET-R0362](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10006) Crosscheck of JVET-R0236 (Latency reduction in transformation process with TU-level signalling) [Z.-Y. Lin (MediaTek)] [late]

[JVET-R0303](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9947) Modified LFNST signalling for single tree blocks [Y. Kidani, K. Unno, K. Kawamura (KDDI)]

This contribution proposes modified LFNST signalling for single tree blocks. In the latest VVC Working Draft and VTM, a single LFNST index, which defines availability of LFNST, is signaled for both luma and chroma coding blocks in single tree. In single tree case, however, not only luma coding blocks but also chroma coding blocks are considered in the LFNST index parsing condition even though the application of LFNST into chroma coding block is prohibited in the decoding process. The proposed method is to modify the LFNST index parsing condition to remove the redundancy of checking single tree chroma coding blocks. Simulation results under common test condition (CTC) show an overall luma BD-rates of 0.01% for RA compared to VTM 8.0 without running time increment. In contrast, simulation results under non-CTC, where dual tree for I-slice is prohibited by default, show an overall luma BD-rates of 0.00%/0.01% for AI/RA compared to VTM 8.0 without running time increment.

Similar to R0174 – see notes there.

No action.

[JVET-R0416](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10078) Crosscheck of JVET-R0303 (Modified LFNST signalling for single tree blocks) [C. Rosewarne, J. Gan (Canon)] [late]

[JVET-R0304](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9948) Restriction on LFNST signalling for local dual tree chroma coding blocks [Y. Kidani, K. Unno, K. Kawamura (KDDI)]

This contribution proposes to restrict LFNST signalling to local dual tree chroma coding blocks. In the latest VVC Working and VTM, the application of LFNST into single tree chroma coding blocks is prohibited in the decoding process. LFNST can be, however, applied for local dual tree chroma coding blocks in single tree frame. The proposed method is to restrict LFNST signalling to local dual tree chroma coding blocks for design consistency. Simulation results under common test condition (CTC) show an overall luma BD-rates of 0.01% for RA compared to VTM 8.0 without running time increment. In contrast, simulation results under non-CTC, where utilization of dual tree fore I-slice is prohibited by default, show an overall luma BD-rates of 0.05%/0.05% for AI/RA compared to VTM 8.0 with 2% decrease in encoding running time.

Similar to R0056 – see notes there.

No action.

[JVET-R0318](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9962) Alternative methods of LFNST index signaling [M. Koo, M. Salehifar, J. Lim, S. Kim (LGE)]

The adoptions on LFNST in the 17th JVET meeting had resolved complexity issues in LFNST, which led the following two features: 1) an LFNST index can be signalled in the case that Luma CBF (Coded Block Flag) is zero and Chroma coefficient distribution is compatible with LFNST in single-tree case, and 2) Chroma coefficient distribution shall be compatible with LFNST in single-tree case although LFNST is only applied to Luma in single-tree case. Here, the compatibility with LFNST indicates that coefficients should be properly zeroed-out for LFNST and at least one non-zero coefficient should exist at a position other than DC.

In this contribution, three alternative LFNST index signaling methods are proposed to remove one or all of the two features as follows:

* Method 1: Simple addition of a condition to (A) coding\_unit or (B)/(C) residual\_coding syntax table, in order to prevent the signaling in the case of zero Luma CBF
* Method 2: Enabling Chroma LFNST in single-tree case
* Method 3: LFNST index signaling in transform\_unit syntax table

Method 1 removes the first feature, and others both of the two features. And, Method 1 and Method 2 incur minimal changes of spec, but Method 3 requires the fairly amount of spec changes. The BD-rate changes of Y/U/V are summarized as follows:

* Method 1: (A) 0.00%/0.00%/0.00% (AI) and -0.01%/-0.01%/-0.02% (RA),   
   (B) 0.00%/0.00%/0.00% (AI) and -0.01%/-0.01%/0.01% (RA)  
   (C) 0.00%/0.00%/0.00% (AI) and -0.02%/-0.03%/-0.02% (RA)
* Method 2: 0.00%/0.00%/0.00% (AI) and -0.04%/-0.19%/-0.27% (RA)
* Method 3: 0.00%/0.00%/0.00% (AI), -0.02%/-0.04%/-0.06% (RA), and 0.00%/0.00%/0.00% (LD)

According to the experimental results of Method 1 and Method 3, both of the two feature make little impact on coding performance. Furthermore, Method 2 increases complexity due to the Chroma LFNST in single-tree case. It is recommended that 1) no action should be taken on current LFNST index signaling if it is thought that the two features do not incur any critical issues, or 2) Method 1 or Method 2 could be adopted if more conservative approaches are preferable, or 3) Method 3 could be considered if group is not concerned about considerable spec changes.

Similar to R0057, R0174, R0236 – see notes there.

No need for discussion, according to proponents

No action.

[JVET-R0430](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10092) Crosscheck of JVET-R0318 (Alternative methods of LFNST index signalling) [C. Rosewarne, J. Gan (Canon)] [late]

[JVET-R0459](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10121) Crosscheck of JVET-R0318 (Alternative methods of LFNST index signalling) [Y. Kidani, K. Unno, K. Kawamura (KDDI)] [late]

[JVET-R0319](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9963) The interaction between LFNST and BDPCM [M. Koo, M. Salehifar, J. Lim, S. Kim (LGE)]

It was reported via JVET bug tracker (ticket #900) that an LFNST index signaling condition of checking transform skip in the current VVC draft is mismatched with VTM counterpart. Specifically, in the case of BDPCM, transform skip flag is inferred as 1 in current VVC spec, which turns off LFNST index signalling. However, VTM SW treats BDPCM with zero CBF as non-transform skip case. Therefore, in this contribution, two methods for solving this issue are proposed: 1) non-normatively matching SW to spec, and 2) normatively matching spec to SW. The latter normative method is the same as what was suggested in the reported bug tracker ticket #900. In order to see benefit of the latter, VTM encoder was modified to allow Chroma BDPCM with zero CBF even when LFNST is applied in single-tree case. It was reportedly observed that BD-rate change/encoding time/decoding time are 0.00%/102%/102% (AI) and 0.00%/102%/100% (RA) for the first SW fix, and 0.00%/101%/105% (AI) and 0.00%/100%/101% (RA) for the second spec fix with the encoder change, respectively.

A large number of experts supported the method 1 (aligning the SW to the spec), as this appears more consistent and makes one check unnecessary. The adoption of the last meeting (Q0106 which was later combined into Q0784) was also made on basis of the spec text.

It was asked why for the case of aligning the spec with the software the encoder was changed, and why this comes with a very slight loss.

The cross-checker confirms that the software implementation of method 1 matches with the text. He does not know where the loss comes from in method 2

The SW coordinator would like to inspect the code to verify if aligning the SW with the spec is really simplifying implementation.

After the code modification was made available, it was inspected by the SW coordinator and other experts. The opinion was expressed that the software change might not really be a simplification depending on implementation. Further, it was expressed that generally in this late phase of standard development it is preferable to align text with software in case of mismatches.

Decision (align text with software): Adopt JVET-R0319 method 2

The encoder change also proposed with method 2 shall not be adopted, no change to software.

[JVET-R0421](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10083) Crosscheck of JVET-R0319 (The interaction between LFNST and BDPCM) [J. Jung (WILUS)] [late]

[JVET-R0331](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9975) Cleanup of LFNST signalling in single tree [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai)]

First aspect: same as R0057 and R0234. See notes there

Second/third aspect: Was discussed in R0358. See notes there.

No action.

[JVET-R0460](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10122) Crosscheck of JVET-R0331 (Cleanup of LFNST signalling) [Y. Kidani, K. Unno, K. Kawamura (KDDI)] [late]

[JVET-R0352](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9996) On LFNST in shared tree [J. Jung, D. Kim, G. Ko, J.-H. Son, J. S. Kwak (WILUS)]

Similar to R0174. See notes there – no action.

[JVET-R0436](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10098) Crosscheck of JVET-R0352 (On LFNST in shared tree) [M. Koo (LGE)] [late]

[JVET-R0358](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10002) A combined solution for latency reduction in transformation process with TU-level signalling and removal of chroma LFNST [H.E. Egilmez, A. Nalci, V. Seregin, W.-J. Chien, T. Hsieh, M. Karczewicz (Qualcomm), T.-D. Chuang, M.-S. Chiang, Z.-Y. Lin, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek), X. Xiu, T.-C. Ma, Y.-W. Chen, H.-J. Jhu, X. Wang (Kwai), C. Rosewarne, J. Gan (Canon)]

In the current version of VVC (draft 8), the transform-related signaling is performed after residual coding at CU-level, and it depends on the positions of coded coefficients. This dependency inherently introduces additional latency, particularly critical for the two-stage LFNST process, since the parsing of LFNST index and the (inverse) transformation process can only start after coefficients from all color components are decoded. The latency is even further increased when the LFNST process is applied for chroma blocks. In order to reduce the latency and computational complexity, this contribution proposes a combined solution based on the proposals JVET-R0234, JVET-R0235, JVET-R0236, JVET-R0056, JVET-R0331, and JVET-R0176. The proposed combination (i) signals the transform syntax elements at the TU-level after coding luma transform blocks and (ii) removes LFNST from chroma. The experimental results under common test conditions (CTC) show that the proposed combination leads to average BD-rates of “Y:0.12%, U:1.14%, V:1.37%” in AI, and “Y:0.07%, U: 0.27%, V: 0.37%” in RA configurations with about 6% encoder speed-up in AI configurations. This minor coding loss is mainly due to removing LFNST from chroma components, and proposed signaling changes have negligible impact. Additional experimental results with a slightly different encoder setting show that the BD-rate losses can be reduced to “Y:0.02%, U:0.82%, V:1.03%” in AI and “Y:0.04%, U:0.13%, V:0.34%” in RA configurations with similar average encoding runtimes as compared to the VTM-8.0 anchor.

Aspect 1 (from R0236): Move LFNST luma signalling from CU to TU, right after decoding the luma coefficients. That makes the luma signalling independent from chroma (similar to R0174), but handles ISP as special case. Has some similarity with Q0529, which was not adopted.

Though it could be a somewhat cleaner design, it is asserted that the proposed change is too large to introduce at this late stage, where stability of the specification is of prior importance.

Aspect 2 proposes removing LFNST for chroma in dual tree case. This should not be considered (see notes under R0056).

No action.

[JVET-R0401](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10046) Crosscheck of JVET-R0358 (A combined solution for latency reduction in transformation process with TU-level signalling and removal of chroma LFNST) [S. De-Luxán-Hernández (HHI)] [late]

### Partitioning (5)

Contributions in this category were discussed Sunday 19 Apr. 0625–0705 and Monday 20 Apr. 0715-0830 in Track B (chaired by JRO).

[JVET-R0131](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9775) AHG2: On Chroma QT split in 4:2:2 format coding [H. Huang, W.-J Chien, V. Seregin, M. Karczewicz (Qualcomm), T.-D. Chuang, C.-M. Tsai, S.-T. Hsiang, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

This contribution reports several issues that are caused by the adoption of JVET-Q0471 in JVET Q meeting. The issues include inconsistent meaning of minimum quad tree size in chroma tree among different color formats, inconsistent handling of bottom-right picture boundary among different color formats, mismatch between VTM-8.0 and VVC draft 8, and implementation bugs in the VTM-8.0. It’s also noted that the gain reported in JVET-Q0471 can be achieved by encoder configuration. This contribution proposes to revert JVET-Q0471, or align the text with the software.

The following issues are identified:

1. Inconsistent meaning of minimum quad tree size in chroma tree among different color formats. The actual minimum quad tree size in chroma tree in 4:2:2 color format is half of that in 4:2:0 and 4:4:4. The encoder configure of minimum quad tree size in chroma tree doesn’t reflect the actual size when coding in 4:2:2 format. For example, when the user want to stop the quad split when the CU width is equal to 16 chroma samples, the minimum quad tree size in chroma tree is set equal to 16 in 4:2:0 and 4:4:4 format. However, the minimum quad tree size in chroma tree should be set equal to 32 in encoder configure in 4:2:0 format because of the allowing one more level of quad split for 4:2:2 format.
2. Cannot disable the quad split for chroma tree in 4:2:2 format when CTU size is equal to 64x64. In VVC draft 8, when coding in 4:2:0 and 4:4:4 format with CTU size equal to 64, one can disable quad split for chroma tree by setting the MinQtSizeC equal to CTU size, e.g. 64. In 4:2:2 format, due to allowing one more level of quad split, the MinQtSizeC shall be set to 128 to disable the quad split. However, in VVC draft 8, the maximum value of MinQtSizeC cannot be larger than the CTU size, which means the quad split cannot be disabled. (The MinQtSizeC is derived by (1<< MinQtLog2SizeC), and the MinQtLog2SizeC is derived by MinCbLog2SizeY + ph\_log2\_diff\_min\_qt\_min\_cb\_intra\_slice\_chroma. The value of ph\_log2\_diff\_min\_qt\_min\_cb\_intra\_slice\_chroma is constrained in the range of 0 to CtbLog2SizeY − MinCbLog2SizeY, which means the maximun value of MinQtLog2SizeC is equal to CtbLog2SizeY.)
3. Inconsistent handling of bottom-right picture boundary among different color formats. Considering the case when x0 + cbWidth is greater than pic\_width\_in\_luma\_samples and y0 + cbHeight is greater than pic\_height\_in\_luma\_samples and cbWidth is equal to MinQtSizeC in the chroma tree. In the 4:2:2 chroma format, binary split is allowed since cbWidth is not greater than minQtSize (refer to the highlighted part in Table 1), quad split is also allowed since cbSize (cbWidth) is greater than MinQtSizeC \* SubHeightC / SubWidthC (which is MinQtSizeC/2). But in the 4:2:0 format and 4:4:4 format, SubHeightC / SubWidthC is equal to 1, the condition of cbSize is equal to or less than MinQtSize is true, therefore quad tree split is not allowed. Also note that allowing both quad tree and binary tree split at the bottom-right picture boundary causes redundant split.

Mismatch between VTM-8.0 and VVC draft 8. In VTM-8.0, when x0 + cbWidth is greater than pic\_width\_in\_luma\_samples and y0 + cbHeight is greater than pic\_height\_in\_luma\_samples and cbWidth is equal to MinQtSizeC in the chroma tree, quad split is derived as implicit split. But in the VVC draft 8, both horizontal binary split and quad split are allowed.

There is also a ticket #1010 on the issue 4 (mismatch). The other aspects are not critically broken issues, but introduce some inconsistency in that they require handling splits differently for different chroma sampling, which makes encoder/decoder design more complicated.

It is also pointed out that the scaling of the factor subwidthC/subheightC can likewise be achieved by configuring the encoder, such that min QT size is set differently.

The main intent of Q0471 had been some compression gain for 4:2:2 (in the range of 4-6% for chroma), but the results in R0131 show in table 3 that the same gain can be achieved by the conf change.

Decision: Adopt JVET-R0131 Method 2 (reverting decision on Q0471 of last meeting)

[JVET-R0394](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10039) Crosscheck of JVET-R0131 (AHG2: On Chroma QT split in 4:2:2 format coding) [R.-L. Liao (Alibaba)] [late]

[JVET-R0268](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9912) Implicit binary split at picture boundary [G. Li, X. Li, S. Liu (Tencent)]

In VVC draft 8, implicit binary split is used only inside a CTU but not at CTU level, which looks an inconsistent design and leads to worse performance. This contribution proposes a simple change to always allow implicit binary split when the current coding block is across picture boundary and block size is smaller than or equal to minimum allowed QT size. When intra dual tree is used, the dual tree implicit QT split remains unchanged. The method was implemented on top of VTM-8.0. And average BD-rate results with min QT size of 128 luma samples of the proposed method compared with VTM-8.0 are as listed below:

* Intra dual tree on: AI -2.63%, RA -4.81%, LB -6.01%;
* Intra dual tree off: AI -2.89%, RA -4.94%, LB -6.05%.

The results are non-CTC when min QT size is set to 128, and MTT depth =0. This disables the implicit BT split at CTU level.

The majority of the gain comes from class C where the picture boundary is a major part.

The disabling of implicit BT split at CTU level was introduced for the benefit of VPDU implementation. There is some concern that the proposed method might break the VPDU concept.

No action.

[JVET-R0478](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10140) Cross-check of JVET-R0268: Implicit binary split at picture boundary [X. Xiu (Kwai)] [late]

[JVET-R0269](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9913) Fix on minimum QT size value range [G. Li, X. Li, S. Liu (Tencent)]

This contribution proposes a fix on the issue reported in ticket #925, to set value range of min QT size in intra slices with consideration of whether dual tree implicit QT split is applied.

The suggested change would apply in both SPS and PH.

R0347 is related to same issue.

[JVET-R0316](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9960) AhG16: Normative constraints on BT and TT split under MER [Y. Wang, K. Zhang, L. Zhang, H. Liu, Z. Deng (Bytedance)]

Merge estimation region (MER) was adopted for parallel encoding at the last JVET meeting. When MER is applied with a region smaller than a CTU, some non-normative constraints on BT and TT splits are applied. However, such non-normative constraints bring redundancy since the indications of BT or TT split still need to be signalled even when the constraints are satisfied. This contribution proposes to change the non-normative constraints on BT and TT splits under MER to be normative. It is asserted that the redundancy of the signalling when MER is used can be removed. Compared to VTM-8.0 with MER enabled, experimental results reportedly show luma BD-rate changes of -0.26%/-0.39%, -0.39%/-0.54%, and -0.15%/-0.17% with RA/LDB configurations on average for MER size equal to 8×8, 16×16, and 32×32, respectively.

It is commented that this would be a low-level change that would only be beneficial in a non-CTC case with MER that was introduced to help encoders.

No action.

[JVET-R0431](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10093) Crosscheck of JVET-R0316 (AhG16: Normative constraints on BT and TT split under MER) [H. Huang (Qualcomm)] [late]

[JVET-R0347](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9991) AHG2: On minimum QT size, maximum BT size and maximum TT size [H. Huang, J. Chen, W.-J. Chien, M. Karczewicz (Qualcomm)]

In this contribution, it is reported that the value 128 for the minimum QT size, maximum BT size and maximum TT size are redundant under dual-tree condition. It’s also reported that the value 128 for maximum TT size is redundant for single tree condition as well. To address the first issue, it’s proposed to change the upper limit of minimum QT size, maximum BT size and maximum TT size under dual-tree condition to 64. To address the second issue as well as the first, it’s proposed to set the upper limit of minimum QT size and maximum TT size to 64 in both dual-tree and single tree, and set the upper limit of maximum BT size to 64 in dual-tree.

The first solution inhibits min QT size =128 and maxonly for dual tree, the second for both DT and ST. It is claimed that the value of 128 for min QT size is unnecessary also in ST as it would be causing a large loss in CTC, and therefore it can be set to 64 to solve the problem.

There is nothing broken in the spec, but due to the fact that in case of dual tree an implicit split is performed to support the 64x64 VPDU concept. Currently, an encoder could set values of min QT size 128 and max TT size 128 that are overridden later (as defined by semantics) at the decoder side which might be confusing.

The max TT size of 128 is useless in both DT and ST, as it violates the VPDU concept.

In CTC, nothing would change (in case of R0269 and R0347). When an encoder would set the value to 128, the bitstream would change, but decoded output would be identical in dual-tree case. In single-tree case, nothing would change in R0269 (also for non-CTC min QT=128), and also not in R0347 solution 1. In R0347 solution 2, this non-CTC could no longer be operated.

In terms of min QT size R0269 and R0347 sol.1 are just differently expressing semantics, otherwise identical. The aspect of setting max TT size to 64 (in both ST and DT) is not included in R0347.

Usage of min QT size 128 is asserted to be unnecessary, and it seems to be the most straightforward solution to avoid the confusion.

Decision (cleanup/text&SW): Adopt JVET-R0347 solution 2

[JVET-R0473](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10135) Crosscheck of JVET-R0347 (AHG2: On minimum QT size, maximum BT size and maximum TT size) [?? (Mediatek)] [late]

### ACT related (6)

Reviewed in track B Sat. 18 Apr. 1650-1725 and Mon. 20 Apr. 0830-0930 (chaired by JRO) unless indicated differently.

[JVET-R0305](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9949) CU level transform size restriction for adaptive color transform [L.-F. Chen, X. Li, S. Liu (Tencent)]

In order to avoid large temporary buffer, it was decided to set max transform size to 32-point at SPS level when adaptive color transform (ACT) is enabled. However, disallowing 64-point transform leads to 1+% performance drop for RGB camera content. To compensate the coding loss, a simple fix is proposed in this contribution that max transform size is constrained to 32-point for CUs in ACT while for other CUs 64-point transform may still be used. The proposed method is implemented on top of VTM-8.0. Compared with VTM-8.0, the coding loss for RGB camera content is recovered. By using our method, the performance impact for RGB camera content is shown as following.

* AI: -1.5%/2.6%/0.1%
* RA: -1.5%/2.7%/-0.4%
* LB: -1.6%/3.4%/0.8%

Initially presented in AHG session 2.5 0630-0700 (chaired by JRO)

It is pointed out that a number of restrictions were introduced in the last meeting with regard to combining ACT with other tools.

It is also pointed out that the VTM until recently had various bugs in 444 and 422 modes, in particular regarding the QP setting for chroma. This may make some of the results less interpretable. For example, luma and chroma are showing different tendency here. See contribution R0321.

420 coding would not be affected since ACT is not used there.

The restriction is necessary due to buffering constraints.

Q0378 is also related to this topic.

New results with bug-fixed software (MR1488 and MR1492) were shown Wed 22 0620.

For natural content, the BD rate difference -3.66%/4.04%/1.31% for G/B/R in RA with dual tree on, and -4.41%/4.55%/1.74% in RA with dual tree off. The proposal seems to shift rate between components for the benefit of green. It is pointed out that this may be due to an encoder problem.

It is also pointed out that the changes of performance are very different, G gain is 20% for old town cross.

For screen content, no benefit.

The proposal does not solve a problem, and would require a low-level change.

No action.

[JVET-R0329](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9973) Mismatch on clipping input residuals to IACT [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai), J. Zhao, S.-H. Kim (LGE)]

See further notes under R0355.

Decision (BF/aligntext): Adopt JVET-R0329.

[JVET-R0336](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9980) Adaptive colour transform clean-ups [J. Xu, L. Zhang, W. Zhu, K. Zhang (Bytedance)]

Included in R0355.

[JVET-R0355](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9999) On clipping input residuals to IACT [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai), J. Zhao, S.-H. Kim (LGE), J. Xu, L. Zhang, W. Zhu, K. Zhang (Bytedance)]

In the VVC draft 8, a clipping operation is applied to the residuals of three color components before the inverse adaptive colour transform (IACT) is applied. In the current specification, the clipping range is []. Given that the ACT transform increases the bit-depth of Cg and Co residuals by 1-bit, this contribution proposes to increase the clipping range of Cg and Co by one more bit, i.e., []. Simulation results show that for RGB sequences the proposed change has negligible BD-rate performance impact on lossy coding and bit-exact bit-rates for lossless coding.

The mismatch between SW and text regarding clipping/bitdepth range was reported in ticket #993. This inhibits usage in lossless coding, i.e. there is clearly an issue to be resolved. In R0355, it is proposed to align the software with the text in the Y component (where the bit depth of the SW can be reduced by 1 while still achieving lossless coding), whereas for Co and Cg the bit depth of the spec needs to be increased by 1, and the software can stay as is. The solution in R0355 basically came from R0336.

During the discussion, some other experts raised the opinion that the original solution of R0329 would be more appropriate to resolve the issue, as it handles all three components equally in terms of clipping (which would avoid chccking the component in certain implementations), and this would just align the text with the software (no need to change the software), so it is proven that it works.

The advantage of R0336 would be that it saves one bit in the buffer of Y.

It was also asked if the difference between R0329 and R0336 could not just be an implementation issue, i.e. implementing the operation of R0336 with 1 bit higher bit depth, or implementing R0329 Y with 1 bit less. As this was not clear, the most straightforward and safest solution seemed to be adoption of R0329.

[JVET-R0420](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10082) Crosscheck of JVET-R0355 (On clipping input residuals to IACT) [T. Tsukuba (Sony)] [late]

[JVET-R0378](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10023) TU split for ACT [K. Kondo, M. Ikeda, T. Suzuki (Sony)]

In this contribution, it is proposed to allow a large transform such 64-points when an adaptive color transform (ACT) is disabled at the coding block. In the last meeting, to restrict the large transform was adopted. It can help to reduce buffer size and latency between inverse-transform and inverse-colour transform. However, it was restrictive because the 64-points transform can not be used even if ACT was disabled. This contribution reports the test results when the 64-points transform is allowed. Based on the common test condition for RGB 4:4:4 as described in JVET-Q2013, simulation results reportedly show that the average {G, B, R} BD-rate {0.01%,-0.26%,-0.25%} for screen contents and {-0.57%, -0.25%, -0.43%} for natural contents in AI configurations.

Conceptually similar with R0305, but the latter has somewhat more gain (where it was however questioned how these relate to the bug in previous software). R0305 additionally applies the adaptive transform size restriction to subblocks.

V3 of R0378 shows additional results which correct the settings in terms of QP table as suggested in R0321. Overall gain is 0.25%/0.25%/0.29% in 4:4:4 RGB CTC for AI, and for natural content it is 0.6%/0.26%/0.39%, which seems to be similar to the results reported in the abstract.

There are additional results for RA in the new version, which are still incomplete.

It is questioned how relevant a use case is of coding RGB 4:4:4 content in a lossy mode (with CTC up to QP37), when it could be converted to YUV, which is usually saving several percents. Compared to that, the gain in AI is relatively small, and for screen content it is almost zero. This does not justify a low-level change.

No action.

[JVET-R0380](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10025) Scaling list for adaptive colour transform [S. Iwamura, S. Nemoto, A. Ichigaya (NHK), K. Naser, P. de Lagrange, F. Le Leannec, P. Bordes (InterDigital)]

In this contribution, modifications of scaling matrix derivation are proposed. In VVC Draft 8, adaptive colour transform (ACT) for 4:4:4 can be controlled at the CU level flag (cu\_act\_enabled\_flag). Although the energy distribution of transform coefficients in RGB and YCgCo domain would be different, in VVC draft 8, user defined scaling lists are always shared for G and Y, for B and Cg, for R and Co, which may cause undesirable behaviour of quantization process. To avoid the undesirable behaviour, this contribution proposes to introduce additional flag (scaling\_matrix\_act\_disabled\_flag) in APS to disable scaling matrix for the block coded with ACT.

V2 document add solution #2 which repurposes the existing “scaling\_matrix\_for\_lfnst\_disabled\_flag” to disable scaling list for both LFNST and ACT coded block.

V3 document add solution #3 and #4, which add a new SPS flag instead of APS.

The initial solution and solution 2 are obsolete due to the adoption of scaling list signalling at SPS in R0064.

Solution 3 is proposing a similar (but separate) mechanism for ACT

Solution 4 is proposing using the same flag that disables usage of scaling list for LFNST also for ACT.

There were different opinions about the necessity of disabling scaling matrices for ACT on.

It was also asked if the three transforms are used in combination? They probably are, but this does not seem to be a problem.

There is the general opinion that such a mechanism would be useful, as the charcteristics of RGB and YCoCg in the spatial domain are probably different. Solution 3 seems to be more appropriate, as the characteristics of LFNST and ACT are probably different, and the additional flag would only be relevant in a 4:4:4 profile.

It is asked if it is more appropriate to switch off the scaling matrices for RGB coded blocks rather than YCoCg? Would it be better to design the scaling matrices for the latter and disable for the RGB coded blocks? It was also asked how it is handled in HEVC, and whether there are more blocks coded in YCoCg or in RGB typically.

Was further reviewed Wed. 22 0640 UTC. Numbers of frequency of usage for RGB/YCoCg are presented. As a general tendency, YCoCg is more frequently used in high QP, and RGB is more frequently used in lower QP. Three are two sequences where YCC is preferred over the entire CTC QP range. If however blocks in skip mode are not counted, it is more evident that a sequence dependency exists.

Another new solution (called solution 3-3 in the new version zip v4) is proposed that allows switching, either disabling scaling matrices for RGB or YCC. This is only existing in the slide deck

Decision: Adopt JVET-R0380 solution 3-3. Proponents shall provide the spec text in a new upload. It is to the discretion of the editors to align the naming of new syntax elements in a consistent way (e.g. “…designate\_rgb\_flag” does not appear appropriate)

## AHG11: Screen content coding (9)

Initially presented in AHG sessions 2.3 Thu 9 April 1300-1500 and 2.5 Tue 14 April 0700-0900 (chaired by JRO)

[JVET-R0145](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9789) AHG 11/15: On the use of limited EGk signalling [J. Gan, C. Rosewarne (Canon)]

Only four low level syntax elements remain (cu\_qp\_delta\_abs, palette\_predictor\_run, num\_signalled\_palette\_entries, and palette\_escape\_val) that use the general EGk binarisation. EGk is the only non-truncated binarisation used for low level signalling. This contribution proposes to replace the use of EGk with limited EGk for the four low level syntax elements. This change in binarisation has previously occurred for residual coding and mvd coding. It is asserted that the proposed changed binarisations remove unbounded codes from low-level syntax.

Presented Thu 9 1317 UTC (chaired by JRO)

There is no problem solved by this proposal, EGk has been used practically for a long time

It is pointed out that the EGk has advantages for syntax elements that change the valid range, such as delta QP

No benefit in terms of simplification

Other experts expressed concerns about adoption

No action.

It was later remarked by the proponents that an asserted benefit would be simplification of conformance testing.

[JVET-R0397](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10042) Crosscheck of JVET-R0145 (AHG 11/15: On the use of limited EGk signalling) [H.-J. Jhu (Kwai Inc.)] [late]

[JVET-R0146](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9790) AHG11: Context coded bin limits for palette coding [J. Gan, C. Rosewarne (Canon)]

To limit the required throughput of the CABAC engine, the number of context coded bins is limited to 1.75 bins per sample. This limit is explicitly calculated and enforced in the residual coding process. In palette coding, the number of context coded bins is not explicitly limited. With the adoption of JVET-Q0504, an “evil” bitstream can be constructed that would reach 1.984 context coded bins/sample. This contribution proposes a number of options for solving this bug. The preferred option explicitly calculates the context coded bins limit for palette mode CUs.

Presented Thu 9 1333 UTC (chaired by JRO)

More investigation is necessary to understand if the worst case is really exceeded, as

* The comparison is only made against the max number of transform coefficients per color component. As palette either codes all color comp jointly, this might only exceed the max number for monochrome case (which only would apply if there was a dedicated monochrome profile)
* In residual coding, additional context coded bins occur for motion, mode etc.

More detailed analysis was presented (see R0146r2). It is confirmed that the worst case of CC bins in transform coding goes up to 2.125 (with 4x4 blocks, where the bin count for last position affects lowest number of coefficients).

No need for action.

[JVET-R0472](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10134) Crosscheck of JVET-R0146: AHG11: Context coded bin limits for palette coding [C. Hollmann (Ericsson)] [late]

[JVET-R0229](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9873) AHG11: Fixed number of reuse flags for palette mode [R.-L. Liao, Y. Ye, M. G. Sarwer (Alibaba)]

In the VVC draft 8, number of reuse flags to be decoded is related to the size of the palette predictor. In the case that two neighbouring blocks are both coded in palette mode, the syntax of the second block cannot be parsed until the new palette predictor size is obtained. In this contribution, the number of reuse flags is set to a fixed value, that is, 63 and 31 for single tree slice and dual tree slice, respectively. Therefore, the syntax of second block can be parsed with no dependency on how large the previous block’s palette predictor is. Fixed number of reuse flags can be achieved by two methods: 1) initializing the palette predictor size to the fixed value; 2) add a requirement of bitstream conformance to palette\_predictor\_run signaling. It is reported that, as compared to VTM-8.0 with palette on, the overall coding performance impact for {Y, U, V} in 4:4:4 color format is:

* #1:{0.01%,0.01%,0.01%}for AI,{0.03%,0.05%,0.01%}for RA,{x.xx%,x.xx%,x.xx%}for LB
* #2:{0.01%,0.00%,0.02%}for AI,{0.03%,0.04%,-0.01%}for RA,{x.xx%,x.xx%,x.xx%}for LB

For class F in 4:2:0 color format, the overall coding performance impact for {Y, U, V} is:

* #1:{-0.01%,-0.07%,0.03%}for AI,{0.01%, 0.08%,0.07%}for RA,{x.xx%,x.xx%,x.xx%}for LB
* #2:{-0.02%,-0.04%,0.05%}for AI,{-0.02%,0.10%,0.08%}for RA,{x.xx%,x.xx%,x.xx%}for LB

For class TGM in 4:2:0 color format, the overall coding performance impact for {Y, U, V} is:

* #1:{0.00%,0.01%,0.00%}for AI,{0.05%,-0.06%,-0.04%}for RA,{0.01%,-0.09%,0.11%}for LB
* #2:{0.01%,0.00%,-0.01%}for AI,{0.05%,-0.04%,-0.04%}for RA,{0.07%,-0.06%,0.07%}for LB

Presented Thu 9 1350 UTC (chaired by JRO)

It is not obvious that there is a severe issue. It is mentioned that method 1 could even be more complicated.

It is pointed out that JVET-R0310 is same as method 1. However, in that other contribution it is claimed that a parsing dependency exists. Several experts pointed out that there is no parsing dependency as it is typically defined.

Also the bit stream restriction does not seem to be necessary.

No action.

[JVET-R0441](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10103) Crosscheck of JVET-R0229 (AHG11: Fixed number of reuse flags for palette mode) [Y.-H. Chao (Qualcomm)] [late]

[JVET-R0240](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9884) AHG11: On maximum palette size and palette predictor size [Y.-H. Chao, T. Hsieh, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm)]

In this contribution, it is proposed to reduce maximum palette and palette predictor size. Three methods are proposed in this contribution:

1. Reduce the maximum palette and palette predictor size to 16 and 32 in single tree slice and to 8 and 16 in dual tree slice
2. Reduce the maximum palette and palette predictor size to 16 and 32 in single tree slice and to 8 and 16 in dual tree slice for YUV420 format, while the size for other color formats stays the same as in VVC draft 8.
3. Allow the signaling of maximum palette size and maximum palette predictor size in SPS, same syntax as in HEVC SCC extension. The allowed maximum palette and palette predictor size are restricted to 32 and 64.

The results of method 1 on YUV4:4:4 screen content sequences versus non-420 CTC anchor (PLT=1) are shown as:

* 1.48% AI, 1.05% RA and x.xx% LDB

The results of method 1 and 2 on YUV4:2:0 class F and TGM versus VTM8 with PLT=1 are shown as:

* Class F: 0.16% AI, 0.30% RA and 0.09% LDB
* Class TGM: 0.71% AI, 0.59% RA, and 0.19% LDB

The results of method 3 with maximum palette and palette predictor size signaled to be 16 and 32 for YUV4:2:0 format versus VTM8 with PLT=1 are shown as:

* Class F: 0.16% AI, 0.30% RA and 0.09% LDB
* Class TGM: 0.72% AI, 0.59% RA, and 0.19% LDB

Presented Thursday 9 April at 1407 UTC (chaired by JRO)

Presentation deck not uploaded.

Method 3 does not reduce decoder worst case complexity (and was also proposed previously, but not adopted). Also method 2 is not reducing worst case complexity, as 4:2:0 is not the worst case. Method 1 is reducing the complexity in terms of CABAC throughput, and the memory storage, but also has loss of up to 1.5% (AI)

Memory is not a significant issue here, according other experts’ opinion

It was not obvious that CABAC throughput of palette is the worst case.

No evidence was shown that further reduction of the palette size is needed.

[JVET-R0381](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10026) Crosscheck of JVET-R0240 (AHG11: On maximum palette size and palette predictor size) [H.-J. Jhu (Kwai Inc.)] [late]

[JVET-R0309](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9953) [AHG16] Clean-up on palette predictor update for local dual tree [H. Jang, J. Nam, S. Yoo, N. Park, S. Kim, J. Lim (LGE)]

This contribution proposes to clean-up regarding predictor palette update for local dual tree structure. Three alternative clean-up methods are suggested as described below:

* Clean-up 1. There is mismatch between SPEC and SW. Here, propose to fix SPEC to align with SW regarding local dual tree predictor palette update process.
* Clean-up 2. Update predictor palette entry only for luma component but not for chroma component in local dual tree structure.
* Clean-up 3. Remove palette predictor update process of local dual tree structure.

The suggested clean-up method 2 shows {0.00%, 0.00%, -0.06%} and method 3 shows{0.00%, 0.07%, 0.10%} coding performance respectively for average of ClassF/SCC under CTC with palette on. It is asserted that proposed clean-up methods save H/W power consumption with closed to zero coding loss and also cut worst case decoding latency by disabling predictor palette update for local dual tree.

Presented Thursday 9 April at 1427 UTC (chaired by JRO)

For “clean-up 1”, spec should be aligned with software. This is also included in JVET-R0333. See further notes there.

Items #2 and #3 try to simplify the interaction of palette with local dual tree structures. It is agreed that there is no problem in the spec such as unspecified decoder behaviour. Also in local dual tree the total predictor table size is identical with single tree. No need for action on these items.

[JVET-R0310](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9954) [AHG16] Clean-up by removing parsing dependency for palette [H. Jang, J. Nam, S. Yoo, N. Park, S. Kim, J. Lim (LGE)]

See notes under JVET-R0229.

[JVET-R0320](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9964) AHG11: Maximum QP for escape value in palette coding [J. Xu, L. Zhang, W. Zhu, K. Zhang (Bytedance)]

Currently, EG(5) is used to code escape values in palette mode. It is observed that when QP is larger than or equal to 23, the bit length of escape values reaches its minimal, i.e. 6. Thus, it is proposed to limit the maximum QP to be 23 to reduce quantization distortion.

Presented in Session 2.5 Tue 14 April 0500 (chaired by JRO)

This does not appear to be a cleanup (another min check necessary). Small compression gain is observed.

Even small loss in LDB configuration (mainly coming from one sequence).

The relative small gain may be due to the fact that palette is less used in higher QP, and that also escape may be less selected.

No action was taken on this.

[JVET-R0396](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10041) Crosscheck JVET-R0320 (AHG11: Maximum QP for escape value in palette coding) [R.-L. Liao (Alibaba)] [late]

[JVET-R0333](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9977) AHG11: Mismatches related to palette prediction [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

This contribution reports some mismatches between VVC draft 8 and test model software VTM-8.0 on updating the palette prediction in local dual tree cases. First, in the VVC draft 8, under local-dual tree case the update process of palette prediction is performed only for chroma CU while in the VTM-8.0 it is performed for both luma and chroma CUs. Secondly, in the VVC draft 8, the palette prediction for a luma CU under a local-dual tree does not use the chroma values of those entries in the palette predictor, and vice versa. But in the VTM-8.0, luma and chroma values of each entry in the palette predictor are used together in palette prediction.

In this contribution, one method is proposed to solve the first mismatch and two methods are proposed to solve the second mismatch in different ways. In the first change, it is proposed to change the specification text to align with the VTM-8.0 software for palette update in the first mismatch. The proposed change has no impact on coding performance. In the second change, it is proposed to change the specification text to align with the VTM-8.0 software for forming a palette in the second mismatch. The proposed change has no impact on coding performance. In the third change, in forming a palette, the same default values used for signaled palette entries are also used for predicted palette entries to fix the second mismatch. The proposed change reports negligible BD-rate changes compared to VTM8.0.

Presented Thu 9 1450 UTC (chaired by JRO)

Presentation deck not included.

It is obvious that the text spec is incomplete. The third change which modifies both text and software does not seem to be justified, as it is not simpler and has some small coding loss.

The AHG meeting recommended that the first and second change (as called so in v2 of word or v3 zip) should be adopted.

AHG session 2.1 ended Thu April 9 1505 UTC

Confirmed in track B Tue. 21 Apr.

Decision (mismatch/aligntext): Adopt JVET-R0333 first and second change (as called in v2 of word or v3 zip).

[JVET-R0438](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10100) Crosscheck of JVET-R0333 (AHG11: Mismatches related to palette prediction) [Y.-H. Chao (Qualcomm)] [late]

[JVET-R0334](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9978) AHG11: Disabling chroma CU palette mode on under local dual tree [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

In VTM8.0, under local dual tree case, the palette prediction update process is performed after each palette mode coded CU. In other words, a palette mode chroma CU cannot be decoded until all palette mode luma CUs under the same local-dual tree are decoded. This may become be a complexity bottleneck and cause latency in the pipeline.

In this proposal, it is proposed to disable palette mode for chroma CU under local dual tree cases. The results on YUV4:2:0 sequences compared to VTM8.0 are:

Class F: 0.00% AI, 0.00% RA, -0.01% LB

Class SCC: 0.00% AI, 0.03% RA, -0.02% LB

Presented in track B Sun Apr. 19, 0846-0930 (chaired by JRO)

The results are covering 4:2:0, but 4:2:2 would also be affected (not 4:4:4, as no local dual tree concept exists in the latter). 4:2:2 is uncommon for screen content.

The latency problem suggested is not related to parsing. Only predictor update and reconstruction is affected.

Several experts said that with the proposal, implementation would be simplified by using the existing single tree palette would be used just for luma, while chroma is decoded in parallel in some other mode. With local dual tree for palette, chroma needs to wait until luma is finished. However, the process of filling the palette would not yet be the same as single tree, as default values would need to be filled for chroma predictor update.

It is further expressed that the proposal would reduce the latency just for palette, and not for other modes that would be used local dual tree (e.g., CCLM).

Though the benefit is not large, and it only touches a cornercase in potential 4:4:4 profile (where a 444 stream is carrying 420 or 422 content using palette), several experts expressed opinion that this is a reasonable simplification. Cross-checker confirms that the implementation and text are aligned and stable.

Decision (cleanup/text&SW): Adopt JVET-R0334

[JVET-R0439](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10101) Crosscheck of JVET-R0334 (AHG11: Disabling chroma CU palette mode under local dual tree) [Y.-H. Chao (Qualcomm)] [late]

## AHG14: Lossless and near-lossless coding (17)

Reviewed in AHG session 2.4 Thursday 9 April 2320 - Friday 10 April 0115 (chaired by BB), continued Tuesday 14 April in session 2.6 0850-0920 and session 2.7 1300-1515 (chaired by JRO and BB). Further review in track B Sat. 18 Apr. 1300-1535 and 1550-1645 (chaired by JRO)

### Transform skip-related (16)

[JVET-R0045](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9689) AHG15: cleanup for signaling of minimum QP of transform skip [J. Li, K. Abe (Panasonic)]

This contribution proposes to replace syntax “min\_qp\_prime\_ts\_minus4” (in range of [0-48]) with “internal\_minus\_input\_bit\_depth” (in range of [0-8]) to remove redundancy of signalling and make the design more compact.

It was commented that the name of the new syntax element could be changed and the semantics could be improved.

There was a question whether an encoder would choose one of the values of min\_qp\_prime\_ts\_minus4 not suited for lossless coding. Participants were generally in favor of this cleanup.

The AHG meeting recommended to adopt this (with editorial improvements of the specification draft text).

Confirmed in track B Tue. 21 Apr.

Decision (cleanup): Adopt JVET-R0045 (with editorial improvements of the specification draft text to be done by editors).

[JVET-R0083](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9727) AHG14: Residual coding constraints for transform skip blocks [A. Nalci, H.E. Egilmez, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)]

In 17th JVET meeting, the slice level flag “slice\_ts\_residual\_coding\_disabled\_flag” was adopted into VVC as part of JVET-Q0089. This flag can bypass transform skip residual coding (TSRC) and enables the use of regular residual coding (RRC) for TS blocks. In VVC Draft 8, when slice\_ts\_residual\_coding\_disabled\_flag=1 both dependent quantization (DQ) and sign data hiding (SDH) can be used for TS blocks. Additionally, as reported in [Spec Ticket #859], though VTM-8.0 software disables the dequantization part of DQ for TS blocks it keeps the DQ related state-based context derivation.

In variant (#1a), it is proposed to disable both DQ and SDH for TS blocks. In addition to this variant, (variant #1b) further encoder fixes for RDOQ are provided for both BDPCM and non-BDPCM TS blocks when slice\_ts\_residual\_coding\_disabled\_flag=1 as discussed in [VVC Ticket #981].

* For lossless coding on YUV420 sequences, the simulation results show overall bit-rate savings of -0.16% AI, -0.17% RA, and -0.28% LDB with Class F: -0.47% AI, -0.56% RA, and -0.65% LDB and Class TGM: -0.47% AI, -0.57% RA, and -0.60% LDB.
* For lossless coding on YUV444 and RGB sequences, the simulation results show overall bit-rate savings about -0.32% AI, -0.43% RA, and -0.46% LDB.
* For lossy coding without encoder fixes, the simulation results show overall BD-rate savings (luma) of -0.03% AI, -0.03% RA, and -0.03% LDB with Class F: -0.80% AI, -0.70% RA, and -1.02% LDB and Class TGM: -0.86% AI, -0.86% RA, and -1.32% LDB.
* For lossy coding after encoder fixes, the simulation results show overall BD-rate savings (luma) of -0.05% AI, -0.05% RA, and -0.10% LDB with Class F: -0.99% AI, -0.83% RA, and -1.21% LDB and Class TGM: -1.23% AI, -1.08% RA, and -1.80% LDB.

In variant #2, only DQ is disabled for TS blocks and in variant #3 only SDH is disabled for TS blocks. The results for variant #2 is the same as variant #1, no results were provided for variant #3 since SDH is disabled under CTC and encoder crash occurs when SDH is enabled in current VVC software as reported in Ticket #981.

In variant #4, it is proposed to align the current spec text to the VVC software, in which dequantization part of DQ is disabled for TS blocks as in current VVC software however DQ related state transitions and contexts are kept.

Discussed in session 2.6 Tuesday April 14 0850-0920 (chaired by JRO and BB)

Question: Is anything wrong with the current spec? The ticket #981 refers to software. There is a spec related ticket #859.

To achieve lossless coding, an encoder has to disable both DQ and SDH (and other things) at high level. This also applies for mixed lossy/lossless coding, which might then be performing worse than in case of local disabling these tools. Currently, disabling is possible at picture level.

Currently, the SW modifies DQ reconstruction for TS with RRC blocks locally, whereas the spec does not have such an element. Otherwise, it would not be possible to get lossless reconstruction. It is noted that when introducing the switch between RRC and TSRC, the modification of DQ reconstruction was never mentioned. The context derivation of DQ is retained.

Decision (cleanup/SW): It is pointed out that it might be better to clean up the software in this regard, even though due to disabling the combination of RRC with DQ at higher level this would never be used, it might be confusing for implementers. Experts from Qualcomm (original proponents from JVET-Q0089) volunteered doing the cleanup.

In the results for test 1 above, the anchor is not the CTC config for lossless, but a version that disables the context derivation of DQ as well as the reconstruction part. Results indicate that the SW mismatch (using context derivation of DQ) is not providing benefit.

There is no problem with TSRC, it is able to achieve lossless coding and there is no mismatch between spec and software.

An encoder could, with current spec, take the following options for mixed lossy/lossless

* Disable DQ, and enable RRC with TS, which would penalize the lossy coded parts
* Enable DQ, and disable RRC with TS, which would penalize the lossless coded parts (mainly for natural content, as per previous findings)

For lossless-only coding, there is no problem at all. For natural content, an encoder would just take the first choice if it is natural content.

No results are available for mixed lossy/lossless (as we don’t have CTC for this). Also, the current VTM encoder would need to modified, and realistic conditions (in terms of applications) are missing.

Aligning the text with software would introduce a block-level change that is not in the spec currently.

Another option would be a high-level restriction disallowing usage of DQ if TS/RRC is enabled (or the other way round). Also BDPCM should be considered in this context, as it can be enabled when TS is enabled.

It is mentioned that such a high-level restriction would be the cleanest approach with least danger of introducing even additional problems. See also further notes under R0119.

Issue was resolved by avoiding low-level changes - see further notes under R0271

[JVET-R0469](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10131) Crosscheck of JVET-R0083 (AHG14: Residual coding constraints for transform skip blocks) [J. Gan (Canon)] [late]

[JVET-R0084](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9728) AHG14: On signaling for lossless coding [M. Karczewicz, M. Coban, A. Nalci, H.E. Egilmez, V. Seregin (Qualcomm), T.-C. Ma, X. Xiu, Y.-W. Chen, H.-J. Jhu, X. Wang (Kwai Inc.)]

No need to present according to proponents

[JVET-R0417](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10079) Crosscheck of JVET-R0084 (AHG14: On signalling for lossless coding) [T. Tsukuba (Sony)] [late]

[JVET-R0116](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9760) AHG11/AHG14: On sign data hiding of transform skip block [M. G. Sarwer, Y. Ye, J. Luo (Alibaba)]

It is asserted that, in VTM-8.0, if slice\_ts\_residual\_coding\_disabled\_flag == 1, the encoder RDOQ process does not select proper residual coding method for transform skip (TS) and BDPCM blocks. In this contribution, the encoder RDOQ process is modified so that it can select correct residual coding method during RDOQ process.

It is further reported that, in VTM-8.0 software, an encoder-decoder mismatch is also observed if both slice\_ts\_residual\_coding\_disabled\_flag == 1 and pic\_sign\_data\_hiding\_enabled\_flag == 1. This contribution also proposes two methods to resolve the encoder-decoder mismatch issue. In the first method, sign data hiding (SDH) is disabled for BDPCM blocks only, whereas in the second method, SDH is disabled for both TS and BDPCM blocks. The encoder RDOQ bug fix (mentioned above) are included in both of the methods.

During the discussion, it is questioned whether the encoder/decoder mismatch is not just an issue of VTM implementation. The spec is asserted to clearly define how SDH works from a decoder perspective, regardless if it is regular transform, TS or TS/BDPCM. The encoder may have a problem of determining the hidden sign value, though. A normative change may not be needed to resolve the encoder/decoder mismatch.

The normative changes that are suggested: disable SDH at block level when BDPCM is on (method 2.1), or when TS is on (regardless if with or without BDPCM (method 2.2)

The problem only occurs with TS/RRC

The proposal also includes a cleanup, removing the condition on DQ/SDH at block level, as both are mutually exclusive at high level.

Relative to this cleanup, another condition would be introduced at block level.

R0141 also proposes method 2.2, which is also equivalent to R0083 variant 3. Document R0154 also proposes both methods 2.1 and 2.2, and also a high level solution additionally. R0144 method 2 is identical to 2.2. R0325 aspect 2 also proposes method 2.2. Add corresponding notes for those docs

It is the general opinion that the combination of TS/BDPCM with SDH/DQ and RRC is not beneficial and difficult to handle by an encoder. A high level disabling of this combination would also resolve the problem.

A solution resolving the problems with SDH/DQ should be consistent.

Options:

* Fix the software bugs, and keep the text unchanged
* High level disabling of the combination TS/RRC with either DQ or SDH (which are mutually exclusive)
* Block-level inhibiting that said combinations.

Several experts expressed the opinion that the second option (high level disabling the combination) would be the safest solution for the problems raised, with least danger of introducing additional problems, making the software bug fixes most simple (the fix of DQ context derivation would still be necessary).

See further notes as per decision on R0271

[JVET-R0418](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10080) Crosscheck of JVET-R0116 (AHG11/AHG14: On sign data hiding of transform skip block) [T. Tsukuba (Sony)] [late]

Presentations in track B Sat. 18 April were starting from here.

[JVET-R0139](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9783) AHG9: High-level control flag for lossless coding [T. Zhou, E. Sasaki, T. Ikai (Sharp)]

This contribution proposes a high-level control flag for lossless coding in VVC. It includes two options:

Option 1: A sequence parameter set (SPS) level flag for lossless mode

Option 2: A picture parameter set (PPS) level flag for lossless mode

In both cases, some applicable flags that are always constant in lossless mode are not signaled when the proposed lossless flag is equal to 1. It is asserted that the proposed syntax can be beneficial for sequence or picture level lossless case and it avoids useless flag signalling in lossless coding case.

The intent is for entire-picture lossless coding.

The motivation is inferring the disabling of tools that disallow lossless coding at SPS and PPS, such that various other flags can be saved

Further, there is a low-level change which saves the TS flag at CU level.

The saving of HLS information is not relevant, and even more for lossless coding

Entire-picture lossless coding is not a relevant application for VVC (due to high complexity, and level constraints).

No action.

[JVET-R0141](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9785) Disabling Dependent Quantization and Sign Data Hiding in Transform Skip blocks [T. Hashimoto, E. Sasaki, T. Aono, T. Ikai (Sharp)]

Same as R0083 variant 1a. See further notes there and under R0271.

[JVET-R0398](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10043) Crosscheck of JVET-R0141 (Disabling Dependent Quantization and Sign Data Hiding in Transform Skip blocks) [[K. Abe (Panasonic)](mailto:abe.kiyo@jp.panasonic.com)] [late]

[JVET-R0144](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9788) AHG14: On lossless operation with RRC [J. Gan, C. Rosewarne (Canon)]

This contribution asserts that “slice\_ts\_residual\_coding\_disabled\_flag” introduces a bug for mixed lossy/lossless coding when either of the dependent quantization or sign data hiding coding tools are also enabled. It is proposed to fix this bug for each of the DQ and SDH coding tools by additionally conditioning their application on the transform\_skip\_flag.

The proposal disables DQ or SDH locally, whenever TS/RRC is used. It still uses the context derivation of DQ, i.e. basically it aligns the text with the software for the DQ aspect; for SDH, also the software is changed.

It is further claimed that the necessary block-level change is minimum, as it is only necessary once per block and not once per coefficient (as the syntax would suggest the latter).

It is claimed that the benefit would be for mixed lossy/lossless coding, where otherwise by disabling SDH/DQ compression penalty would occur for lossy blocks.

One problem to make a judgment based on a realistic lossy/lossless use case scenario is not possible.

The whole problem is not about conceptual wrong design, but about coding efficiency.

R0110 is a software contribution that reports on experiments with mixed lossy/lossless coding. This uses lossless coding for a smaller area (slice) and reports losses in the range of 4-7% for natural content, when RRC is not used for lossless coding.

It is pointed out that, as the lossy part is in normal QP range, and therefore, the highest amount of bits likely goes into lossless part, the loss might be much lower if TS/RRC would stay enabled, but DQ/SDH disabled.

It is further pointed out that potentially a mechanism for enabling/disabling DQ/SDH at slice level would also solve the problem of better compression performance for lossy/lossless coding. Contributions R0271 and R0155 are suggesting approaches which move the control of DQ/SDH to slice level.

It is pointed out during the discussion that overriding the picture level flags for DQ/SDH when TS/RRC is enabled would be an alternative solution achieving this, as there could be arguments that the overhead at slice header would be too large.

Issue was resolved - see further notes under R0271

[JVET-R0450](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10112) Crosscheck of JVET-R0144 (AHG14: On lossless operation with RRC) [A. Nalci (Qualcomm)] [late]

[JVET-R0153](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9797) AHG9/AHG16: On slice\_ts\_residual\_coding\_disabled\_flag [J. Choi, S. Yoo, J. Heo, J. Choi, J. Lim, S. Kim (LGE)]

See notes under JVET-R0049 for aspect 1. Other aspects resolved by other decisions.

[JVET-R0154](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9798) AHG9/16: On sign data hiding for BDPCM blocks [S. Yoo, J. Choi, J. Lim, S. Kim (LGE)]

The current VVC draft specification could allow both the sign data hiding (SDH) and BDPCM to be enabled. However, the levels of the coefficients can be modified by BDPCM, and it can affect the SDH decision in the residual coding. This document proposes two control mechanisms to prevent the unintended usage of sign data hiding (SDH) when BDPCM is enabled and transform skip residual coding is disabled. Firstly, a flag to enable sign data hiding (sps\_sign\_data\_hiding\_enabled\_flag) is not signalled when BDPCM is enabled. Secondly, sign data hiding is disabled in each residual coding block when corresponding block is BDPCM coded. Thirdly, sign data hiding is disabled in each residual coding block when corresponding block is transform skipped.

“Method 1” is a high-level change that does not allow enabling SDH in SPS when BDPCM is enabled. Alternatively, this could be done by bitstream constraint.

“Method 2” and “Method 3” are identical with M1 and M2 in R0116.

It is agreed that the combination of BDPCM and SDH is a somewhat useless combination. A block level change would be undesirable at this point of VVC development, and restricting it at a high level would be sufficient, also simplifying conformance testing.

Issue was resolved - see further notes under R0271

[JVET-R0155](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9799) AHG9/14: On lossless coding granularity [S. Yoo, J. Choi, J. Lim, S. Kim (LGE)]

In this contribution, two granularities for the lossless coding is provided by high level syntax changes. Currently, the lossy and lossless mixture can be allowed at a picture level since the dependent quantization (DQ) and the sign data hiding (SDH) switches are defined in the picture header. Therefore, the different granularities for the lossless coding is proposed.

* Method 1: Slice level lossless coding
* Method 2: Picture level lossless coding

It is proposed to move the control flags for SDH and DQ from picture header to slice header.

Issue was resolved - see further notes under R0271

[JVET-R0219](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9863) Alternative block size conditions for BDPCM [K. Unno, K. Kawamura, S. Naito (KDDI)]

In the last meeting, it was adopted that chroma BDPCM for 4:2:0 and 4:2:2 format. In the current spec, BDPCM applied CU can be separated into multiple TUs depending on the max transform skip size and the max TU size, in contrast with BDPCM applied CU always has only one TU in the VVC D7. In this contribution, it is proposed to change the block size condition of BDPCM. Two alternatives are proposed. Method 1 proposes to add a restriction that chroma BDPCM can be applied only if the CU is not separated into multiple TUs. Method 2 proposes to relax block size conditions that BDPCM can be applied regardless of separating CU to multiple TUs for not only chroma but also luma.  
Experimental of Method 1 with CTC QPs show BD-rates for luma are ‑0.01%/0.02%/0.04% (AI/RA/LD) for Class F, ‑0.01%/‑0.02%/‑0.09% (AI/RA/LD) for Class TGM.   
Experimental of Method 1 with Low QPs show BD-rates for luma are 0.00%/0.01%/‑0.01% (AI/RA/LD) for Class F, ‑0.02%/‑0.02%/‑0.01% (AI/RA/LD) for Class TGM.  
Experimental of Method 2 with CTC QPs show BD-rates for luma are ‑0.09%/‑0.06%/0.13% (AI/RA/LD) for Class F, 0.01%/‑0.02%/0.03% (AI/RA/LD) for Class TGM.  
Experimental of Method 2 with Low QPs show BD-rates for luma are‑0.02%/0.04%/‑0.04% (AI/RA/LD) for Class F, ‑0.02%/0.02%/‑0.09% (AI/RA/LD) for Class TGM.

During the discussion, it is pointed out that there is not a design problem, and it is also not asserted as inconsistent that for certain block sizes BDPCM is restricted for luma, but not for chroma.

No action necessary.

[JVET-R0419](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10081) Crosscheck of JVET-R0219 (Alternative block size conditions for BDPCM) [T. Tsukuba (Sony)] [late]

[JVET-R0258](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9902) AHG9: Reduce redundant signalling in picture header [J. Enhorn, M. Pettersson, R. Sjöberg, M. Damghanian, Z. Zhang (Ericsson)]

The ph\_dep\_quant\_enabled\_flag aspect of item 1 of this contribution belongs to this category.

No further need for presentation according to proponents.

[JVET-R0317](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9961) AHG9: On slice transform skip residual coding method signalling [M. Coban, V. Seregin, Y. He, A. Nalci, M. Karczewicz (Qualcomm)]

See notes under JVET-R0049 except the PPS aspect which is to be discussed in HLS

[JVET-R0325](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9969) AHG14: Disabling dependent quantization and sign bit hiding for transform skip mode [T.-C. Ma, X. Xiu, Y.-W. Chen, H.-J. Jhu, X. Wang (Kwai Inc.)]

Aspect 1 method1 is similar to R0271 variant 1. Other aspects were also resolved – see adoption R0271.

[JVET-R0353](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9997) AHG14: On Interaction between ACT and BDPCM [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

In HEVC, RDPCM, which is a similar coding tool to BDPCM in VVC, can be applied to both luma and chroma components when Adaptive color transform is used. On the other hand, in current VVC, interaction between ACT and Intra BDPCM is inconsistency; When ACT is used, Intra BDPCM for chroma is normatively disallowed while Intra BDPCM for luma is allowed.

This contribution proposes to enable a combination of ACT and Chroma BDPCM, which makes the interaction between ACT and Luma/Chroma BDPCM consistency.

Simulation results show that:

For 444/lossless condition (DualTreeOn),

* Average bitrate differences for RGB are 0.0% for AI, -0.71% for RA and -0.90% for LB
* Runtimes (Enc, Dec) for RGB are (99%, 97%) for AI, (100%, 97%) for RA and (101%, 98%) for LB

For 444/lossless condition (DualTreeOff),

* Average bitrate differences for RGB are -2.19% for AI, -1.23% for RA and -1.19% for LB
* Runtimes (Enc, Dec) for RGB are (96%, 92%) for AI, (99%, 98%) for RA and (100%, 96%) for LB

For 444/SCC/common QP condition (QP=22, 27, 32, 37, DualTreeOff),

* Average BD-rate differences (R, G, B) are (0.07%, 0.10%, 0.09%) for AI, (0.01%, 0.03%, 0.04%) for RA and (-0.07%, -0.06%, -0.07%) for LB
* Runtimes (Enc, Dec) for RGB are (96%, 97%) for AI, (99%, 100%) for RA and (99%, 97%) for LB

For 444/SCC/low QP condition (QP=2, 7, 12, 17, DualTreeOff),

* Average BD-rate differences (R, G, B) are (-0.22%, -0.18%, -0.20%) for AI, (-0.05%, -0.08%, -0.13%) for RA and (-0.13%, -0.14%, -0.17%) for LB
* Runtimes (Enc, Dec) for RGB are (95%, 99%) for AI, (99%, 100%) for RA and (99%, 98%) for LB

It is reported that, to reduce encoder run time, BDPCM flag for luma was always set to the same value as luma.

Similar proposals were made by the last meeting, and these were not adopted, as it was assessed that the compression benefit was too low (was in a similar range as with the new contribution).

It is not really an obligation to keep the same design as HEVC – VVC is a different standard, and what was good in HEVC may not be relevant here.

No action.

[JVET-R0477](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10139) Cross-check of JVET-R0353: AHG14: On Interaction between ACT and BDPCM [X. Xiu (Kwai)] [late]

[JVET-R0354](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9998) AHG14: BDPCM for Inter/IBC-predicted residuals [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

In HEVC, RDPCM, which is a similar coding tool to BDPCM in VVC, can be applied to Intra-predicted residuals, Inter-predicted residuals and IBC-predicted residuals. On the other hand, in current VVC, BDPCM can be applied to only intra-predicted residuals.

This contribution proposes to apply to both Inter-predicted residuals and IBC-predicted residuals to make the design of BDPCM consistent with HEVC.

Simulation results show that:

For 444/lossless condition (DualTreeOn),

* Average bitrate differences for YUV are -0.53% for AI, -1.14% for RA and -1.32% for LB
* Average bitrate differences for RGB are -0.72% for AI, -1.40% for RA and -1.93% for LB
* Runtimes (Enc, Dec) for YUV are (105%, 102%) for AI, (108%, 98%) for RA and (113%, 98%) for LB
* Runtimes (Enc, Dec) for RGB are (102%, 97%) for AI, (107%, 99%) for RA and (108%, 96%) for LB

For 444/SCC/common QP condition (QP=22, 27, 32, 37, DualTreeOff),

* Average BD-rate differences (Y, U, V) are (-0.07%, 0.12%, -0.01%) for AI, (-0.03%, 0.14%, 0.12%) for RA and (0.04%, 0.14%, 0.19%) for LB
* Average BD-rate differences (R, G, B) are (-0.09%, -0.11%, -0.10%) for AI, (-0.15%, -0.16%, -0.14%) for RA and (-0.19%, -0.20%, -0.21%) for LB
* Runtimes (Enc, Dec) for YUV are (105%, 99%) for AI, (110%, 100%) for RA and (111%, 97%) for LB
* Runtimes (Enc, Dec) for RGB are (102%, 98%) for AI, (107%, 99%) for RA and (109%, 98%) for LB

For 444/SCC/low QP condition (QP=2, 7, 12, 17, DualTreeOff),

* Average BD-rate differences (Y, U, V) are (-0.17%, -0.13%, -0.18%) for AI, (-0.59%, -0.57%, -0.57%) for RA and (-0.33%, -0.32%, -0.33%) for LB
* Average BD-rate differences (R, G, B) are (-0.27%, -0.27%, -0.27%) for AI, (-0.60%, -0.50%, -0.64%) for RA and (-0.44%, -0.45%, -0.44%) for LB
* Runtimes (Enc, Dec) for YUV are (106%, 100%) for AI, (115%, 102%) for RA and (120%, 100%) for LB
* Runtimes (Enc, Dec) for RGB are (103%, 100%) for AI, (108%, 100%) for RA and (113%, 99%) for LB

In the last meeting, applying BDPCM for inter was proposed in Q0460. The current contribution extends that, additionally also applying for IBC.

The additional coding gain is relatively low (mainly for screen content). Further, the encoder runtimes are increased – no good tradeoff.

No action.

[JVET-R0451](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10113) Crosscheck of JVET-R0354 (AHG14: BDPCM for Inter/IBC-predicted residuals) [A. Nalci (Qualcomm)] [late]

### Other (1)

[JVET-R0169](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9813) AHG14: Report of CABAC skip mode results on VTM-8.0 [K. Abe, T. Toma, V. Drugeon (Panasonic)]

This contribution is an information contribution which reports the coding results of CABAC skip mode on VTM-8.0. 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 23% bits increasing for AI, RA, and LDB on VTM-8.0, and 8%, 7%, and 10% bits increasing for AI, RA, and LDB on VTM-8.0-lossless.Just for information, as follow-up.

## AHG15: Quantization control (4)

Discussed in AHG session 2.5 Tue 14 April 0520-0630

[JVET-R0055](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9699) AHG15: On referencing a non-existent scaling list [C.-Y. Lai, O. Chubach, C.-Y. Chen, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

In this contribution, three methods to fix the issue of referencing a non-existent scaling list are presented. It is proposed to infer a non-existent scaling list to be the pre-defined matrix with all elements equal to 16 according to scaling\_list\_copy\_mode\_flag and scaling\_list\_pred\_id\_delta.

Problem occurs in 4:0:0 where chroma lists are not signalled

Method 1: define the non-existing scaling list as default

Method 2: always signal a scaling list for chroma (i.e. revert the decision of last meeting)

Method 3: bitstream constraint

Refers to ticket #926. In the discussion following that ticket. Methods 1 and 3 had been discussed there.

See further notes under R0326.

[JVET-R0127](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9771) AHG15: On scaling list prediction [A. K. Ramasubramonian, B. Ray, G. Van der Auwera, M. Karczewicz (Qualcomm)]

This document proposes changes to the derivation of scaling list reference ID when the chroma scaling lists are not signalled. Scaling lists may be explicitly signalled, copied or predicted from other scaling lists – the scaling list used for copying or predicting is referred to as the reference scaling list. The current specification allows luma scaling lists to be copied or predicted from lists that correspond to chroma scaling lists even when the chroma lists are absent; it is asserted that this behaviour is undesirable. The document proposes to modify the reference scaling list ID derivation by skipping the absent chroma lists. It is asserted that the proposed method fixes the issue of referring absent lists; due to the small bit savings, the proposed method is argued to be preferable compared to explicit constraints or inferring default lists.

Also related to ticket #926. Another method is proposed that disallows prediction from chroma scaling list when it is not present. This would also require a syntax change, reducing the range of code words to only allowing reference to luma values.

See further notes under R0326.

[JVET-R0166](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9810) AHG15: Issue on chroma scaling matrix for 4:4:4 [K. Abe, T. Toma (Panasonic)]

This contribution points out the issue that VTM-8.0 does not work with enabling scaling matrix for 4:4:4 format and proposes two solutions. Solution1 proposes to fix VTM to strictly align to current VVC specification text, it needs to introduce size64 chroma scaling matrices reusing size32 matrices. Solution2 proposes alternative method of current VVC specification text by introducing size64 chroma scaling matrix using individual matrix id. It can simplify the specification and improve the tuning capability.

The proposed solution 2 would also require signalling the size 64 chroma matrices for the 420 case.

It is not fully clear that the separate scaling matrices for chroma block size 64 are really needed.

No support for solution 2.

The AHG meeting recommended to align the VTM with text regarding the upscaling of chroma matrices for 444 64 size (adopt method1 of R0166).

Confirmed in track B Tue. Apr. 21.

Decision (SW BF): Adopt JVET-R0166 method 1. Align the VTM with spec. text regarding the upscaling of chroma matrices for 4:4:4 for transform size 64.

[JVET-R0326](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9970) AHG15: On Chroma Quantization Matrix Signaling [H. Zhang, X. Li, G. Li, L. Li, S. Liu (Tencent)]

This contribution proposes two fixes for the issue reported in ticket #926 that prediction may be from chroma quantization matrix which is not signaled.

**Method #1** Valuesinnon-signaled chroma QM is set to 16.

**Method #2** Value of **scaling\_list\_copy\_mode\_flag**[id] is inferred to be equal to 1 when it is not present

Also related to ticket #926.

Both methods are using default value (similar to method 1 of R0055), but defining it differently. Method 2 of R0326 is identical to method 1 of R0055

Method 1 of R0326 was already proposed in the original Q0505, but not included in the last meeting’s decision. It is pointed out by the editor that the text description is not optimum.

It is agreed that method 3 of R0055 (encoder constraint) is not desirable.

It is agreed that method 2 of R0055 (reverting the decision of last meeting) is not desirable.

Compression efficiency is not an argument for scaling matrices.

Both method 1 of R0055 (same as method 2 of R0326), and the method of R0127 would solve the problem.

R0055 method 1 would have less impact on implementation logic changes, and had already been discussed in the reflector.

R0127 inhibits unnecessary codewords which seems to be more clean from the spec perspective.

It was recommended by the AHG meeting that R0055M1/R0326M2 should be adopted.

Confirmed in track B Tue. Apr. 21.

Decision (BF/text and SW): Adopt JVET-R0055 method 1. Define the chroma scaling list which are not existing in case of 4:0:0 (but are allowed to be used for prediction) as default

It is noted that JVET-R0326 method 2 is identical.

# High-level syntax (HLS) proposals (261)

## AHG9: General high-level syntax (181)

### Combinations of subpictures and other features (3)

[JVET-R0043](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9687) AHG9: On subpicture interaction with other tools [J. Li, K. Abe (Panasonic)]

Discussion began here with AHG Session 1.15 on Monday 13 April at 1300 UTC (GJS & YKW).

This contribution proposes to disable tool combinations between (1) subpicture and field coding (2) subpicture and Gradual Decoder Refresh (GDR). It is asserted that the concept between subpicture and field coding are mutually exclusive and that subpicture and GDR do not work well together.

Currently, the field coding indication is essentially metadata. It is not coupled with any aspects of coding. It was commented that it seemed undesirable to couple these only to disallow the combination, which could plausibly be used – e.g., splitting the left and right halves of the picture into two subpictures.

A virtual boundary can be used for GDR, and in the current draft, a virtual boundary can only be used with subpictures if the virtual boundary is in the SPS. However, GDR can also be used without a virtual boundary (e.g., with coding as would have been done for prior standards while providing GDR header information).

The proposed restrictions did not seem necessary and would prohibit potential uses, so no action was taken on this.

[JVET-R0058](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9702) AHG8/AHG9/AHG12: On the combination of RPR, subpictures, and scalability [Y.-K. Wang, L. Zhang, K. Zhang, Z. Deng (Bytedance)]

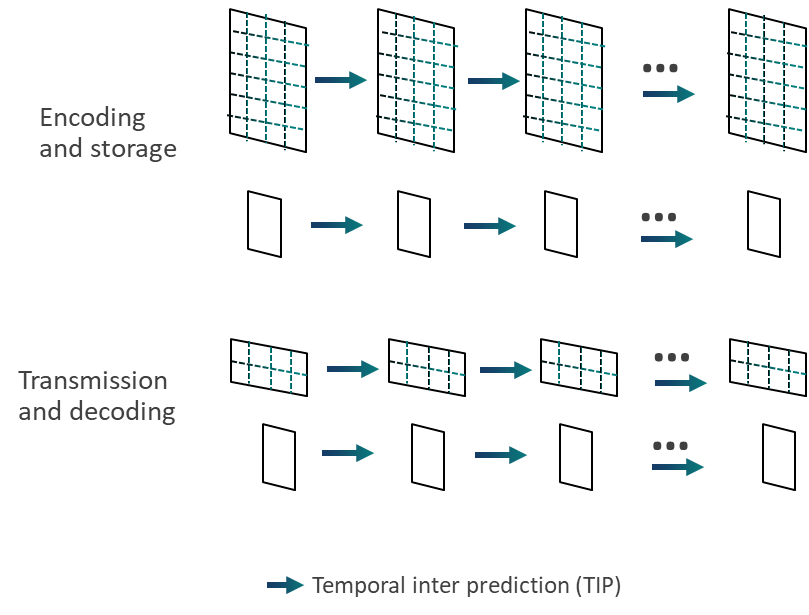
Discussed in AHG Session 1.15 on Monday 13 April at 1320 UTC (GJS).

The latest VVC draft text includes constraints that basically disallow any other combination of subpictures and scalability with inter-layer prediction (ILP) than a restricted combination of subpictures and SNR scalability.

The contributor made the following comments and assertions:

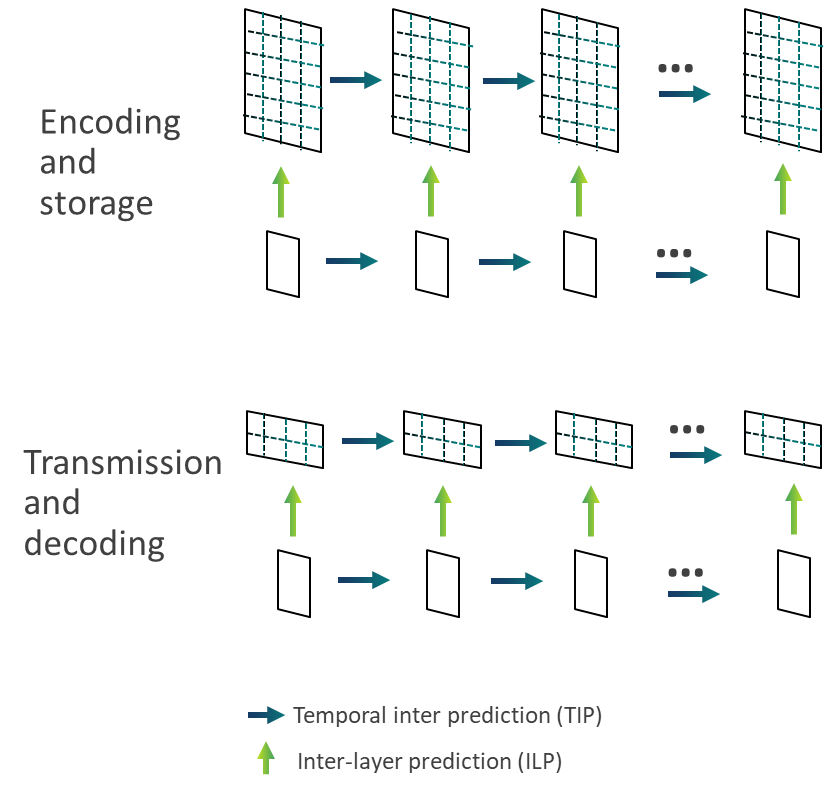
1. They could not figure out a reason why whether a layer is an output layer should make a difference herein. Rather, they thought the constraint should also apply when the layer containing the i-th subpicture is not an output layer of an OLS. The contributor asserted that the entire constraint should be specified in a manner that does not consider whether a layer is an output layer of an OLS.
2. The requirement for the value of subpic\_treated\_as\_pic\_flag[ i ] to be aligned across layers should be included, as otherwise the extraction of the subpicture sequence with the same subpicture index across the layers won't be possible.
3. The requirement for the value of loop\_filter\_across\_subpic\_enabled\_flag[ i ] to be aligned across layers should be excluded, as regardless of the value of this flag, as long as the subpic\_treated\_as\_pic\_flag[ i ] is equal to 1 the subpicture sequence is extractable. Setting of the value of loop\_filter\_across\_subpic\_enabled\_flag[ i ] should be left for the encoder to decide for trading-off the quality of single extractable subpicture sequences vs the quality of sets of extractable subpicture sequences, just as why the two flags are signalled independently from each other.
4. The entire constraint should only apply when sps\_num\_subpics\_minus1 is greater than 0, to avoid the cases of one subpicture per subpicture being covered by the constraint, unintentionally.
5. The temporal scope, i.e., the set of AUs, in which the constraint applies is not clearly specified.
6. The requirement for the value of each of the scaling window parameters scaling\_win\_left\_offset, scaling\_win\_right\_offset, scaling\_win\_top\_offset, and scaling\_win\_bottom\_offset to be aligned across layers should be included, to make sure RPR for inter-layer reference pictures (ILRPs) is not needed when there are multiple subpictures per picture, as the latter is not supported in the latest VVC design.
7. It is unnecessary to disallow a layer to use multiple subpictures per picture while its reference layer has just one subpicture per picture. As we know, a typical subpicture-based viewport-dependent 360o video delivery scheme is shown in the figure below, wherein a higher-resolution representation of the full video consists of subpictures, while a lower-resolution representation of the full video does not use subpictures and can be coded with less frequent random access points than the higher-resolution representation. The client receives the full video in the lower-resolution and for the higher-resolution video it only receives and decode the subpictures that cover the current viewport.

Another participant commented that the example use case would be highly beneficial for viewport-dependent streaming.



**A typical subpicture-based viewport-dependent 360o video coding scheme**

By allowing a layer to use multiple subpictures per picture while its reference layer has just one subpicture per picture, the coding scheme shown in the figure below would be allowed, where the only difference compared to the approach shown in the above figure is that ILP is allowed.



**A typical subpicture-based viewport-dependent 360o video coding scheme based on subpictures and spatial scalability with ILP**

A flag called res\_change\_in\_clvs\_allowed\_flag is proposed to be added.

It was commented that negative scaling window offsets would be helpful for the suggested use (see R0114 and R0217).

The contribution proposes the following changes related to the combination of RPR, subpictures, and scalability:

1. Change the constraint on the combination of subpictures and scalability (in the semantics of subpic\_treated\_as\_pic\_flag[ i ]) as follows:
   1. To impose cross-layer alignment restrictions on all layers in each dependency tree, independent of whether any of the layers is an output layer of an OLS.
   2. To require cross-layer alignment of subpic\_treated\_as\_pic\_flag[ i ]. (This is also proposed in R0118 aspect 2 and R0186 aspect 3.)
   3. To not require cross-layer alignment of loop\_filter\_across\_subpic\_enabled\_flag[ i ].
   4. To not impose cross-layer alignment restrictions when sps\_num\_subpics\_minus1 is equal to 0.
   5. To clearly specify the applicable scope through the target set of AUs specified as follows: For each CLVS of a current layer referring to the SPS, let the target set of AUs targetAuSet be all the AUs starting from the AU containing the first picture of the CLVS in decoding order to the AU containing the last picture of the CLVS in decoding order, inclusive.
   6. To require cross-layer alignment of the scaling window parameters (for pictures having the same spatial resolution).
   7. To impose cross-layer alignment restrictions only on the current layer and all the higher layers that depend on the current layer, while not on the higher layers that do not depend on the current layer or on the lower layers.
2. Change the following RPR aspects related to the combination of RPR, subpictures, and scalability as follows:
   1. Instead of having just one SPS flag for controlling RPR, use two SPS flags (ref\_pic\_resampling\_enabled\_flag and res\_change\_in\_clvs\_allowed\_flag), one for controlling the use of RPR as a tool, and the other for controlling whether the picture resolution can change within the CLVS.
   2. Consequently, also specify two general constraint flags, one for each of these two flags.
   3. Require all pictures with the same resolution within a CLVS to have the same scaling window.
3. Disallow the collocated picture of a current picture to be an LTRP or ILRP.
4. In the decoding processes involving the clipping operations for treating subpicture boundaries in motion compensation and motion prediction as picture boundaries, the condition on when to apply the clipping operations is changed such that the clipping operation is not applied when the reference picture is not split into multiple subpictures.

The comments during the AHG review were generally positive. R0114 and R0217 are related.

It was commented that HEVC allows the collocated picture to be an LTRP or ILRP and was questioned whether this aspect is necessary.

This was further discussed Thursday 23 April (GJS, JRO).

Lower layer is not split into subpictures, while higher layer is.

An editorial improvement of the contribution was provided.

Item 3 was dropped.

Item 4 has a condition change on motion compensation, and it was commented that this is not entirely a high-level change.

It was commented that R0184 (on subpictures with wrap-around) also has some effect on the lower level.

In -v2 of this contribution, the aspect on disallowing the collocated picture of a current picture to be an LTRP or ILRP was dropped.

In -v3 of this contribution, an editorial chanage was made to the proposed text changes for clarity improvement.

In -v4 of this contribution, the following two aspects were dropped as it was pointed out and confirmed during further offline discussion that the constraints unnecessarily limit the functionalities of RPR and scalability:

* 1. To require cross-layer alignment of the scaling window parameters (for pictures having the same spatial resolution) for the combination of SNR scalability and multiple subpictures per picture.
  2. To require all pictures with the same resolution within a CLVS to have the same scaling window.

In -v5 of this contribution, a discussion was added regarding subpicture-level processing and vector-by-vector based processing regarding the addition of one condition the the decoding processes involving the clipping operations for treating subpicture boundaries in motion compensation and motion prediction as picture boundaries, regarding whether to add the following constraint:

Either of the following is allowed for a picture with multiple subpictures in a dependent layer, but not both for the same picture:

* All the active reference pictures for the picture have the same subpicture layout as the picture itself. (Like in VVC Draft 8)
* All the active reference pictures are inter-layer reference pictures that have a single subpicture.

This was further discussed in the closing plenary of Friday 24 April at 1340 UTC (GJS & JRO).

The first bullet is already expressed in the current draft. Adding the second bullet removes the low-level dependency.

It was noted that this is proposing a relaxation of the constraints on subpictures and RPR.

A participant said this would help support a major use case of 360° viewport-dependent streaming.

Software had not been provided.

One expressed concern was whether encoders would respect the conformance constraint. Another said we have a variety of such constraints and the constraint and its intent are clear.

The proponent committed to making software available within 3 weeks and to provide conformance bitstreams.

Decision (functionality cleanup): Adopt, with the constraint expressed in the -v5 version, subject to the above commitment.

[JVET-R0184](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9828) AHG9/AHG12: On reference picture wraparound for subpictures [S. Paluri, Hendry, S. Kim (LGE)]

Discussed in AHG Session 1.15 on Monday 13 April (GJS & YKW).

In the current VVC draft, reference picture wraparound for subpictures is only possible when the subpic\_treated\_as\_pic\_flag is equal to 0. This contribution asserted that the reference picture wraparound functionality could be extended for cases when subpic\_treated\_as\_pic\_flag equal to 1 with the subpicture width is equal to the picture width without having to have additional signalling. This contribution enables this functionality semantically.

In this contribution, the following is proposed:

1. Allow reference picture wraparound for subpicture with subpic\_treated\_as\_pic\_flag[ i ] equal to 1 when the width of the subpicture is the same as the width of the picture, without additional signalling.
2. At slice level, derive the boundaries to be applied for decoding of blocks in the slice. If the slice belongs to an independently coded subpiture, use the subpicture boundary; otherwise, use picture boundary. It is remarked that this 2nd proposal item can be considered as editorial updates.

Examples shown in Q0403 were discussed. Two examples are shown below.

Case 1

|  |  |
| --- | --- |
| Wrap off | Wrap off |
| Wrap on | |
| Wrap on | |

The above example would have different behaviour in different subpictures. The next figure would not.

Case 2

|  |
| --- |
| Wrap on |
| Wrap on |

The second case could be used for, e.g., top-bottom stereoscopic ERP coding (or segmenting a single ERP).

Both of these are currently disallowed with subpictures treated as picture boundaries.

It was commented that we should avoid potential confusion in what is allowed and how it operates.

It was suggested to have wrap-around be a whole-picture property. This would invoke wrap-around as follows, with wrapping at the picture boundaries (thick boundaries, independent of the subpicture layout), as in case 3.

Case 3

|  |  |
| --- | --- |
|  |  |
|  | |
|  | |

The group seemed inclined to consider only the second of these three variations (case 2). The case just above and the case below would be prohibited:

Case 4

|  |
| --- |
| Wrap on |
| Wrap off |

For signalling, wrap is in the SPS and the wrap offset is signalled in the PPS.

AHG Recommendation (cleanup): Allow case 2 (only). Text was later provided in a -v2 revision and confirmed to be OK on Wednesday.

Discussion for AHG Session 1.15 ended on Monday 13 April at 1525 UTC.

### High level tool control (65)

#### Chroma deblocking *tc* and *β* offsets signalling (13)

[JVET-R0338](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9982) AHG9: A summary of proposals on chroma deblocking tc and β offsets signalling [Y.-K. Wang (Bytedance)]

Discussed in AHG Session 1.1 Monday 6 April at 1315 UTC (GJS & YKW).

This contribution intends to provide a summary of the 12 proposals on signalling of chroma deblocking tc and β offsets submitted to this JVET meeting by the 3 April 2020 submission deadline.

It is suggested that this summary, in terms of a list of design questions, is used for the reviewing of these proposals, such that the discussions can be in a more structured and efficient manner.

1. Skip the signalling of the chroma tc and β deblocking offset syntax elements (SEs) in the PPS when the chroma format is ( 4:0:0 or (4:4:4 and the separate color plane coding mode is in use) ) and/or when the parameter values for chroma are the same as for luma?
   1. Yes, (R0077, R0078, R0095, R0106, R0152, R0172, R0206, R0218, R0232), and condition the SEs on
      1. A new PPS flag for controlling the presence of chroma deblocking parameters (R0077, R0078, R0081, R0106, R0206)
      2. The existing pps\_chroma\_tool\_offsets\_present\_flag currently for controlling the presence of the QP offsets in the PPS (R0078, R0095, R0106, R0152, R0172, R0206, R0218, R0232) AHG Recommendation (cleanup): Recommended by AHG. (The editor may also consider renaming the flag.) If the flag is zero, the chroma offsets (if needed) are inferred from the luma offsets.
      3. ChromaArrayType (R0172)
   2. No. (R0048, R0079, R0081, R0232)
      1. Impose semantics constraints that values shall be equal to 0 when ChromaArrayType is equal to 0. (R0079, R0081, R0232)
2. Skip the signalling of the chroma tc and β deblocking offset syntax elements (SEs) in the PH and the SH when the chroma format is (4:0:0 or (4:4:4 and the separate color plane coding mode is in use) ) and/or when the parameter values for chroma are the same for luma?
   1. Yes, (all the 12 contributions), and condition the SEs on
      1. ChromaArrayType (R0048, R0078, R0079, R0081, R0095, R0106, R0152, R0172, R0206, R0218, R0232)
      2. A new PPS flag for controlling the presence of chroma deblocking parameters (R0077, R0078, R0106)
      3. The existing pps\_chroma\_tool\_offsets\_present\_flag currently for controlling the presence of the QP offsets in the PPS (R0078, R0152, R0232) AHG Recommendation (cleanup): Recommended by AHG. (The editor may also consider renaming the luma beta and tc offset control syntax elements.) If the flag is zero, the chroma offsets (if needed) are inferred from the luma offsets.
      4. A new PH flag and a new SH flag (R0081, R0206)
   2. No, but impose semantics constraints that values shall be equal to 0 when ChromaArrayType is equal to 0. (R0079, R0232)

[JVET-R0048](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9692) AHG9: On chroma deblocking parameters [C.-M. Tsai, C.-W. Hsu, S.-T. Hsiang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-R0077](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9721) AHG9: On chroma deblocking parameters signalling [J. Xu, L. Zhang, Y.-K. Wang, K. Zhang, Z. Deng (Bytedance)]

[JVET-R0078](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9722) AHG9: On signalling of deblocking parameters for coding monochrome pictures [H.-W. Sun, H.-B. Teo, C.-S. Lim (Panasonic)]

[JVET-R0079](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9723) AHG9: On signalling of chroma deblocking filter parameters for monochrome [T. Tsukuba, M. Ikeda, Y. Yagasaki, T. Suzuki (Sony)]

[JVET-R0081](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9725) AHG9: Chroma deblocking strength signalling [Z. Zhang, M. Pettersson, M. Damghanian, J. Enhorn, K. Andersson, J. Ström, R. Sjöberg (Ericsson)]

[JVET-R0095](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9739) AHG9: Clean-up of chroma deblocking control parameter signalling [M. G. Sarwer, Y. Ye, J. Luo, J. Chen (Alibaba)]

[JVET-R0106](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9750) AHG9: On Deblocking Control [S. Deshpande, J. Samuelsson, A. Segall, T. Zhou, T. Ikai (Sharp)]

Item 2 of this contribution belongs to this category.

[JVET-R0152](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9796) AHG9: On signalling of chroma deblocking offsets in monochrome picture [J. Choi, J. Choi, J. Heo, S. Yoo, J. Lim, S. Kim (LGE)]

[JVET-R0172](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9816) AHG9: Removed Redundant Coding of Chroma Deblocking Filter Parameters [K. Naser, F. Le Léannec, T. Poirier (InterDigital)]

[JVET-R0206](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9850) AHG9: Modified signalling of Chroma deblocking control parameters [A. M. Kotra, S. Esenlik, B. Wang, H. Gao, E. Alshina (Huawei)]

[JVET-R0218](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9862) AHG9: Decoding conditions of deblocking control parameters for chroma [K. Unno, K. Kawamura, S. Naito (KDDI)]

[JVET-R0232](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9876) AHG9: APS, LMCS, deblocking and PPS constraints [N. Hu, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

#### Deblocking control signalling - other aspects (5)

Discussion began here with AHG Session 1.8 on Tuesday 7 April at 2320 UTC (GJS & YKW).

[JVET-R0072](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9716) AHG9: On signalling of deblocking control [Z. Deng, Y.-K. Wang, L. Zhang, K. Zhang, J. Xu (Bytedance)]

Discussed in AHG Session 1.8 on Tuesday 7 April at 2320 UTC (GJS).

It is asserted that the deblocking control mechanism in the latest VVC text is pretty complicated, not straightforward, not easy to understand, and consequently prone to errors. This contribution proposes to change the deblocking signalling based on a 2-bit deblocking mode indicator in the PPS, summarized as follows:

* Replace the three PPS flags for deblocking signalling with a 2-bit deblocking mode indicator that specifies the following four modes: a) deblocking fully disabled and not used for all slices; b) deblocking used for all slices using 0-valued β and tC offsets; c) deblocking used for all slices using β and tC offsets explicitly signalled in the PPS; and d) deblocking further controlled at either picture or slice level.
* The two flags in PH/SH are renamed to be ph/slice\_deblocking\_filter\_used\_flag and ph/slice\_deblocking\_parameters\_override\_flag, with the use flag specifying whether deblocking is used for the current picture/slice, and the override flag specifying whether the β and tC offsets are overridden by the values signalled in the PH/SH.

There was discussion of the various cases described in the document.

It was commented that deblocking is the only case where a disabling in the PPS can be overridden at the picture level. Some participants said this is OK, as it enables PPS sharing, and noted that we have such an override in HEVC. Others said this is the only place in the text that allows a disabling to be overridden.

It was agreed that there is no clear bug in the current design, although it does appear that there are a number of editorial bugs in the current semantics of the text.

No clear need for action was identified by the AHG on this, so the AHG did not recommend action.

[JVET-R0183](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9827) AHG9: On deblocking control signalling [S. Paluri, Hendry, S. Kim (LGE)]

Discussed in AHG Session 1.8 (GJS & YKW).

This contribution asserted that the current signalling for deblocking filter control is complex and may be simplified. For example, the current design allows the deblocking to be disabled at the PPS level and then later to be enabled either in picture header or the slice header. It is asserted that such design may be confusing and make the signalling more difficult to understand.

This contribution proposed the following changes:

1. Signal a flag in the PPS, i.e., pps\_deblocking\_enabled\_flag to specify whether or not deblocking is enabled / applied to pictures that refer to the PPS.
2. When deblocking is enabled (e.g., the value of pps\_deblocking\_enabled\_flag is equal to 1, additional flags can be signalled as follows:
   1. pps\_deblocking\_override\_enabled\_flag, which is an existing flag.
   2. pps\_deblocking\_parameter\_present\_flag to specify whether the PPS deblocking parameter is present.

This is very similar in spirit to R0072, and is a smaller change.

No clear need for action was identified by the AHG on this, so the AHG did not recommend action.

[JVET-R0159](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9803) AHG9: On high level syntax of deblocking filter [J. Chen, J. Luo, Y. Ye, R.-L. Liao (Alibaba)]

Discussed in AHG Session 1.8 (GJS & YKW).

This contribution includes two syntax and semantics changes of deblocking filter (DBF) as follows.

* It is proposed to signal an SPS enabled flag for DBF as done for other loop filters. It was asked whether there are any other features that do not have an SPS-level enabling flag; CU QP delta and CU chroma QP delta enabling were noted. It was commented that the reason there is no such flag is because it was expected that bitstreams would generally have the DBF enabled (and there is no constraint flag for this). Another participant commented that we may have wanted to have control flags for things either in the SPS or PPS but not both. It was commented that in other in-loop filter cases, there is syntax in the PH that is gated by the SPS flag. No clear need for action was identified by the AHG on this, so the AHG did not recommend action.
* Fixing basically editorial bugs of the semantics of DBF control related syntax elements. AHG Recommendation (editorial BF): Adopt (with editor discretion on exact form of expression).

[JVET-R0106](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9750) AHG9: On Deblocking Control [S. Deshpande, J. Samuelsson, A. Segall, T. Zhou, T. Ikai (Sharp)]

Discussed in AHG Session 1.8 (GJS & YKW).

Item 1 of this contribution belongs to this category.

Proposal 1: It is proposed to move the signalling location of syntax element dbf\_info\_in\_ph\_flag to locate it near the other deblocking control parameters signalling.

This is a small proposed change to group together and logically nest the deblocking syntax in the PPS. AHG Recommendation (cleanup): Adopt.

Discussion stopped here for AHG Session 1.8 on Wednesday 8 April 0115 UTC.

[JVET-R0388](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10033) AHG9: Cleanups on deblocking signalling [Z. Deng, Y.-K. Wang, L. Zhang, K. Zhang, J. Xu (Bytedance)] [check for other docs marked late that were on time for the main meeting]

This contribution was discussed in JVET on Wednesday 22 April at about 0845 UTC (GJS).

After the categroy 1 AHG pre-meeting review of the contributions on deblocking signalling control, the proponents further studied the topic taking into account the AHG recommendation. It is asserted that 1) there are still some issues with the semantics that should be fixed, 2) there is a bug in the inference of the slice\_deblocking\_filter\_override\_flag, and 3) the feature of indicating an overriding operation in a picture header or a slice header and then immedaitely send the next bit in the same header to indicate a change of mind is a bit too weird and should be removed.

To address the above issues, this contribution proposes the following changes:

1. Change the semantics of the deblocking signalling control syntax elements as editorial improvement.
2. Infer slice\_deblocking\_filter\_override\_flag to be equal to 0 (instead of to be equal to ph\_deblocking\_filter\_override\_flag) when not present.
3. Skip the signalling of ph\_/slice\_deblocking\_filter\_disabled\_flag when pps\_deblocking\_filter\_disabled\_flag and ph/slice\_deblocking\_filter\_override\_flag are both equal to 1 and infer the value of ph/slice\_deblocking\_filter\_disabled\_flag to be equal to 0 under this condition.

For item 1, it was commented that it would be better to say “in the picture header or slice header” than “at the picture level or slice level”. Another participant said that the version from R0159 is more clear in terms of exactly how specific syntax element interact. This is an editorial matter that can be resolved by the editor.

It was commented and agreed that, as written, we cannot remove “in which slice\_deblocking\_filter\_disabled\_flag is not present” in the semantics of ph\_deblocking\_filter\_disabled\_flag.

Decision (sensibility cleanup): Adopt (with editorial matters to be resolved as noted above).

#### Quantization control signalling (6)

Discussion began here for JVET on 16 April at 0500 (UTC) (GJS, JRO, YKW).

[JVET-R0050](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9694) AHG9: HLS on dependent quantization and sign data hiding [S.-T. Hsiang, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

This contribution proposes five high-level syntax modifications related to dependent quantization and sign data hiding, summarized as follows:

1. When sps\_dep\_quant\_enabled\_flag is equal to 1, a new sequence parameter set (SPS) syntax element **sps\_dep\_quant\_enabled\_pic\_present\_flag** is further signalled to indicate whetherph\_dep\_quant\_enabled\_flag is present in the picture header.

Something similar is in R0258.

1. When sps\_sign\_data\_hiding\_enabled\_flag is equal to 1, a new SPS syntax element **sps\_sign\_data\_hiding\_enabled\_pic\_present\_flag** is further signalled to indicate whetherpic\_sign\_data\_hiding\_enabled\_flag is present in the picture header.

Items 1 and 2 propose to add 2 flags to the SPS to conditionally remove 2 flags in the PH.

The proponent said we have similar presence flags for signalling DMVR, BDOF and PROF. Each of these has a presence flag in the SPS and a conditionally present flag in the PH.

It was asked whether we have a general approach in such situations.

It was asked whether there is a proposal to move the control from the PH to the SH.

There had been other discussions on similar proposed change, for example, about LMCS and scaling lists (see notes for R0404) to save SH bits with SPS gating flags, and such proposed gating flags had not been added.

TSRC is related, and the interaction of TSRC with SDH/DQ is a more important question to be resolved. R0049 discusses TSRC and proposes controlling an SH flag with an SPS flag.

Some participants supported this (not removing the conditional signalling within the SPS) due to the argument for consistency with the approach for DMVR, BDOF and PROF.

Was reviewed in JVET session Fri 24 0750, after consideration of TSRC/DQ/SDH issues..v3 of the doc was shown which included two possible syntax expressions. Method 1 is introducing two new SPS level flags separately, Method 2 introduces a single SDS flag which indicates if either DQ or SDH is enabled. In this follow-up discussion, several experts raised concern that there is no obvious reason introducing new SPS flags for saving one bit at slice level.

No action.

1. pic\_sign\_data\_hiding\_enabled\_flag is renamed as ph\_sign\_data\_hiding\_enabled\_flag. This is only editorial.
2. Simplification of deriving the variable signHidden by setting the value of signHidden equal to 0 if pic\_sign\_data\_hiding\_enabled\_flag is equal to 0 in the syntax table (editorial only).
3. Signal sps\_dep\_quant\_enabled\_flag and sps\_sign\_data\_hiding\_enabled\_flag independently but dependent quantization and sign data hiding are still mutually exclusive for each picture.

SDH and DQ cannot both be used at the same time. The contribution removes a presence condition for one of these flags in the SPS. The proposed syntax would allow some pictures to use SDH and others to use DQ in the same CLVS, which is not currently allowed and which was agreed not to be desirable, so no action was taken on this.

It was commented that there are also other proposals relating to HLS for these features (e.g., R0116).

[JVET-R0068](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9712) AHG8/AHG9/AHG12: Miscellaneous HLS topics [Y.-K. Wang, L. Zhang, Z. Deng, J. Xu, K. Zhang, K. Fan (Bytedance)]

Item 7 of this contribution belongs to this category. The contribution proposes to change the syntax name of (pps\_)init\_qp\_minus26 to init\_qp\_minus32 and update the semantics accordingly.

In HEVC the QP range is from −QpBDoffset to 51, so 26 is approximately the midpoint for 8 bit video.

In VVC the QP range is from −QpBDoffset to 63. For 10 bit video this is −12 to 63.

It was commented that the typical QP in VVC is also a little higher than in HEVC.

It was noted that there is a 37 in the proposed semantics that should be 31.

It was commented that the same change had been proposed in L0553 and had not been adopted for the same reason as noted above.

There was some discussion of what we think the typical QP would be for use of VVC.

It was agreed not to take action on this.

[JVET-R0073](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9717) AHG9: Some cleanups on QP delta signalling [Z. Deng, L. Zhang, Y.-K. Wang, J. Xu, K. Zhang (Bytedance)]

This contribution proposes the following changes on QP delta signalling, asserted to make the design more consistent between luma and chroma for CU-level and picture/slice-level QP delta signalling:

1. Regarding the CU-level luma QP delta control, it is proposed to:
   1. Add a slice-level on/off control flag (named cu\_qp\_delta\_enabled\_flag) for CU luma QP delta, and condition the presence based on the PPS-level on/off control flag. This would allow the encoder to send QP deltas at the CU level for some slices and not others.

It was noted that chroma QP ordinarily tracks luma QP and was remarked that the overhead for sending QP deltas when they are all zero-valued seems low (they are arithmetically coded and may be as infrequent as one per CTU or they can use a smaller region basis as selected by the encoder).

The proponent said that under some circumstances we have slice-level control of whether there are chroma QP offsets at the CG level without having slice-level control of whether there are luma QP offsets at the CG level. Another participant commented that this may be desirable for HDR, and another commented that the purpose of local luma QP control and local chroma QP control are somewhat different.

Another participant commented that the local chroma QP offsets are likely to be less frequently used than for luma. Another said that chroma QP offset usage might be only for content adaptive purposes and not used in some slices.

No action was agreed to be take on this.

* 1. Rename the PPS-level on/off control flag to be pps\_cu\_qp\_delta\_enabled\_flag for clearer wordings.
  2. Resolve an asserted error in the semantics of pps\_cu\_qp\_delta\_enabled\_flag by using it to specify the presence of cu\_qp\_delta\_abs and cu\_qp\_delta\_sign\_flag in both the transform unit syntax and the palette coding syntax.

Decision (expression of existing intent): The error identified in “c” should be corrected, and the editor should also consider the suggestion in “b”.

1. Regarding the picture/slice-level chroma QP offsets signalling:
   1. Signal the picture-level chroma QP offsets (named ph\_cb\_qp\_offset, ph\_cb\_qp\_offset, and ph\_joint\_cbcr\_qp\_offset).
   2. Add a PPS switch flag (named chroma\_qp\_offset\_info\_in\_ph\_flag) to control whether to signal the chroma QP offsets in picture or slice-level (but never both).
   3. Rename the PPS present flag to be pps\_chroma\_qp\_offsets\_present\_flag and use it to condition the presence of picture/slice level chroma QP offsets.

It was noted that the purpose of the luma and chroma controls are somewhat different since the luma changes are tracked by the chroma changes as a bit rate control functionality. That is different from the purpose of the chroma QP control, which is for just controlling an offset used when tracking luma or for very localized control.

Currently, chroma QP offsets are sent in the PPS or SH, but not the PH.

The luma QP delta is sent at the PH or SH.

R0272 and R0302 were said to be similar.

Since the purpose of the control functionality is different for the luma and chroma controls, it was not agreed that there is a need for changing the way these work to make them more similar, and no action was thus taken on this.

1. Regarding the picture/slice-level luma QP delta signalling:
   1. Add an on/off control flag in the PPS (named pps\_luma\_qp\_delta\_present\_flag) to condition the presence of picture/slice level luma QP delta.

See the notes above; no action was taken on this.

[JVET-R0076](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9720) AHG9: Chroma QP mapping table cleanups [J. Xu, L. Zhang, Y.-K. Wang, K. Zhang, Z. Deng (Bytedance)]

This contribution proposes the following HLS changes to chroma QP mapping tables:

1. Change qp\_table\_start\_minus26 to qp\_table\_start and update the semantics accordingly.

This would allow the table to start in the negative range, but the proponent said there would be no desire to have an offset in this range. The coding of this would be unsigned rather than signed as currently.

This table is sent in the SPS.

There seemed to be no need for action on this.

1. Change num\_points\_in\_qp\_table\_minus1 to num\_points\_in\_qp\_table and update the semantics accordingly. num\_points\_in\_qp\_table equal to 0 indicates that for each QpY QpChroma is equal to QpY.

There is no shortcut for an identity mapping. The way to signal that is to send 0 for the val\_minus1 and 1 for the diff\_val. This is done in the VTM (there had been a bug in this, which has been fixed). The proponent said this is not very intuitive and would prefer that if no pivot points are sent, an identity mapping is inferred.

It was commented that similar proposals had previously been discussed with no action taken, and that it was undesirable to add more special cases, and that the reference software can help inform people of what to do, so no action was taken on this.

1. Use separate chroma QP mapping tables for I slices and B/P slices.

Currently, our CTC uses different tables for AI versus RA/LB/LP. They are not very different, and it was commented that these had probably not really been optimized. This may have been to try to have some offset to balance the dual tree gain for chroma. The difference appeared to be very minor (off by one QP value in part of the range). Lower-level chroma QP offset can alternatively be used for a very similar effect if desired. There seemed to be no clear need for action on this, so no action was taken.

It was commented that we should check the luma/chroma balance used in the CTC and consider using offsets to adjust that.

[JVET-R0489](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10151) Cross-check of JVET-R0076 (AHG9/AHG15: Chroma QP mapping table cleanups) [A. K. Ramasubramonian (Qualcomm)] [late]

[JVET-R027](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9916)2 AHG9: On chroma QP offsets in picture header [K. Misra, J. Samuelsson, S. Deshpande, F. Bossen, A. Segall (Sharp)]

See the notes above for R0073.

[JVET-R0302](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9946) AHG12: On signalling of chroma QP [L. Li, X. Li, B. Choi, S. Wenger, S. Liu (Tencent)]

See the notes above for R0073.

Discussion stopped here for JVET on 16 April at 0815 (UTC) (GJS, JRO, YKW).

#### High-level control of features that use APSs: LMCS, scaling lists, and ALF (23)

Discussion began here in AHG Session 1.16 on Monday 13 April at 1540 (GJS & YKW).

Follow-up discussion in JVET on 23 April 1520 (JRO)

[JVET-R0404](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10049) AHG9: A summary of proposals on high level control of LMCS, Scaling list, ALF and SAO [L. Zhang, Y.-K. Wang (Bytedance)]

Discussed in AHG Session 1.16 (GJS).

This contribution intends to provide a summary of the 21 proposals on high level control of LMCS, scaling list, ALF and SAO submitted to this JVET meeting by the 3 April 2020 submission deadline.

It is suggested that this summary, in terms of a list of design questions, is used for the reviewing of these proposals, such that the discussions can be in a more structured and efficient manner.

**For high-level control and semantics changes of LMCS, the following aspects are proposed:**

1. Controlling of presence of the SH LMCS enabled flag slice\_lmcs\_enabled\_flag
   1. Conditionally add a new SPS SE to indicate whether slice\_lmcs\_enabled\_flag is present, and when not present, infer the value to be equal to the PH LMCS enabled flag. ([JVET-R0051](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9695))

This is to save a flag at the slice header level if all slices have LMCS enabled if the PH has LMCS enabled.

It was commented that saving a bit at the SH level doesn’t seem especially important for LMCS, so no action was taken on this.

* 1. Replace the PH flag ph\_lmcs\_enabled\_flag with a 2-bit ph\_lmcs\_mode\_idc, with 3 modes specified: disabled (mode 0), used for all slices (mode 1), and enabled (mode 2); and only signal slice\_lmcs\_enabled\_flag for mode 2. ([JVET-R0063](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9707))

This is similar in spirit to item a, but using a bit at the PH level instead of at the SPS level to distinguish the cases.

It was commented that saving a bit at the SH level doesn’t seem especially important for LMCS, so no action was taken on this.

* 1. Skip the signalling of the SH LMCS enabled flag for the case when the PH is in the SH. ([JVET-R0089](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9733), [JVET-R0098](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9742), [JVET-R0210](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9854), [JVET-R0200](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9844), [JVET-R0202](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9846))

AHG Recommendation (cleanup): Adopt. Text is in R0098 and software will be provided by that proponent.

* 1. Move the SH flag slice\_lmcs\_enabled\_flag to be just after the ALF parameters ([JVET-R0200](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9844)) so that the header information for LMCS is grouped in a similar way as in the picture header. (It was commented that there may also be another parsing simplification from this.)

AHG Recommendation (cleanup): Adopt.

1. Slice-level control of chroma residual scaling (currently only controlled in the PH).
   1. Remove the PH control flag (ph\_chroma\_residual\_scale\_flag) and add one flag in SH. (method 1 of [JVET-R0096](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9740), method 2 of [JVET-R0171](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9815))
   2. Add a control flag in slice level under the condition "if( slice\_lmcs\_enabled\_flag  &&  ph\_chroma\_residual\_scale\_flag )". (proposal 2 of [JVET-R0089](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9733), method 2 of [JVET-R0096](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9740), method 1 of [JVET-R0171](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9815))

Currently, luma and chroma processing are switched on and off together at the SH level. This would enable controlling them separately.

The proposed chroma flag would only be sent if the luma flag is turned on.

It was commented that we generally have separate control of chroma at the same degree of local level as luma. Others commented that LMCS was brought in as a single tool and the design is somewhat unified (with the balance between luma and chroma somewhat maintained by changing chroma together with luma) and they thought currently logical.

In the absence of sufficient support, no action was recommended on this.

1. Add a constraint to disable chroma residual scaling of LMCS for pictures within a GDR period ([JVET-R0393](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10038)).

The proponent indicated that enabling the chroma scaling can cause a GDR “leak”.

It was asked whether there would be a leak if the virtual boundary is at a CTU boundary. The proponent responded that this would not cause a leak.

It was commented that another approach could be to just add a NOTE to caution the reader that enabling chroma residual scaling could cause a GDR problem if there is a virtual boundary that is not aligned with a CTU boundary. AHG Recommendation (Ed.): It is suggested to add such a NOTE. The editor is requested to consider this. (No normative effect.)

1. Revised semantics (italics for report emphasis only):
2. Change the semantics of sps\_lmcs\_enabled\_flag equal to 1 to use the wording of "may be used" instead of "is used". ([JVET-R0051](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9695), [JVET-R0160](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9804))

**sps\_lmcs\_enabled\_flag** equal to 1 specifies that luma mapping with chroma scaling *may be* used in the CLVS. sps\_lmcs\_enabled\_flag equal to 0 specifies that luma mapping with chroma scaling is not used in the CLVS.

1. Revise the current semantics of ph\_lmcs\_enabled\_flag to the following: ([JVET-R0051](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9695), [JVET-R0160](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9804), [JVET-R0210](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9854))

**ph\_lmcs\_enabled\_flag** equal to 1 specifies that luma mapping with chroma scaling *may be* enabled *for slices* associated with the PH. ph\_lmcs\_enabled\_flag equal to 0 specifies that luma mapping with chroma scaling *is* disabled for *all* slices associated with the PH. When not present, the value of ph\_lmcs\_enabled\_flag is inferred to be equal to 0.

1. Revise the current semantics of ph\_chroma\_residual\_scale\_flag to the following:

* **ph\_chroma\_residual\_scale\_flag** equal to 1
  + 1. specifies that chroma residual scaling *may be* enabled for slices associated with the PH. ([JVET-R0051](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9695), [JVET-R0160](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9804))
    2. specifies that chroma residual scaling is enabled for all slices associated with the PH *and whether it is applied for each slice is further controlled by the slice\_lmcs\_used\_flag signalled in the slice header*. ([JVET-R0063](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9707))
* **ph\_chroma\_residual\_scale\_flag** equal to 0
  + 1. ph\_chroma\_residual\_scale\_flag equal to 0 specifies that chroma residual scaling *is disabled for all* slices associated with the PH. ([JVET-R0051](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9695), [JVET-R0063](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9707), [JVET-R0160](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9804))

1. Change the semantics of slice\_lmcs\_enabled\_flag equal to 1 to use the wording of "luma mapping is enabled for the current slice and chroma scaling may be enabled for the current slice" instead of "luma mapping with chroma scaling is enabled for the current slice" ([JVET-R0160](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9804)):

**slice\_lmcs\_enabled\_flag** equal to 1 specifies that *luma mapping* is enabled for the current slice and *chroma scaling may be enabled for the current slice*. slice\_lmcs\_enabled\_flag equal to 0 specifies that luma mapping with chroma scaling is not enabled for the current slice. When slice\_lmcs\_enabled\_flag is not present, it is inferred to be equal to 0.

AHG Recommendation (Ed. BF / expression of existing intent): Agreed as detailed above (editor has discretion over exact expression).

AHG Recommendation (Ed.): It is suggested to remove “one, more, or all” phrases in the text.

Discussion ended here for AHG Session 1.16 on 13 April at 1715.

Discussion began here for JVET on 15 April at 0600 (UTC) (GJS, JRO, YKW).

**The following design questions on high level control of scaling lists were proposed:**

1. Controlling of presence of the SH explicit scaling list enabled flag slice\_explicit\_scaling\_list\_used\_flag
2. Conditionally add a new SPS SE to indicate whether slice\_explicit\_scaling\_list\_used\_flag is present, and when not present, infer the value to be equal to the PH explicit scaling list enabled flag. ([JVET-R0051](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9695))

It was commented that saving a bit at the SH level doesn’t seem especially important for explicit scaling lists, so no action was taken on this.

1. Replace the PH one-bit flag by a 2-bit ph\_explicit\_scaling\_list\_mode\_idc, with 3 modes specified: disabled (mode 0), used for all slices (mode 1), and enabled (mode 2). and only signal slice\_explicit\_scaling\_list\_used\_flag for mode 2. ([JVET-R0064](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9708))

It was commented that saving a bit at the SH level doesn’t seem especially important for explicit scaling lists, so no action was taken on this.

1. Skip the signalling of the SH explicit scaling list enabled flag for when the PH is in the SH. ([JVET-R0089](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9733), [JVET-R0098](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9742), [JVET-R0202](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9846))

Decision (cleanup): Adopt. Text is in R0098 and software will be provided by that proponent.

1. Move the SH flag slice\_explicit\_scaling\_list\_used\_flag to be just after the ALF parameters (but after slice\_lmcs\_enabled\_flag). ([JVET-R0200](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9844)) so that the header information for explicit scaling lists is grouped in a similar way as in the picture header. (It was commented that there may also be another parsing simplification from this.)

Decision (cleanup): Adopt.

**For high level control and semantics changes of ALF/SAO, the following aspects are proposed:**

1. Control ALF and SAO at SPS, PH (on/off control, ALF APS information for ALF) and SH level (on/off control) and remove the slice level ALF parameter adaptation. ([JVET-R0160](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9804))

Currently, we allow the ALF APS ID to be either at the PH level or slice level (but not both). This is different from how LMCS and scaling lists are handled, which has the APS ID only at the PH level (with lower level on/off).

It was asked whether there was a reason that we got into this position where we have this sort of difference between the level of control of these different features.

Some test results were provided in R0149, showing that the ALF flexibility is useful for distributed encoding (e.g., 4% for 512×512 subpictures), assuming ALF would be disabled entirely for all subpictures if the parameters cannot change on a subpicture basis.

It was commented that coordinated encoding would probably not be feasible for real-time distributed encoding, although perhaps ALF could be used in just one subpicture and not the others.

It was commented that table size is more of a problem for LMCS, such that would make it more difficult to allow multiple parameters within a picture for LMCS than for ALF.

ALF allows indication of more than one APS in the SH or PH with selection between them at the CTU level. The CTC uses the CTU-level switching capability.

It was commented that from an implementation perspective it may not matter whether multiple ALF parameters are sent in the PH or the same number of them is used at the SH level, and sending them at the SH level seems more friendly to BEAM applications.

No clear need for action was identified for this, and the current flexibility seems useful for BEAMing, so no action was taken on this.

1. Indication of chroma ALF
   1. Use two separate flags (one for Cb, one for Cr) to replace ph\_alf\_chroma\_idc in PH and slice\_alf\_chroma\_idc in SH. ([JVET-R0225](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9869))

The functionality is not proposed to be changed, just the signalling.

It was asked whether this proposed change is purely editorial or not. It seemed to be purely editorial, except for the order of the bits. We usually signal Cb first, then Cr, and that is what this is proposing.

Decision (cleanup): Adopt (as a non-editorial matter, this is just a swap of the bit order).

1. Indication of CC-ALF
   1. Use two separate SEs (alf\_ctb\_cc\_cb\_flag and alf\_ctb\_cc\_cr\_idx) to replace alf\_ctb\_cc\_cb\_idc in CTU level. ([JVET-R0225](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9869))

This is different in concept from the previous item above.

The motivation is to make it more clear what is happening. It was commented that this is a low-level normative change, not really a matter of HLS, as it affects CABAC parsing. It takes one syntax element that is coded as ae(v) and makes it into two syntax elements that are coded differently. No test results were provided.

No action was taken on this.

1. In PH/SH, add a constraint such that if CCALF is disabled in SPS, an ALF\_APS cannot contain any CCALF filters. ([JVET-R0232](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9876) section 3.2)

It was discussed whether, editorially, the location of the constraint should be different from what is proposed.

Decision (cleanup): Adopt this aspect.

1. Revised semantics (italics for report emphasis only):
2. Change the semantics of ph\_alf\_enabled\_flag equal to 0 to use the wording of "is disabled for all slices" instead of "may be disabled for one, or more, or all slices" ([JVET-R0068](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9712), [JVET-R0251](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9895))

**ph\_alf\_enabled\_flag** equal to 0 specifies that adaptive loop filter *is* disabled for *all* slices associated with the PH. ([JVET-R0068](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9712))

ph\_alf\_enabled\_flag *being present and* equal to 0 specifies that adaptive loop filter *is* disabled for *all colour components* in *all* slices associated with the PH. When not present, ph\_alf\_enabled\_flag is inferred to be equal to 0. ([JVET-R0251](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9895))

(The phrase “being present” is noted to be necessary for proper expression of this.)

It was commented that it seems undesirable to infer the value 0 for ph\_alf\_enabled\_flag if it is possible for slice\_alf\_enabled\_flag to be equal to 0 in that case. It was suggested to rephrase the semantics to avoid this inference.

It was also commented, and agreed, that we should also avoid having a value of a syntax element that means something different when it is inferred versus what it would mean if it is present.

1. Change the semantics of sps\_alf\_enabled\_flag equal to 1 to use the wording of "may be enabled" instead of "is enabled" ([JVET-R0160](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9804)):

**sps\_alf\_enabled\_flag** equal to 0 specifies that the adaptive loop filter is disabled. sps\_alf\_enabled\_flag equal to 1 specifies that the adaptive loop filter *is* enabled.

1. Change the semantics of sps\_sao\_enabled\_flag equal to 1 to use the wording of "may be applied" instead of "is applied" ([JVET-R0160](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9804)):

**sps\_sao\_enabled\_flag** equal to 1 specifies that the sample adaptive offset process *may be* applied to the reconstructed picture after the deblocking filter process. sps\_sao\_enabled\_flag equal to 0 specifies that the sample adaptive offset process is not applied to the reconstructed picture after the deblocking filter process.

AHG Recommendation (Ed. BF / expression of existing intent): Agreed as detailed above (editor has discretion over exact expression).

**For APS related aspects, the following are proposed:**

1. Move scaling\_matrix\_for\_lfnst\_disabled\_flag from the scaling\_list\_data( ) syntax to the SPS. ([JVET-R0064](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9708))

The current location of the flag allows a scaling matrix with LFNST to be used in some pictures and not others.

Decision (cleanup): Adopt.

1. Parameter set updating, cross-layer sharing, and decoding order of APSs
   1. Update to the content of an ALF APS NAL unit within a PU is allowed. ([JVET-R0070](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9714))

See the notes for the next item.

* 1. Allow update of the content of an ALF APS NAL unit between subpictures of a PU. ([JVET-R0149](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9793))

The motivation for this and the previous item is basically to increase the number of ALFs that can be applied within a single picture (currently limited to 8).

An example use case is with 96 subpictures.

Each ALF APS takes about 512 bytes, so 8 of them take 4k bytes.

It was discussed that some decoders may either process the data in a different order from the parsing order or may perform ILF stages as a separate pass. All ALF parameters for the entire picture may need to be stored.

It was noted that re-using APSs across different pictures would be less feasible if encoders are forced to re-use the same indices within a picture.

It was commented that if the encoders are coordinated well, there may not really need to be entirely separate ALF parameters for each subpicture.

Given the substantial memory impact, at least for some decoder architectures, the methods proposed in these contributions were not supported.

It was suggested to consider a constraint on the total memory used (or the number of filters in the APSs – there are up to 25 luma and 8 chroma filters in one APS) rather than the number of APSs, since the amount of memory used by an APS depends on its content. JVET-R0480 is a late contribution containing such a proposal.

Discussion stopped here on Wednesday 15 April at 0915 (UTC).

Discussion started here for JVET on 16 April at 0820 (UTC) (GJS, JRO, YKW).

* 1. Sharing of an APS NAL unit across layers is proposed to be disallowed. ([JVET-R0070](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9714)). The usefulness of the sharing was asserted to be questionable, and disallowing sharing could potentially simplify semantics and extraction and multilayer concepts.

It was commented that multiview might be a case where sharing may sometimes feasible, and noted that the number of APSs is limited (4 for LMCS, 8 for ALF and scaling lists, with all layers sharing the same value space). Updating of PSs is allowed between PUs but not within PUs.

It was commented that we already have sharing for SPSs and PPSs, so it should not be too difficult to express in semantics.

It was commented that R0194 discusses PS sharing issues.

Given the discussion and the limited number of APSs allowed, no action was taken on this.

* 1. Add the following constraints: When both one or more prefix APS NAL units and one or more suffix APS NAL units are present between two consecutive VCL NAL units in decoding order, the VCL NAL units shall belong to different subpictures and all the suffix APS NAL units shall precede, in decoding order, all the prefix APS NAL units. ([JVET-R0149](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9793))

No action was needed on this due to the lack of action on items “a” and “b”.

* 1. To constrain suffix APS NAL units to be located after the last VCL NAL unit of the PU. ([JVET-R0201](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9845))

It was discussed whether all constraints to enable random access functionality need to be in the VVC standard itself or some of them need to be specified somewhere else.

Discussion stopped here for JVET on 16 April at 0915 (UTC). Subsequent discussions were from Thu 23 April 1525 in JVET (chaired by JRO)

* 1. To allow prefix and suffix APS NAL units with particular APS identifier and type to have different content. ([JVET-R0201](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9845))
  2. To constrain prefix APS NAL unit to be located before the first VCL NAL unit of the PU. ([JVET-R0201](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9845))

Was again discussed Thu 23 April after offline study. It was confirmed by independent experts that an issue exists, and that all three constraints are necessary to resolve the issue.

Decision (cleanup): Adopt JVET-R0201 (all three constraints)

1. Signalling APS information in PH/SH
   1. Add additional signalling of alf\_data()/scaling\_list\_data()/lmcs\_data() in SH or PH, and add a constraint such that all presence flags of ALF/Scaling list/LMCS in SH shall be 1 when no\_aps\_constraint\_flag is equal to 1. ([JVET-R0180](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9824))
   2. Add a mode of directly including the APS data structure inside a PH NAL. ([JVET-R0273](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9917))

It is not clear what the benefit would be. The no\_aps\_constraint\_flag introduced in the last meeting introduces the problem that an encoder uses it cannot use the related tools any more. It is therefore suggested to introduce another place of signalling the information carried in APS either in the picture header or in the slice. It is noted that eve when not using APS ALF could still be used at least with fixed filters.

The introduction of multiple mechanisms to signal the same information might overburden the specification for the benefit of very specific bit streams.

The opinion was also expressed that one intent seems to be coding efficiency. Several experts expressed concerns about introducing this. There were also concerns raised that aspects might be complicated. No support was expressed by non-proponents. No action.

1. Constraint for APS types:
   1. Add a constraint for APS type based on the enabled tools in SPS. If a tool that uses an APS is disabled, then the APS with the corresponding APS type should not be present in a bitstream. ([JVET-R0232](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9876) section 2)

There is no problem if an encoder sends an APS even if the related tool is disabled. On contrary, it might even inhibit cases where an APS which was sent in a stream before could re-used later. No action.

1. Constraint for alf\_data in ALF APS:
   1. Add a constraint to CC-ALF based on sps\_ccalf\_enabled\_flag. When sps\_ccalf\_enabled\_flag is equal to 0, an ALF\_APS cannot contain any CCALF filters. ([JVET-R0232](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9876) section 3.1)

Same comment as under 4) – if CCALF parameters are in an APS but never used there is no problem with the decoding. No action.

1. Remove BitDepth constraint for lmcs\_data in LMCS APS ([JVET-R0232](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9876) section 7, it is noted that JVET-R0433 includes this – no need to discuss separately according to proponents):

**lmcs\_delta\_cw\_prec\_minus1** plus 1 specifies the number of bits used for the representation of the syntax lmcs\_delta\_abs\_cw[ i ]. The value of lmcs\_delta\_cw\_prec\_minus1 shall be in the range of 0 to *14*, inclusive.

PH:

**ph\_lmcs\_aps\_id** specifies the adaptation\_parameter\_set\_id of the LMCS APS that the slices associated with the PH refers to. The TemporalId of the APS NAL unit having aps\_params\_type equal to LMCS\_APS and adaptation\_parameter\_set\_id equal to ph\_lmcs\_aps\_id shall be less than or equal to the TemporalId of the picture associated with PH.

*The value of lmcs\_delta\_cw\_prec\_minus1 of the APS NAL unit having aps\_params\_type equal to LMCS\_APS and adaptation\_parameter\_set\_id equal to ph\_lmcs\_aps\_id shall be in the range of 0 to BitDepth – 2, inclusive.*

[JVET-R0051](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9695) AHG9: HLS on LMCS and scaling list [S.-T. Hsiang, Z.-Y. Lin, C.-Y. Lai, O. Chubach, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-R0063](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9707) AHG9: Signalling of LMCS control [L. Zhang, Y.-K. Wang, K. Zhang (Bytedance)]

[JVET-R0064](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9708) AHG9: Signalling of scaling list control [Y.-K. Wang, L. Zhang, K. Zhang (Bytedance)]

[JVET-R0068](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9712) AHG8/AHG9/AHG12: Miscellaneous HLS topics [Y.-K. Wang, L. Zhang, Z. Deng, J. Xu, K. Zhang, K. Fan (Bytedance)]

Item 4 of this contribution belongs to this category.

[JVET-R0089](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9733) AHG9: On slice level control of LMCS and explicit scaling list [J. Jung, D. Kim, G. Ko, J.-H. Son, J. S. Kwak (WILUS)]

[JVET-R0096](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9740) AHG9: On signalling of chroma residual scaling [M. G. Sarwer, Y. Ye, J. Luo, J. Chen (Alibaba)]

[JVET-R0098](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9742) AHG9: On Slice Header Signalling of LMCS and Scaling Lists Information [ S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

[JVET-R0070](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9714) AHG9: On repetition and update of non-VCL data units [Y.-K. Wang, L. Zhang, Z. Deng (Bytedance)]

Items 4 and 5 of this contribution belongs to this category.

This relates to R0149 and R0201 aspects 2 and 3.

[JVET-R0149](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9793) AHG9/AHG12: Relaxing an APS constraint [M. M. Hannuksela, M. Homayouni, A. Hallapuro, A. Aminlou (Nokia)]

This relates to R0070 and R0201 aspects 2 and 3.

[JVET-R0201](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9845) AHG9: On prefix and suffix APSs [N. Ouedraogo, G. Laroche, P. Onno (Canon)]

[JVET-R0160](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9804) AHG9: High level syntax cleanup for LMCS, ALF and SAO [J. Chen, J. Luo, M. G. Sarwer, Y. Ye, R.-L. Liao (Alibaba)]

[JVET-R0171](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9815) AHG9: Slice-Level Chroma Residual Scaling Flag [K. Naser, E. François, F. Hiron, C. Chevance (InterDigital)]

[JVET-R0180](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9824) AHG9: On ALF, LMCS and Scaling List Parameters Signalling [K. Naser, F. Le Léannec, T. Poirier, P. de Lagrange (InterDigital)]

[JVET-R027](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9917)3 AHG9: APS signalled in picture header [V. Seregin, M. Coban, Y. He, M. Karczewicz (Qualcomm)]

[JVET-R0200](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9844) AHG9: APS information signalling in Slice Header [G. Laroche, N. Ouedraogo, P. Onno (Canon)]

The first aspect (on slice\_lmcs\_enabled\_flag) of item 2 of this contribution belongs to this category.

[JVET-R0202](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9846) AHG9: Syntax cleanups when Picture Header is in the Slice Header [G. Laroche, N. Ouedraogo, P. Onno (Canon)]

The slice\_lmcs\_enabled\_flag and slice\_explicit\_scaling\_list\_used\_flag aspects of item 1 of this contribution belong to this category.

[JVET-R0210](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9854) AHG9: Cleanup of Picture Header Syntax Structure in Slice Header [S. Esenlik, B. Wang, A. Kotra, E. Alshina (Huawei)]

The slice\_lmcs\_enabled\_flag aspect this contribution belongs to this category.

[JVET-R0225](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9869) AHG9: On ALF/CC-ALF high level syntax [X.W. Meng (PKU), X. Zheng (DJI), S.S. Wang, S.W. Ma (PKU)]

[JVET-R0232](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9876) AHG9: APS, LMCS, deblocking and PPS constraints [N. Hu, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

All aspects excluding the deblocking aspect of this contribution belong this this category.

[JVET-R0251](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9895) AHG9: Fixes related to the picture header [M. Pettersson, R. Sjöberg, M. Damghanian, Z. Zhang, J. Enhorn (Ericsson)]

Item 2 of this contribution belongs to this category.

[JVET-R0393](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10038) AHG9: On LMCS for GDR [L. Wang, S. Hong, K. Panusopone, M. M. Hannuksela (Nokia)] [late]

[JVET-R0462](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10124) Crosscheck of JVET-R0393 (AHG9: On LMCS for GDR) [T. Ikai (Sharp)] [late]

[JVET-R0480](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10142) AHG9: Restricted maximum numbers of ALF and CC-ALF filters [L. Zhang, Y.-K. Wang, K. Zhang, Z. Deng (Bytedance)] [late]

Was presented Thu 23 April 1615

This contributions proposes the following aspects regarding restrictions of the maximum numbers of ALF and CC-ALF filters:

1. Replace the constraints on the number of ALF APSs with constraints on the number of filters, more specifically, the following constrain are proposed to be added:

The total number of adpative loop filter classes for luma component, the total number of alternative filters for chroma components, and the total number of cross-component filters in all APS NAL units for a PU shall be less than or equal to 200, 64, and 64, respectively.

1. On top of item 1), further change the coding of the APS ID in the APS syntax from u(5) to u(v), with the length being 9, 2, and 3, respectively for ALF, LMCS, and scaling list APSs, respectively.
2. On top of item 1), further change the coding of ALF APS indices and the number of ALF APSs in PH and SH from u(v) to ue(v).

In v2, the total number of adaptive loop filter classes for luma component in all APS NAL units for a PU is restricted to be less than or equal to 128 instead of 200.

It was commented that the proposal appears too flexible. The number of APS should be somewhat restricted, not be set to the maximum number of filters theoretically possible. Usage of ue(v) is also undesirable, could become quite large. It is furthermore not clear if there would not indeed be impact on low-level design (mapping table), and what the impact on the prediction would be.

Not clear what the benefit for coding efficiency would be, or if not even some overhead penalty might occur when the APSs come with low number of filters.

Too much changes at this late stage. Might introduce more issues than it solves. Needs further study.

No action

#### High level control of other tools (17)

See R0097 on luma transform size larger than 32×32 with transform skip (aspect #2 overlaps with R0049). There is also a relevant ticket #1024 about this (a fortuitous ticket number for a 32×32 issue). Move its notes to this section?

Discussion started here in the JVET plenary on 19 April at 1415 (UTC) (GJS & JRO).

Continued in JVET Thu 23 Apr. 1645 (chaired by JRO)

[JVET-R027](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9915)1 AHG9: High-level constraints of dependent quantization and sign data hiding [A. Nalci, M. Coban, M. Karczewicz (Qualcomm)]

[This was previously in the notes between R0258 and R0317. Add notes to clarify when it was initially reviewed.]

This was initially reviewed in Track B and was later moved here from section 5.4.1 since it is an HLS signalling issue.

In 17th JVET meeting, a slice level flag “slice\_ts\_residual\_coding\_disabled\_flag” was adopted into VVC as part of JVET-Q0089 for lossless coding. This flag can bypass transform skip residual coding (TSRC) regardless of the residual type and transform or regular residual coding (RRC) is used for TS blocks. Since TS blocks can now be coded with RRC, dependent quantization (DQ) and sign data hiding (SDH) can introduce undesired behavior as pointed in Ticket #981, lossy results for lossless coding and potential coding loss. In this proposal several high-level aspects are proposed to alleviate this issue.

In variant #1, signalling of **slice\_ts\_residual\_coding\_disabled\_flag** based on the picture level flags **ph\_dep\_quant\_enabled\_flag** and **pic\_sign\_data\_hiding\_enabled\_flag** is disallowed such that, if either flag is 1 then TS blocks always use TSRC.

In variant #2, the picture header flags **ph\_dep\_quant\_enabled\_flag** and **pic\_sign\_data\_hiding\_enabled\_flag** are first moved to slice header and signaling of slice level DQ and SDH flags are done depending on the **slice\_ts\_residual\_coding\_disabled\_flag.** If **slice\_ts\_residual\_coding\_disabled\_flag=1** DQ and SDH flags are not signaled and inferred as 0.

In variant #3, the picture header flags ph\_dep\_quant\_enabled\_flag and pic\_sign\_data\_hiding\_enabled\_flag are moved to slice header before slice\_ts\_residual\_coding\_disabled\_flag and the signalling of slice\_ts\_residual\_coding\_disabled\_flag are conditioned on these flags. In this case, if slice\_ts\_residual\_coding\_disabled\_flag=0 then DQ and SDH are automatically turned off at the slice level.

In variant #4, picture header flags **ph\_dep\_quant\_enabled\_flag** and **pic\_sign\_data\_hiding\_enabled\_flag** are moved to slice header (as in variant #2) however no signalling constraint is enforced. These tools can be turned off at the slice level (using config settings) to ensure lossless coding.

Variant #4 is identical with R0155 as presented.

Variant #3 is another option that was also mentioned in R0155 (but not presented).

Variant #1 is identical with R0153 aspect 2 method 2, and R0325

Variant #4 seems to be the most straightforward solution to resolve the coding efficiency problem of mixed lossy/lossless coding (where we don’t even know how severe that problem is). Definitely, there is nothing broken in the current spec, but software needs to be fixed wrt to DQ context derivation.

On the other hand, variant #3 (and also variant #2, which is spending 1 more bit in typical case) would at the same time resolve the issues brought in context of combining BDPCM and SDH. The same problem would probably exist when BDPCM was combined with DQ (which is not exercised in current software).

Decision (text/SW): Adopt JVET-R0271 variant #3

This also resolves the problem of text/software mismatch wrt to using DQ context derivation in TS/RRC coding.

[JVET-R0049](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9693) AHG9: HLS on disabling TSRC [S.-T. Hsiang, C.-W. Hsu, Z.-Y. Lin, T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

This contribution and related contributions were initially reviewed in AHG the Category 2 pre-meeting as reported in JVET-R0340, then in a JVET plenary on Sunday 19 April. The notes were moved here from section 5.4.1 since this is an HLS topic.

In VVC Draft 8, extra bit costs are consumed for signalling the new syntax element slice\_ts\_residual\_coding\_disabled\_flag for each of the coded slices. This contribution proposes three methods for high-level syntax modifications related to disabling transform skip residual coding, as follows:

* In Method 1, a new syntax element sps\_ts\_residual\_coding\_disabled\_slice\_present\_flag is added to the sequence parameter set (SPS) to specify whether slice\_ts\_residual\_coding\_disabled\_flag is present in the slice header.
* In Method 2, two new syntax elements sps\_ts\_residual\_coding\_disabled\_slice\_present\_flag and sps\_ts\_residual\_coding\_disabled\_slice\_default\_flag are added to the SPS. When slice\_ts\_residual\_coding\_disabled\_flag is not present, it is inferred to be equal to the value of sps\_ts\_residual\_coding\_disabled\_slice\_default\_flag.
* In Method 3, signalling slice\_ts\_residual\_coding\_disabled\_flag in the slice header is conditioned on sps\_transform\_skip\_enabled\_flag equal to 1 without adding any new syntax element.

Method 1 same is in JVET-R0097.

Method 3 same as in JVET-R0097, JVET-R0068 (item 8) plus inference to 1 for slice\_ts\_residual\_coding\_disabled\_flag, JVET-R0142, JVET-R0317 without the PPS flag, JVET-R0153 aspect 1, JVET-R0182 with inverse semantics.

The motivation behind method 1 is to not signal slice\_ts\_residual\_coding\_disabled\_flag for lossy coding cases, which are considered to be the main application.

It was commented that at the last meeting, slice\_ts\_residual\_coding\_disabled\_flag was adopted as a slice level flag instead of PPS or SPS flag. This would not prevent syntax as proposed here to gate its presence.

A participant questions whether the additional control syntax to save the signalling of slice\_ts\_residual\_coding\_disabled\_flag is really needed. Functionality is not affected by any of the proposed methods.

It was agreed that it is desirable to not always send slice\_ts\_residual\_coding\_disabled\_flag since it is expected to only be used for lossless coding scenarios.

It was further agreed that it makes sense to condition slice\_ts\_residual\_coding\_disabled\_flag on sps\_transform\_skip\_enabled\_flag (Method 3).

Method 3 as discussed (in combination with R0271):

SPS: sps\_transform\_skip\_enabled\_flag

SH: if( sps\_transform\_skip\_enabled\_flag && !( sh\_SDH  | |  sh\_DQ) )

slice\_ts\_residual\_coding\_disabled\_flag

Method 1 as discussed (in combination with R0271):

SPS: sps\_transform\_skip\_enabled\_flag

SPS: if( sps\_transform\_skip\_enabled\_flag )

sps\_ts\_residual\_coding\_disabled\_flag

SH: if( !sps\_ts\_residual\_coding\_disabled\_flag && !( sh\_SDH  | |  sh\_DQ ) )

slice\_ts\_residual\_coding\_disabled\_flag

Method 1 would allow an encoder to disable TSRC completely (e.g., if it only want to support one kind of residual coding). Method 3 would not allow this unless it also enables SDH or DQ.

We don’t want the combination of SDH/DQ enabled with TS enabled and TSRC disabled.

Variant 2 of R0271 was also discussed.

It was requested for offline work with proponents of R0049 and R0271 and document submission for a clear similar syntax description and truth table analysis of combinations of variants 2 and 3 of R0271 with methods 1 and 3 of R0049. See documents R0483, R0485, R0486 which were submitted later.

uses of interest: lossy and lossless regions, with

* lossy & lossless screen content regions
* lossy & lossless camera-captured content

The plenary session of 19 April stopped here at 1500.

[JVET-R0483](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10145) AHG9: Combination of JVET-R0049 and JVET-R0271 [M. G. Sarwer, Y. Ye, J. Luo, J. Chen (Alibaba), A. Nalci, M. Coban, H. E. Egilmez, M. Karczewicz (Qualcomm), S. T. Hsiang, C. W. Hsu, Z. Y. Lin, T. D. Chuang, O. Chubach, C. Y. Chen, Y. W. Huang, S. M. Lei ( MediaTek), T. C. Ma, X. Xiu, Y. W. Chen, H. J. Jhu, X. Wang ( Kwai), S. Yoo, J. Choi, J. Lim, S. Kim (LGE), Z. Deng, Y. K. Wang, L. Zhang, K. Zhang (ByteDance), K. Naser, F. L. Léannec, T. Poirier, M. Kerdranvat (InterDigital), T. Hashimoto, E. Sasaki, T. Aono, T. Ikai (Sharp), J. Gan (Canon)] [late]

Discussed in JVET Thu 23 April 1645 UTC

Abstract: This contribution combines method 1 and method 3 of JVET-R0049 with variation 2 and variation 3 of JVET-R0271.

It can be seen from the truth tables that any of the combinations allows whatever an encoder would like to support in combinations, and disallowing the “problematic” combination.

Variation 2 vs. variation 3:

* Variation 2 signals SDH/DQ dependent on TSRCdis
* Variation 3 signals TSRCdis depending on SDH/DQ.

There is no real advantage of one over the other. So we could stick to the method that was initially thought to be preferable, which is var. 3

About method 1 vs. method 3, it is unclear whether method 1 is suggested to just disable the presence of the slice level flag with another SPS flag, or if it disables TSRC entirely. The method from R0049 suggests just disabling the flag, but it is said that there is another contribution R0182, which is disabling TSRC at SPS entirely.

As there is no consensus on the latter issue, and method 3 has minimum amount of changes, the combination M3 from R0049 and V3 from R0271 are the preferable option.

This answer precisely what was asked for in the plenary session –

Decision (cleanup): Adopt JVET-R0483 Combination 4

Discussion closed here Thu 23 April 1735. Subsequent docs to be discussed Fri. 24 Apr. morning. From the discussion, it appears that those are doing something more than originally requested.

[JVET-R0485](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10147) AHG9: Combination of JVET-R0049 and JVET-R0271 with Inverse Semantics and improved SPS signaling [K. Naser, F. Le Léannec, T. Poirier, M. Kerdranvat (InterDigital)] [late]

Similar to JVET-R0483, this contribution also combines method 1 of JVET-R0049 with variation 2 and variation 3 of JVET-R0271. However, the new added SPS flag for controlling TSRC is considering as described in the meeting notes (d6) “sps\_ts\_residual\_coding\_disabled\_flag” instead of “sps\_ts\_residual\_coding\_slice\_disabled\_present\_flag”. It is asserted that this changes the semantics of the new added flag changes also the number of bits signaled at SH when the same analysis is performed as in JVET-R0483. This document provides also further analysis about the all possible combinations that can be exercised by the encoder.

Presented Friday 24 April 0530 UTC.

The contribution proposes to introduce an SPS flag that disables TSRC at sequence level.

Several experts said they would not support such a change. No consensus could be reached.

No action was taken on this.

[JVET-R0486](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10148) On TSRC, DQ and SDH signalling [J. Samuelsson, S. Deshpande, F. Bossen, A. Segall, T. Hashimoto, E. Sasaki, T. Aono, T. Ikai (Sharp), A. Nalci, H.E. Egilmez, M. Karczewicz (Qualcomm), S. T. Hsiang, C. W. Hsu, Z. Y. Lin, T. D. Chuang, O. Chubach, C. Y. Chen, Y. W. Huang, S. M. Lei (MediaTek), M. G. Sarwer (Alibaba)] [late]

This contribution presents a proposal for high level signalling of Transform Skip Residual Coding (TSRC), Dependent Quantization (DQ) and Sign Data Hiding (SDH). It is asserted that the proposed changes minimize the impact on the existing design and avoids increasing the number of syntax elements signalled in Slice Header for common cases, in comparison to other proposals being discussed at the 18th JVET meeting (such as the combination of JVET-R0049 and JVET-R0271). The key aspect of the proposal is to derive variables to determine if DQ and SDH is used in a slice while keeping the flags for enabling/disabling DQ and SDH in the picture header. Version 2 of the document fixes a typo in the conclusions. Version 3 of the document fixes an incorrect sentence in the introduction section and adds additional authors to the document. Version 4 of the document updates the patents rights declaration. Version 5 of the document adds additional authors. Version 6 shows change marks compared to -v5-clean and adds additional authors. The -v5 version is also included in the zip file showing all changes compared to the first version of the document.

Presented Friday 24 April at 0500 UTC (JRO).

It is proposed to keep the enabling flags for DQ/SDH in PH, and introduce variables which ar either set to the value of the enabling flags, or turn those tools off in slices where TSRC is disabled.

Furthermore, it is proposed to use method 1 from R0049.

It is pointed out that this would require a slight re-design of low level (storing the variable rather than using the flags directly). This might however not be a big problem.

It is commented that the main advantage might be a slight saving of bits in SH.

Another expert comments that switching DQ/SDH on and off at slice level is not needed by other use cases rather than mixed lossy/lossless coding.

One expert points out that the approach may be more difficult to understand in the spec.

Some concern was raised whether the approach would still be consistent when the SPS flag was removed.

There was no good reason to override the decision made about R0483 which completely solves the problem.

No action was taken on this.

[JVET-R0068](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9712) AHG8/AHG9/AHG12: Miscellaneous HLS topics [Y.-K. Wang, L. Zhang, Z. Deng, J. Xu, K. Zhang, K. Fan (Bytedance)]

Discussion started here in JVET Track A on 21 April at 1300 (UTC) (GJS, JRO, YKW).

Items 3, 8, and 9 of this contribution belong to this category.

Item 3 proposes to change the semantics of sps\_affine\_amvr\_enabled\_flag equal to 1 to use the wording of "may be used" instead of "is used".

Decision (editorial bug fix): Adopt (clarify that this has “one way” semantics).

Editor action item: There should be a general review of the word “may”, for wording consistency and clarity – e.g., whether it expresses permission.

See notes under JVET-R0049 which is equivalent on item 8.

Item 9 proposes to signal five\_minus\_max\_num\_affine\_merge\_cand instead of five\_minus\_max\_num\_subblock\_merge\_cand when sps\_affine\_enabled\_flag is equal to 1, and MaxNumSubblockMergeCand is derived as a sum of the maximum allowed number of sbTMVP candidates and the maximum allowed number of affine candidates.

Only when affine is enabled is “five\_minus\_max\_num\_subblock\_merge\_cand” signalled. The proponent said this seemed confusing.

Another participant said that this parameter is needed only when affine is enabled, and there is not really a problem here that needs to be solved. If affine is not enabled, the number of candidates is known to be 1.

Another participant commented that this could create a situation where the number of affine merge candidates is signalled to be 0 but affine mode will be used, which seems too strange.

JVET-R0068 aspect 9, JVET-R0215, R0371, and R0373 are related.

See the notes for R0371.

[JVET-R0215](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9859) AHG9: Max num of subblock merge candidate signalling [R. Yu, M. Pettersson, R. Sjöberg, M. Damghanian, Z. Zhang, J. Enhorn (Ericsson)]

In the current VVC draft specification version 8, the maximum number of subblock based merging motion vector prediction candidates is signalled in the SPS by the five\_minus\_max\_num\_subblock\_merge\_cand syntax element which is present when sps\_affine\_enabled\_flag is equal to 1. It is reported that currently the value of five\_minus\_max\_num\_subblock\_merge\_cand is restricted to be in the range of 0 to 5, inclusive.

It is asserted that such restriction allows an undesired scenario where five\_minus\_max\_num\_subblock\_merge\_cand may be set equal to 5 when sps\_affine\_enabled\_flag is set equal to 1. In this scenario, the subblock merging candidate number becomes 0, which turns off merge for affine as well as for subblock temporal motion vector prediction (SbTMVP) regardless of the values of the SbTMVP enabling flags.

The contribution proposes two alternatives for avoiding the claimed undesired scenario.

1. Alternative 1 proposes to change the range restriction of the syntax element five\_minus\_max\_num\_subblock\_merge\_cand to be in the range of 0 to 5 − sps\_affine\_enabled\_flag, inclusive. It is further proposed to infer the value of five\_minus\_max\_num\_subblock\_merge\_cand to 5 when it is not present.
2. Alternative 2 proposes to signal the maximum affine merge candidate number when sps\_affine\_enabled\_flag is set to 1. It is further proposed to derive the maximum number of subblock candidates MaxNumSubblockMergeCand in the picture header as a sum of the value of the SbTMVP enabling flags and the maximum affine merge candidate. The derivation process of the subblock merging candidate list is also modified to make sure that the number of affine merge candidate that appears in the final candidate list does not exceed the signalled maximum affine merge candidate number.

The proponent suggested to focus on alternative #1.

One participant said that the current specification is not necessarily a problem and suggested that it would be sufficient to add a NOTE to explain that in one case, subblock merge cannot be used since it has no candidates (when five\_minus\_max\_num\_subblock\_merge\_cand is equal to 5, no subblock merge candidate is available even though the SPS indicates that subblock merge candidates are enabled).

The signalling method in R0068 would avoid the unusual case.

See the notes for R0371.

[JVET-R0371](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10015) AHG2/9: On max num of subblock merge candidates [H. Huang, J. Chen, W.-J. Chien, M. Karczewicz (Qualcomm)]

In the contribution JVET-R0215, it is reported that the current VVC draft allows an undesired scenario where five\_minus\_max\_num\_subblock\_merge\_cand may be set equal to 5 when sps\_affine\_enabled\_flag is set equal to 1, which turn off the subblock temporal motion vector prediction (SbTMVP) even the values of the SbTMVP enabling flags are true. In this contribution, an alternative solution with minimum text change is proposed. In the proposed method, the range of five\_minus\_max\_num\_subblock\_merge\_cand is set to 0 to 5 − sps\_sbtmvp\_enabled\_flag, inclusive.

Editorially, the proposed text has an inference rule that was said to be incorrect and unnecessary and should be deleted.

It was said that this proposal doesn’t change the current functionality.

This is equivalent to R0373 method 2.

Decision (cleanup to avoid strange encoder behaviour): Adopt R0371 (without the inference rule).

[JVET-R0373](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10017) AHG9: On Maximum Number of Subblock Merge Candidates Y.-C. Yang, C.-Y. Teng (Foxconn) [late]

This proposes two approaches to similar issues as in other contributions above.

* Method 1:
  + **five\_minus\_max\_num\_subblock\_merge\_cand** specifies the maximum number of subblock-based merging motion vector prediction candidates supported in the SPS subtracted from 5. The value of five\_minus\_max\_num\_subblock\_merge\_cand shall be in the range of 0 to 4, inclusive.
  + MaxNumSubblockMergeCand is always greater than 0 when affine is enabled.
* Method 2:
  + **five\_minus\_max\_num\_subblock\_merge\_cand** specifies the maximum number of subblock-based merging motion vector prediction candidates supported in the SPS subtracted from 5. When sps\_sbtmvp\_enabled\_flag is equal to 1. The value of five\_minus\_max\_num\_subblock\_merge\_cand shall be in the range of 0 to 4, inclusive. When sps\_sbtmvp\_enabled\_flag is equal to 0. The value of five\_minus\_max\_num\_subblock\_merge\_cand shall be in the range of 0 to 5, inclusive.
  + MaxNumSubblockMergeCand can be set to 0 when affine is enabled.
  + MaxNumSubblockMergeCand is always greater than 0 when SbTMVP and picture TMVP are enabled.

The proponent said Method 2 was identical to R0371.

It was asked whether the flexibility of enabling affine but disabling affine merge is useful. One participant said this is a useful combination since it could avoid a pipeline issue in the encoder (needing availability of neighbours) while allowing affine to be used and achieving most of the gain of this mode.

See the notes for R0371.

[JVET-R0150](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9794) AHG9/AHG12: Moving joint chroma coding sign flag from picture header to slice header [M. M. Hannuksela, J. Lainema (Nokia)]

This contribution proposes to move ph\_joint\_cbcr\_sign\_flag from the picture header to the slice header. It is asserted that the proposed change enables encoders to set joint chroma coding residual sign adaptively in applications that perform subpicture extraction and merging.

It was commented that coordinated encoding is assumed in the BEAM scenario, encoding settings are coordinated, and there are a number of other features that could hypothetically be different in different picture headers.

No action was thus taken on this.

[JVET-R0214](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9858) AHG9: MMVD syntax modifications [R. Yu, M. Pettersson, R. Sjöberg, M. Damghanian, Z. Zhang, J. Enhorn (Ericsson)]

This contribution proposes the following modifications to the syntax related to merge mode with motion vector difference (MMVD) in the VVC draft specification version 8:

1. Move the location of sps\_fpel\_mmvd\_enabled\_flag to directly follow sps\_mmvd\_enabled\_flag. It is claimed that this modification makes the specification text cleaner as it groups together the MMVD related syntax elements in the SPS.

Cleanup to group related things together.

1. Infer the value of sps\_fpel\_mmvd\_enabled\_flag to be equal to 0 when the flag is not present. It is reported that the current specification text does not specify the value of sps\_fpel\_mmvd\_enabled\_flag when the flag is not present. It is asserted that the current specification text is broken since an unspecified value of sps\_fpel\_mmvd\_enabled\_flag would make the presence of ph\_fpel\_mmvd\_enabled\_flag in the picture header undetermined.

Editorial spec bug fix.

1. Add a no\_mmvd\_constraint\_flag in general\_constraint\_info(). When this flag is equal to 1, sps\_mmvd\_enabled\_flag shall be equal to 0. It is claimed that MMVD is a relative substantial inter coding feature. A constraint flag that allows indicating that such a feature is not used in the bitstream is claimed to be desirable to have.

Extra constraint flag. Instead it was suggested to replace/rename the current flag no\_fpel\_mmvd\_constraint\_flag to no\_mmvd\_constraint\_flag and change the semantics accordingly.

Decision (cleanup): Adopt (all aspects) with change of flag rather than additional flag as above.

Discussion stopped here in JVET Track A on 21 April at 1515 UTC.

[JVET-R0097](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9740) AHG9: Transform and transform-skip related HLS clean-up [M. G. Sarwer, Y. Ye, J. Luo, J. Chen (Alibaba)]

Aspect 1 of this was initially discussed in Track B on Saturday 18 April, and the notes were then moved here to be better categorized.

This contribution proposes two aspects to clean up the signaling of sps\_max\_luma\_transform\_size\_64\_flag and slice\_ts\_residual\_coding\_disabled\_flag.

* In aspect 1, if the luma CTB size is not larger than 32, sps\_max\_luma\_transform\_size\_64\_flag is not signalled and inferred to be 0.
* In aspect 2, two methods are proposed to reduce the signaling overhead of slice\_ts\_residual\_coding\_disabled\_flag in slice header.
  + Method 1: an SPS level flag is introduced to indicate the presence of slice\_ts\_residual\_coding\_disabled\_flag in the bitstream. The proposed SPS level flag is signalled if the sps\_transform\_skip\_enabled\_flag is equal to 1.
  + Method 2: if the sps\_transform\_skip\_enabled\_flag is equal to 0, slice\_ts\_residual\_coding\_disabled\_flag is not signalled and inferred to be 0.

Moved here from AHG cat. 2 discussions and recommendations of track B

See notes under JVET-R0049 for aspect 2.

Aspect 1 was presented Sat 18 Apr. It is proposed to replace the existing bitstream constraint by a syntax constraint. This was asserted to be cleaner from LL perspective and is suggested to be adopted from the side of track B – was further discussed in Sunday plenary and agreed. Decision (cleanup): Adopt JVET-R0097 aspect 1.

It is mentioned that also a ticket #1024 was issued that pointed out a conformance stream violating the bit stream constraint.

[JVET-R0142](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9786) AHG9: Slice header signalling clean up [T. Hashimoto, T. Aono, T. Ikai (Sharp)]

See notes under JVET-R0049 – this contribution is equivalent.

[JVET-R0182](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9826) AHG9: Removed Redundant Slice Level TSRC Flag [K. Naser, F. Le Leannec, T. Poirier, M. Kerdranvat (InterDigital)]

See notes under JVET-R0049.

The subsequent documents of this category were discussed Friday 24 April 0540-0640 UTC (chaired by JRO).

[JVET-R0216](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9860) AHG9: Signalling the parallel merge level relative to the minimum coding block size [R. Yu, M. Pettersson, R. Sjöberg, M. Damghanian, Z. Zhang, J. Enhorn, J. Ström (Ericsson)]

In the current VVC draft specification, the minimum luma coding block size is specified in the SPS. The allowed range for the minimum luma coding block size is from 4 to Min( 64, CTU size ). In the Brussels JVET meeting, a parallel merge mechanism was adopted in VVC. The mechanism allows parallel derivation of merge candidate lists for blocks within a certain size of a region, which is also referred to as the parallel merge level. The parallel merge level is signaled in the SPS and it indicates the size of the region wherein parallel merge is possible. The allowed range for the parallel merge level is from 4 to the CTU size.

It is reported in this contribution that the current specification allows signalling of the parallel merge level to be smaller than the minimum coding block size, which is asserted to be confusing and unnecessary. It is therefore proposed to signal the parallel merge level relative to the minimum coding block size. It is claimed that the proposed signalling cleans up the signalling of the parallel merge level and brings some minor bit-savings.

R0237 is related. See further notes there.

No action.

[JVET-R0237](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9881) AHG9: Constraints based on the minimum coding block size [K. Zhang, L. Zhang, Y.-K. Wang, Z. Deng, Y. Wang, J. Xu, H. Liu (Bytedance)]

In the current VVC text, there are some cases that assertedly cause contradition or confusion considering MinCbSizeY:

1. The maximum allowed block size for transform skip may be smaller than MinCbSizeY.
2. log2\_parallel\_merge\_level\_minus2 may be smaller than log2\_min\_luma\_coding\_block\_size\_minus2.
3. The coding tools MTS, LFNST, SBT, ISP can only be applied to blocks smaller than a size, which may be smaller than MinCbSizeY.

Four constraints are proposed in this contribution to address the problems above:

1. It is constrained that the maximum allowed block size for transform skip cannot be less than MinCbSizeY.
2. It is constraend that log2\_parallel\_merge\_level\_minus2 must be greater than or equal to log2\_min\_luma\_coding\_block\_size\_minus2.
3. It is constrained that sps\_transform\_skip\_enabled\_flag and sps\_mts\_enabled\_flag must be equal to 0 when MinCbSizeY is greater than 32.
4. It is constrained that sps\_lfnst\_enabled\_flag, sps\_sbt\_enabled\_flag, and sps\_isp\_enabled\_flag must all be equal to 0 when MinCbSizeY is greater than MaxTbSizeY.

The constraint 2) is trying solving the same inconsistency as R0216. It prevents signalling values that would be overridden somehow later, and therefore the syntax is redundant.

It is however pointed out that there is no benefit for the decoder. Several experts expressed concerns if these specific changes would even give benefit for an encoder.

No action was taken on this.

[JVET-R0252](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9896) AHG9: On high-level signalling of mvd\_l1\_zero\_flag [M. Pettersson, R. Yu, R. Sjöberg, M. Damghanian, Z. Zhang, J. Enhorn, D. Liu (Ericsson)]

This contribution proposes to move mvd\_l1\_zero\_flag from the picture header back to the slice header. It is claimed that having mvd\_l1\_zero\_flag in the slice header provides the same flexibility as in HEVC and may be useful when RPL information is different between slices, such as for subpictures with different random access points.

The contribution also proposes a claimed editorial fix to replace mvd\_coding( x0, y0, 1 ) by mvd\_coding( x0, y0, 1, cpIdx ) in the semantics for mvd\_l1\_zero\_flag.

This would be beneficial mainly for compression performance in case of mixing subpictures from different origin.

JVET-R0137 item 2 proposes the same (with somewhat different formulation of the condition).

Several experts expressed that this is only beneficial for a very specific use case. Nothing is broken in the current concept.

No action on moving mvd\_l1\_zero\_flag to slice.

Decision (ed. BF/text): JVET-R0252 semantics cleanup aspect.

[JVET-R0137](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9781) On mvd\_l1\_zero\_flag and NoBackwardPredFlag [T. Chujoh, E. Sasaki, T. Ikai (Sharp)]

Item 2 of this contribution belongs to this category.

In this contribution, some solutions for two problems of current VVC Draft 8 have been proposed. One problem is that there is no specification of the variables ColPic and NoBackwardPredFlag and the other problem is that mvd\_l1\_zero\_flag is specified in only picture header even if reference picture list structure can be changed on slice header. Two solutions for the first problem have been shown Option 1 is that the variable ColPic as the almost same as that of HEVC is defined and a new variable IdenticalDirectionalFlag which is replaced to previous NoBackwadPredFlag is specified by using the decoding process for symmetric motion vector difference reference indices. Option 2 is that the variables ColPic and NoBackwadPredFlag as the same as that of HEVC are defined. Also, two solutions for the second problem have been shown. Option 1 is that the change of enabling condition of symmetric motion vector difference and mvd\_l1\_zero\_flag by the variable IdenticalDirectionalFlag and option 2 is that mvd\_l1\_zero\_flag is specified in the picture header or in the slice header by the syntax element rpl\_info\_in\_ph\_flag exclusively. Neither proposal changes the results of the CTC.

See notes under R0252. No action necessary as the move of the mvd\_l1\_zero\_flag to SH is not desirable.

[JVET-R0258](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9902) AHG9: Reduce redundant signalling in picture header [J. Enhorn, M. Pettersson, R. Sjöberg, M. Damghanian, Z. Zhang (Ericsson)]

Excluding the ph\_dep\_quant\_enabled\_flag aspect of item 1, all other aspects of this contribution belong to this category.

This document contains two proposals claimed to reduce the picture header bit count. The proponents claim that the total number of PH+SH bits for RA has increased by approximately 22% from VTM-7.0 to VTM-8.0. Note that picture headers were implemented first in VTM-8.0. The following two modifications are proposed:

1. Add three SPS flags sps\_temporal\_mvp\_ph\_present\_flag, sps\_fpel\_mmvd\_ph\_present\_flag and sps\_dep\_quant\_ph\_present\_flag to control the presence of ph\_temporal\_mvp\_enabled\_flag, ph\_fpel\_mmvd\_enabled\_flag and ph\_dep\_quant\_enabled\_flag in the picture header. (normative)
2. Set sps\_bdof\_pic\_present\_flag, sps\_dmvr\_pic\_present\_flag and sps\_prof\_pic\_present\_flag to 0 in the CTC RA. The proponents claim that the values for the corresponding flags controlled by these flags do not change in the CTC. (encoder only)

The proponents point out that the two proposed modifications may be considered for adoption independently from each other.

The proponents claim that the two changes together would reduce the total number of picture header bits for the CTC RA bitstreams by 12%.

It was expressed that in case of multiple slices, VTM would probably have less header bits in total than HM. The PH was introduced exactly for the benefit of saving header bits in the multiple slice case. In case of single slice in a picture, saving header bits is not so important.

No support by other experts. No action.

[JVET-R0287](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9931) AHG9: On high level control parameters [H. Huang, Y.-J. Chang, M. Coban, W.-J. Chien, V. Seregin, M. Karczewicz (Qualcomm)]

The contribution proposes the following changes on high level tool control syntax elements.

1. Signal qtbtt\_dual\_tree\_intra\_flag in PH for dual-tree on/off control
2. Signal log2\_transform\_skip\_max\_size\_minus2 with u(2) used for the maximum block size used for transform skip.

It is claimed that for some sequences the picture based control of dual tree provides compression benefit (not in CTC) for I-frame only coding. Some other opinion was raised that usage of dual tree is more commonly controlled at sequence level. No action.

It is further proposed to change the signalling of log2\_transform\_skip\_max\_size\_minus2 from ue(v) to u(2) for saving one bit in SPS. It is howeer pointed out that the ue(v) code may have less bits in the most common case. No action on this.

### General and misc. HLS topics (9)

Discussion started here for AHG Session 1.9 on Wednesday 8 April at 1300 UTC (GJS & YKW).

[JVET-R0041](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9685) AHG8/AHG9: On picture types and related constraints [Y.-K. Wang (Bytedance), R. Sjöberg, M. Pettersson, M. Damghanian, Z. Zhang, J. Enhorn, R. Yu (Ericsson)]

Discussed in AHG Session 1.9 (GJS).

This contribution proposes some changes related to definitions of the terms "associated IRAP picture", "associated GDR picture", and "trailing picture" and the constraints regarding different types of pictures and their relationships in terms of decoding order, output order, and prediction relationship.

The proposed changes are summarized as follows:

1. The definition of associated GDR picture is added and the definition of associated IRAP picture is updated, such that each picture of a layer, except the first picture in the layer in the bitstream, is specified to be associated with the previous IRAP or GDR picture of the same layer in decoding order, whichever is closer.
2. The definition of trailing picture is updated, such that a trailing picture may also be associated with a GDR picture.
3. The following existing constraints are updated such that they only impose restrictions to pictures within the same layer:
   1. On the output order of pictures preceding an IRAP picture in decoding order
   2. On the decoding order of pictures associated with an IRAP picture and some non-leading pictures
   3. On RPLs for a CRA picture
4. Constraints for an STSA picture, in terms of relative decoding order, output order, and prediction relationship with the associated IRAP picture and the same-layer pictures in the preceding and succeeding AUs, are specified, similarly as a trailing picture.
5. Similar constraints for IRAP pictures and the same-layer pictures in the preceding and succeeding AUs in terms of relative decoding order, output order, and prediction relationship are specified for GDR pictures.

It was suggested to explicitly distinguish a “single-layer bitstream” from a “multi-layer bitstream”. As proposed, there may not be a need for such a distinction.

Some action is needed in this area; this is basically filling in gaps and proposing bug fixes for expression of the existing technical intent; no new functionalities are introduced.

Contribution R0226 is related.

It was commented that there may need to be some further cleanup regarding mixed NAL unit types; there are other contributions on that issue.

It was commented that it may be desirable to find a way to simplify / unify the discussions of GDR and IRAP if feasible (esp. if the recovery POC count is zero for the GDR).

It was noted that GDR characteristics are less restricted than IRAP, e.g. in regard to IRAP. The proponent said they had not intended to add constraints to GDR pictures, beyond what is necessary.

It was noted that various definitions depend on NAL unit types, and this could make the definitions difficult to comprehend outside the context of the document (a characteristic preferred by ISO editing guidelines).

AHG Recommendation: Adopt. (Further offline review is encouraged, and interacting aspects with other contributions remain in need of consideration.). See future details in the notes for JVET-R0226.

[JVET-R0226](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9870) AHG9: Proposal to change the definition of trailing picture [R. Sjöberg, M. Pettersson, M. Damghanian, Z. Zhang, J. Enhorn, R. Yu (Ericsson)]

Discussed in AHG Session 1.9 (GJS & YKW).

The proponents of this proposal assert that STSA pictures are trailing pictures in HEVC but not in VVC, and that the rules for trailing pictures therefore do not apply for STSA pictures. It is proposed to include STSA pictures in the group of trailing pictures so that the rules do apply also for STSA pictures.

The proponents also claim that bitstreams starting with a GDR picture may contain pictures that do not have any associated IRAP picture and that the current VVC draft disallows the use of TRAIL\_NUT pictures for this case. The proponents believe that TRAIL\_NUT pictures should be allowed for pictures that do not have any associated IRAP picture.

The proposal is summarized as:

* Include STSA pictures and pictures with no associated IRAP picture into the trailing picture type.
* Only allow pictures having an associated IRAP picture to be “leading pictures”.
* Condition the conformance requirements regarding relationships between trailing pictures and associated IRAP pictures to only apply to trailing pictures that do have an associated IRAP picture.
* Add the following rule: “Any picture that precedes a GDR picture in decoding order shall precede the GDR picture in output order”

It was questioned whether “trailing picture” is a good term if there are cases where this picture is not trailing anything else.

A difference with R0041 is that this associates a trailing picture with the most recent IRAP, whereas R0041 associates it with the most recent picture that is either an IRAP or GDR picture. The intent here is to have as few restrictions as possible that apply around a GDR picture. This was further discussed as noted below

Can a trailing picture reference a RADL picture (a RADL of an IRAP)? No (although there is a trick for one picture corresponding to a field coding case). This is the same in R0041 and R0226 (and HEVC).

Both contributions allow a picture that follows a GDR picture in output order to refer to another picture that follows the GDR picture in decoding order that precedes the GDR picture in output order (in a way that is not allowed if the GDR picture was an IRAP picture).

Both this contribution and R0041 constrain a picture that precedes a GDR picture in decoding order to also precede it in output order. It was discussed whether such a constraint should apply only after the recovery point is reached. ThisThis was also further discussed as noted below.

This was further discussed on Thursday 23 April at 1415. The two questions noted for further discussion were resolved in a -v2 revision of R0041, such that a picture is associated with the closest preceding IRAP or GDR picture in decoding order.

Two options for preventing gaps in the output following a GDR were described. Option 1 would not allow an “output gap” in picture output, while option 2 would allow this. It was remarked that if the display is using “dirty pictures” whether output judder exists or not is under control of the encoder, so option 2 seemed preferred.

This includes a sensibility constraint that when a picture is not a leading picture of an IRAP picture, it shall not be a RADL or RASL picture.

Decision (cleanup / expression of existing intent): Adopt R0041-v2 with option 2 for the output gap aspect.

[JVET-R0267](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9911) AHG9/AHG12: On mixed NAL unit types [Y. He, M. Coban, V. Seregin, A.K. Ramasubramonian, M. Karczewicz (Qualcomm)]

Discussed in JVET Track A on 20 April at 1430 (GJS & YKW).

Item 3 belongs in this category.

This item was moved here since it seemed more relevant to this subject area.

Add the following constraint (R0267)?

When the current picture is an IDR picture and sps\_idr\_rpl\_present\_flag is equal to 1, there shall be no picture referred to by an entry in RefPicList[ 0 ] or RefPicList[ 1 ] that precedes, in output order or decoding order, any preceding IRAP picture in decoding order (when present).

It was noted that we have this constraint for CRA pictures, so the existing constraint could just be generalized to apply to all IRAP pictures (simply replacing CRA with IRAP when expressing the constraint). The possibility of generalizing clause 8.3.2 to also produce (empty) RPLs for IDR pictures regardless of the value of the flag was also discussed. These editorial matters are left to the discretion of the editor.

Decision (editorial bug fix in expression of existing intent): Adopt this constraint (rephrased to account for multilayer context).

Discussion of this in JVET Track A ended on 20 April at 1440.

[JVET-R0065](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9709) AHG8/AHG9: On IRAP and GDR AUs [Y.-K. Wang (Bytedance)]

This was initially discussedd in AHG Session 1.9 (GJS & YKW).

Item 22 of this contribution belongs to this category.

This contribution proposes the following changes related to IRAP and GDR AUs:

* Each GDR AU is required to be “complete” (i.e., to have a picture for each of the layers present in the CVS). That means, an incomplete AU consisting of GDR pictures is not a GDR AU, similarly as in the current VVC text that an incomplete AU consisting of IRAP pictures is not an IRAP AU. This aspect seems to be straightforward completion of the specification of GDR to account for multi-layer usage.
* Add a flag named irap\_or\_gdr\_au\_flag to the AUD to specify whether the AU is an IRAP or GDR AU, and mandate the presence of an AUD NAL unit in each IRAP or GDR AU when vps\_max\_layers\_minus1 is greater than 0.

The following issues were reportedly observed in the existing scalability design in the latest VVC text (in JVET-Q2001-vE/v15):

* Currently, an IRAP AU may start a new CVS and is required to be complete (i.e., to have a picture for each of the layers present in the CVS), while a GDR AU may also start a new CVS but is NOT required to be complete. Itwas believed that this is an oversight, as otherwise some layer-wise startup decoding process would have to be specified for such GDR case.
* A CVSS AU, which starts a new CVS, is required to be complete (i.e., to have a picture for *each of the layers present in the CVS*). However, according to the current design, the decoder is not able to check whether an AU includes a picture "for each of the layers present in the CVS" before it receives the last picture of the CVS, while on the other hand, even the last picture of the CVS is not easy to be determined because it is not easy to determine the start of any of CVS except for the very first CVS of the bitstream. Basically, that means, the decoder can only figure out the boundaries of CVSs after receiving the entire bitstream.

This contribution tries to address the above issues.

An OLS may contain more layers than are present in the bitstream.

It was discussed to what extent there may (or should) be out-of-band signalling to inform the decoder of the start of a new CVS or the establishment of a new target OLS. It was commented that the bitstream should at least be decodable without needing to rely on some such external means.

Another contribution R0274 proposes to not require an IRAP AU to be complete.

This was further discussed on 23 April at 0845 (GJS). The purpose of this is to enable early detection of an IRAP or GDR AU, before receiving all pictures in the AU.

The suggestion here is add a flag in the AUD to identify an IRAP or GDR AU when vps\_max\_layers\_minus1 is greater than 0 and mandate the presence of the AUD in these instances.

The flag would not have a normative effect, but would be required to be present under the specified conditions, as a way to assist decoders that would use the flag.

Decision (cleanup): Adopted (item 2 of the proposal).

[JVET-R0070](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9714) AHG9: On repetition and update of non-VCL data units [Y.-K. Wang, L. Zhang, Z. Deng (Bytedance)]

Discussed in AHG Session 1.9 (GJS & YKW).

Items 1-3, and 6 of this contribution belong to this category.

This contributions proposes the following aspects regarding repetition and update of non-VCL data units and sharing of APSs across layers:

1. VPS, SPS, and DCI NAL units are proposed to be disallowed to be present in an AU that has no nal\_unit\_type in the range of IDR\_W\_RADL to GDR\_NUT, inclusive. It was asked why we would do this – e.g., an SPS could be sent early before it is used. No need to impose such a constraint was identified, so no action was recommended on this.
2. A PU is proposed to be disallowed to have more than one VPS, SPS, or PPS NAL unit with a particular VPS, SPS, or PPS ID, and is proposed to be disallowed to have more than one DCI NAL unit. No need to impose such a constraint was identified, so no action was recommended on this.
3. A slice unit (SU) is proposed to be defined as a set of NAL units that are consecutive in decoding order and contain exactly one coded slice and all its associated non-VCL NAL units.
   1. Within an SU it is proposed to be disallowed to have more than one APS NAL unit with a particular APS ID and of particular APS type.
   2. Within an SU it is proposed to be disallowed to have more than one SEI payload with particular type and a particular content (i.e., repetition).
   3. Within an SU, repetition of other PSs is proposed to be disallowed.

Item 3 was further discussed on 23 April at 1430 UTC (GJS). No clear need to impose such a constraint was identified, so no action was recommended on this.

1. Update to the content of an ALF APS NAL unit within a PU is proposed to be allowed. This aspect should be discussed as a matter of tool control (section 4.1.2.4), as it is not just a matter of HLS, and a similar change is proposed in R0149.
2. Sharing of an APS NAL unit across layers is proposed to be disallowed. This aspect is discussed in section 4.1.2.4.
3. The same types of APSs are proposed to share the same value space for the APS ID, regardless of whether the APSs are prefix or suffix APS NAL units. It was commented that this has been the existing design intent. AHG Recommendation (expression of existing intent): Adopt this aspect.

Discussion stopped here for AHG Session 1.9, with item 3 yet to be reviewed. (Item 3 was reviewed later as noted above.)

Discussion started here for JVET Track A on 19 April at 0900 (UTC) (GJS & YKW).

[JVET-R0082](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9726) AHG9: Byte alignment modifications [Z. Zhang, M. Pettersson, M. Damghanian, J. Enhorn, J. Ström, R. Sjöberg (Ericsson)]

This contribution contains three proposals related to two identical syntax tables rbsp\_trailing\_bits( ) and byte\_alignment( ) in the current version of VVC.

* Proposal 1 is an asserted cleanup to use the syntax element alignment\_bit\_equal\_to\_one to indicate the last bit in the arithmetic decode terminate process.
* Proposal 2 replaces the byte\_alignment( ) last in the slice header (SH) by the contents of the byte\_alignment( ) syntax structure, but without including the leading bit equal to 1. The proponents claim that this removes the only use of byte\_alignment( ) in the specification and that the leading bit equal to 1 has no use.
* Proposal 3 removes the syntax table byte\_alignment( ) since it is claimed to never be used due to proposal 2.

Proposal 1 is only editorial cleanup of the existing technical intent.

Proposal 2 would remove a 1-valued bit at the end of the SH. It was commented that this bit serves a purpose by enabling separate emulation prevention operation for the SH and slice data. The proponent pointed out that this purpose may be useful for an encoder but said it is not needed by the decoder. Another participant said this bit can be used and has been useful for an error check to be performed by the decoder. Proposal 3 is dependent on proposal 2.

Decision (editorial bug fix): Correct the text in the decoding process as per Proposal 1 (The specific details of the editorial expression is at the discretion of the editor.)

Discussion stopped here for JVET Track A on 19 April at 0915 (UTC).

Discussion began here for JVET Track A on 21 April at 1905 (UTC) (GJS & YKW).

[JVET-R0122](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9766) AHG9: On picture output for non-reference pictures [B. Choi, S. Wenger, S. Liu (Tencent)]

In this contribution, it is proposed that the pic\_output\_flag is not signalled in picture header and inferred to be equal to 1, when the value of non\_reference\_picture\_flag is equal to 1. A coded picture with non\_reference\_picture\_flag equal to 1 and pic\_output\_flag equal to 0 should not be included in the bitstream, becaue such a picture is never outputted and never used as a reference.

It was commented that, when a picture with pic\_output\_flag equal to 0 and Temporald less than the highest Temporald was referenced only by the highest temporal layer, and if that temproal layer is dropped, it becomes a "non-reference picture", although the "non-reference picture" flag is still equal to 0.

It was commented that the proposal would disallow a bitstream rewriter to mark a "non-reference picture" that has pic\_output\_flag equal to 1 to have pic\_output\_flag equal to 0 instead.

On the other hand, for that use case, the bitstream rewriter could set non\_reference\_picture\_flag equal to 0 and set pic\_output\_flag equal to 0 for such a use case.

Decision (sensibility cleanup): Adopt. The NOTE needs to be rephased (delegated to the editor).

[JVET-R0147](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9791) AHG9: On picture order count and output order [M. M. Hannuksela (Nokia)]

It is asserted that when a spliced bitstream is formed by concatenating a first bitstream and a second bitstream where the latter starts with a picture having ph\_poc\_msb\_present\_flag equal to 1, the "bumping" process could output pictures in an incorrect order. This contribution proposes to overcome the asserted issue similarly to what is specified in HEVC, including both of the following proposal pieces:

* 1. Add poc\_decr\_flag in the picture header, gated by gdr\_or\_irap\_pic\_flag. poc\_decr\_flag equal to 1 causes PicOrderCntVal values of the pictures in the DPB to be decremented. poc\_decr\_flag shall not be to 1 unless the picture is in a CVSS AU.
* 2. When poc\_decr\_flag is equal to 1, derive a value to be decremented from the PicOrderCntVal values of the pictures in the DPB. The derivation is asserted to be equivalent to one of the POC resetting options of HEVC. The resulting PicOrderCntVal values of the pictures in the DPB are smaller than the PicOrderCntVal of the current picture.

It was commented that during the decoding process of an CVSS AU, all picture decoded earlier would be output (when needed) and the DPB is reset to be empty, thus the problem would not occur. Thus no action was taken on this.

Discussion stopped here for JVET Track A on 21 April at 19:30 (UTC).

[JVET-R0263](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9907) AHG9: On TemporalId and sublayer [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

This contribution was discussed on 23 April at 1440 (GJS).

This contribution proposes the constraints on TemporalId as follows:

1. TemporalId value is in ascending order for sublayers of the same CLVS. It was remarked that the n-th sublayer is the layer with TemporalId equal to n, and that this is already clear in the text.
2. The value of TemporalId shall be the same for all VCL NAL units of a PU or an AU if mixed\_nalu\_types\_in\_pic\_flag is equal to 0; otherwise, the value of TemporalId may be different. This would relax a constraint for mixed NAL unit type. It was commented that this is not consistent with the design intent and would have a substantial impact on the text (e.g., extraction should be possible based on the TemporalId).
3. The value of TemporalId shall be the same within each sublayer of a CLVS if there are multiple sublayers, the value of TemporalId may be different if there is a single sublayer. It was commented that this affects the definition of what is a sublayer; a sublayer is the set of NAL units with a particular value of TemporalId.
4. Sublayer definition update. This was also proposed as a change for the mixed case. Again it was not considered consistent with the design intent.
5. Additional modification options are proposed keep the PTL structure consistent as follows.

* Option1: signal maximum number of sublayers in VPS and pass it to VPS PTL structure
* Option2: signal maximum TemporalId in SPS and pass it to SPS PTL structure

The motivation for most of these items is to require less coordination of sub-bitstream encoding for merging use cases. However, it was commented that coordination is expected as the design intent and these proposed changes would be substantial and likely to introduce problems (for example in the sub-bitstream extraction process). For the last item, participants felt that the requested functionality of gaps in presence of sublayers is already embodied in the text and did not see a clear problem. So no action was taken on this.

Rezoom at 1520.

### Profile, tier, level (PTL) (5)

Discussion started here for AHG Session 1.5 on Tuesday 7 April at 1300 (GJS, YKW, JRO & JB).

[JVET-R0068](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9712) AHG8/AHG9/AHG12: Miscellaneous HLS topics [Y.-K. Wang, L. Zhang, Z. Deng, J. Xu, K. Zhang, K. Fan (Bytedance)]

Discussed in AHG Session 1.5 (GJS, JRO & JB).

Item 2 of this contribution belongs to this category.

Discussed UTC Tuesday 7 April, 2020, 13:00. Chaired by JRO and JB.

The proposal is to use a special entry in the level signalling in the PTL syntax structure to indicate the property of an all-IRAP subset of the bitstream.

It was commented that the encoder could use TemporalId 0 for IRAP pictures. However, it was commented that this will make one less sublayer to be used.

It was commented that in intra based trick play, some IRAP pictures would be output/displayed multiple times.

It was commented that trick play can also use non-intra pictures, and scene cuts may appear in arbitrary positions and can be coded as IRAP pictures.

It was commented that such information, if useful, should use an SEI message.

It was commented that the information is useful, somewhat like marking non-reference pictures etc.

It was commented that DASH already makes use of this information, as a bitstream property.

It was commented that the information may be hard for the encoder to figure it out and set. However, it was counter-argued that this is similar for setting the level for temporal scalable layers.

It was asked what people think about having an SEI message for indicating that the 0-th level in the PTL is for IRAP only.

This was further discussed on 23 April at 1525 (GJS).

This uses an offset of 1 so that index 1 is for sublayer 0. There is a similar offset for max\_tid\_il\_ref\_pics\_plus1[ i ][ j ].

The proposal did not include text of an extraction process to extract this extra subset, or an HRD model for such a subset.

It was commented that this is not necessarily how a decoding system would use intra-only trick play.

This was deferred for further study for a potential future SEI message.

[JVET-R0108](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9752) AHG9: Decoding Capability Information and PTL Signalling [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

Discussed in AHG Session 1.5 Tuesday 7 April at 1410 UTC (GJS, YKW, JRO & JB).

Following is proposed related to DCI and PTL signalling:

* Proposal 1: It is proposed that dci\_max\_sublayers\_minus1 syntax element be removed and instead those bits and the reserved zero bit be used for the syntax element dci\_num\_ptls\_minus1.
* Proposal 2: It is proposed to rearrange the syntax elements in profile-tier-level signalling structure such that general\_level\_idc syntax element, which is unconditionally signalled, is first in the structure and the other conditional signalling, which is all based on profileTierPresentFlag is together, thus requiring only a single if check.
* Proposal 3: It is proposed to conditionally signal sps\_ptl\_dpb\_hrd\_params\_present\_flag only when sps\_video\_parameter\_set\_id is not equal to 0.

Proposal 1:

It was commented that the added semantics constraint on vps\_num\_ptls\_minus1 has a problem.

It was suggested to use 4 reserved bits instead of having 8 bits for the number of PTL structures.

Comment: The current extension mechanism for DCI is a bit heavy.

Suggestion: Reserve a value of dci\_num\_ptls\_minus1, e.g., 15.

AHG recommendation (cleanup): Remove the dci\_max\_sublayers\_minus1 SE, but to use 4 reserved bits (at the begin of the DCI syntax) instead of having 8 bits for the number of PTL structures (as proposed), and reserve the value 15 of dci\_num\_ptls\_minus1.

Proposal 2:

Comments: This makes level goes before profile and tier, while the interpretation of level typically depends on profile.

Comments: The GCI syntax structure can be of variable length. The proposed change makes level at fixed position.

No action was taken on this item.

Proposal 3: See notes in 4.1.6.1.

After discussion of this, at the end of AHG session 1.5, the information contribution JVET-R0243 was discussed. See the notes for that contribution, which have been moved to section 4.5.

[JVET-R0244](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9888) AHG9: Coded Picture Buffer sizes and MinCr in VVC [S. Keating, A. Browne, K. Sharman (Sony)]

Discussion started here for Track A on Wednesday 22 April at 0500 (GJS & YKW).

See also the accompanying information document R0243.

This contribution describes proposed changes to maximum coded picture buffer (CPB) size and MinCrScalingFactor in order to guarantee that the buffer can always store a full picture when compressed at the minimum compression ratio (MinCr).

The contribution reports that a single picture coded at the MinCr bit rate would more than fill the entire CPB for some levels of the Main tier.

It was commented that we have the same issue in AVC and HEVC. At level 6 there is a “kink” in the table (60 000 rather than 80 000 for the max CPB size). This could be an errata report for AVC and HEVC, to change the MinCr limit to be derived from the CPB size limit or add a note for cases where the CPB size imposes a tighter limit than the MinCr does.

It was noted that levels 6, 6.1 and 6.2 have the same luma size limit, and that if a larger CPB size is needed, level 6.1 or 6.2 could be used.

See also contribution R0243, which showed that generated bit rates at low QPs could have coded sizes that scale to larger values (more than twice the number of coded bits) for 4:4:4 relative to 4:2:0.

Decision (cleanup): MaxCPB = 80 000 for level 6, 120 000 for level 6.1, 180 000 for level 6.2, and change MinCrScaleFactor for the 4:4:4 profile to 0.75, and change MinCrBase to 8 for level 6.2.

[JVET-R0245](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9889) AHG9: Level coding in VVC [S. Keating, A. Browne, K. Sharman (Sony)]

This document describes a modified method of encoding the level and a modified decoder constraint allowing increased picture sizes and frame rates to be accommodated.

It was commented that although there is a formula that is currently used, it is not a promise that all future specified numbers will be assigned using that number. The assignment could have just been done with a table, for example – and that would be a purely editorial matter. There is not an obligation to use the same method for future values.

The basic idea is to leave more gaps for sublevels.

The level is proposed to be coded in 8 bits as major\*16+minor, e.g. level 4.1 is coded as 65 (except that level 15.15 becomes the special level for unconstrained picture size).

As proposed, this would leave no gap to insert additional numbers between minor level numbers.

We note that this does not entail an obligation to always use the formula for future-specified levels. Such levels would use a number that reflects the specified onion-shell relationship but may not use the formula. For example, if we want to add a higher frame rate capable decoder.

The contribution also contains a proposal for a hierarchy relationship derived from major and minor level numbers, to enable potential insertion of, e.g., a level 5.3 with a higher sample rate capability than level 6.0. This seemed a bit complication to interpret and it was pointed out that simply by manual selection of a number in the future rather that following the proposed could enable such uses – e.g., this is analogous to the previous experience with Level 1b in AVC.

Decision (cleanup): Adopt the level value scheme of major \* 16 + minor \* 3 (with the top number retaining its special meaning).

The basic idea is to leave the same amount of gap between sublevels but reduce the gap for major levels to enable hypothetical future higher level numbers.

Editor action item: It is suggested to put the number correspondence table in the text, along with an informative note that describes the formula and states that future-specified levels could have values selected in a different manner that respects the specified hierarchy.

[JVET-R0246](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9890) AHG9: Max Luma Picture Size in VVC [S. Keating, A. Browne, K. Sharman (Sony)]

Table A.1 in the current specification specifies the maximum luma picture size for each level; these values are taken from HEVC, which has a maximum block size of 64x64. VVC has a maximum block size of 128x128, meaning that for several levels the specified maximum picture size is not an integer number of 128x128 blocks.

This would round up the max luma sizes for levels 1, 2, 3, 4, and 4.1.

Another possibility discussed in the contribution would be to restrict the max CTU size for levels below level 5. This would have some coding loss (0.39% in Class B and 0.11% in Class D).

A third possibility is to restrict CTU size just for levels 1 and 2 and increase the max luma size for levels 3, 4 and 4.1.

It was commented that already the decoder needs to be able to support incomplete CTUs at the right and bottom, so no action may really be needed, and no action was taken.

Discussion stopped here for Track A on Wednesday 22 April at 0700.

### General constraints information (GCI) (9)

These contributions were discussed 23 April at 1545 (GJS).

[JVET-R0086](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9730) AHG9: Modification of general constraints flags [W. Lim, G. Bang (ETRI)]

The proponent indicated that this contribution no longer needed to be presented.

[JVET-R0173](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9817) AHG9: Cleanup of Constraint Flags [K. Naser, F. Le Léannec, M. Kerdranvat, P. de Lagrange (InterDigital)]

The draft VVC specification provides several constraint flags to profiles where certain coding tools are activated/deactivated. It is asserted that several redundant constraint flags are signalled when either monochrome coding or intra-only profiles are used. This contribution proposes cleaning up the constraint flags such that redundant coding of constraint flags is removed.

Proposals 1 and 2 are alternative ways of introducing various conditioning of the constraints on monochrome and intra. The same sort of conditioning is proposed in R0286 aspect 1. Currently the general constraint flags are never conditioned on anything and they are placed at a fixed position, so they can be easily extracted and carried at a system level in a fixed-length code. to stay consistent with that design philosophy, no action was taken on this.

Proposal 3 changes the semantics of the intra\_only\_constraint\_flag to apply to ph\_inter\_slice\_allowed\_flag rather than slice\_type. It was commented that this would impose a tighter constraint than currently specified and said that the current expression is more desirable, so no action was taken on this.

[JVET-R0178](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9822) AHG9: On APS and GDR constraint Flags [K. Naser, F. Le Léannec, T. Poirier, P. de Lagrange (InterDigital)]

See also 4.1.6.1 regarding GDR.

We currently have a flag no\_aps\_constraint\_flag. It is proposed to add a constraint stating that when this flag is 1, sps\_alf\_enabled\_flag, sps\_lmcs\_enabled\_flag and sps\_scaling\_list\_enabled\_flag shall be equal to 0.

It was commented that ALF can be used without any APS, so it was agreed not to apply this part of the constraint.

Decision (sensibility constraint): Require that when no\_aps\_constraint\_flag is equal to 1, sps\_lmcs\_enabled\_flag and sps\_scaling\_list\_enabled\_flag shall be equal to 0.

[JVET-R0179](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9823) AHG9: Constraint Flag for TSRC [K. Naser, F. Le Léannec, T. Poirier, M. Kerdranvat (InterDigital)]

It was agreed to only discuss proposal 1. This proposes a no\_tsrc\_constraint\_flag constraining slice\_ts\_residual\_coding\_disabled\_flag to be equal to 1.

Decision (cleanup): Adopt (assuming the slice\_ts\_residual\_coding\_disabled\_flag would exist and be the highest level of control for this – this was confirmed in the closing plenary of Friday 24 April at 1455).

[JVET-R0191](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9835) AHG9: On miscellaneous updates for HLS signalling [Hendry, S. Paluri, S. Kim (LGE)]

Item 5 of this contribution belongs to this category.

This proposes to specify a general constraint flag on LMCS i.e., no\_lmcs\_constraint\_flag.

This is also proposed in R0286 aspect 2. See the notes for that contribution.

[JVET-R0207](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9851) AHG9: General constraint information for LFNST [M. Koo, M. Salehifar, J. Lim, S. Kim (LGE)]

This proposes to specify a general constraint flag on LFNST, i.e., no\_lfnst\_constraint\_flag.

This is also proposed in R0286 aspect 2. See the notes for that contribution.

[JVET-R0227](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9871) AHG9: General constraint information semantics constraints and a flag for PH in SH [R. Sjöberg, R. Yu, M. Pettersson, M. Damghanian, Z. Zhang, J. Enhorn (Ericsson)]

The contribution proposes the following modifications to the general constraint information:

1. Mandate the value of no\_ccalf\_constraint\_flag to be equal to 1 when no\_alf\_constraint\_flag is equal to 1. It is reported that when no\_alf\_constraint\_flag is equal to 1, sps\_alf\_enabled\_flag is equal to 0 which disables the adaptive loop filter (ALF) tool, including cross-component ALF.

Decision (sensibility constraint): Adopt.

1. Mandate the value of no\_sbtmvp\_constraint\_flag to be equal to 1 when no\_temporal\_mvp\_constraint\_flag is equal to 1. It is reported that when no\_temporal\_mvp\_constraint\_flag is equal to 1, sps\_temporal\_mvp\_enabled\_flag is equal to 0 which disables temporal motion vector prediction, including SbTMVP.

Decision (sensibility constraint): Adopt.

1. Rename no\_qp\_delta\_constraint\_flag to no\_cu\_qp\_delta\_constraint\_flag. It is reported that the current name is misleading since no\_qp\_delta\_constraint\_flag is only constraining cu\_qp\_delta\_enabled\_flag and not ph\_qp\_delta or slice\_qp\_delta.

Editor action item: The editor is suggested to consider the names of these syntax elements.

1. Add a general constraint flag no\_picture\_header\_in\_slice\_header\_constraint\_flag for the feature to include picture header syntax in the slice header. It is reported that a constraint flag for this feature that was added at the previous meeting in Brussels is missing.

Particularly for BEAM, it may be desirable to establish such a constraint. However, BEAM would impose many other constraints that are not specified. It was also commented that the other constraint corresponds to a gating of a number of other syntax elements and features, as it constrains the number of slices to 1. Some participants said that the picture header syntax is not really a coding tool/feature.

No action was taken on this aspect.

[JVET-R0286](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9930) AHG9: On general constraint information syntax [Y.-J. Chang, V. Seregin, Y. He, M. Coban, M. Karczewicz (Qualcomm)]

The proponent said approach 1 of aspect 1 does not need to be discussed.

For aspect 1 approach 2, R0173 proposes syntax conditions to skip syntax. This contribution proposes sensibility constraints on values without introducing such syntax conditions.

Decision (sensibility constraints): Adopt aspect 1 approach 2. (The editor may remove redundant expression, if any.)

For aspect 2, it was noted that R0191 also proposes such an LMCS flag and R0207 proposes such an LFNST flag.

Decision (general constraints on tools): Adopt constraint flags per aspect 2.

Aspect 3 proposes four flags relating to layered coding: single\_layer\_constraint\_flag, single\_sublayer\_constraint\_flag, single\_sublayer\_per\_layer\_constraint\_flag, and no\_inter\_layer\_pred\_constraint\_flag.

Both the first and second flags would have only one layer, so the name of the second flag seems misleading.

It was suggested that the second flag is just a combination of the first and third.

It was noted that all of this information can be found in the VPS and making this change might require VPS and SPS rewriting for the BEAM case and that the controlled features are not really coding tools per se, but rather syntax structures and functionalities.

Some of these can be equivalently expressed by specifying that the SPS VPS ID shall be equal to 0 or that the number of layers shall be equal to 1 or that vps\_all\_indpendent\_layers\_flag shall be equal to 1.

It was said that no\_inter\_layer\_pred\_constraint\_flag would be equivalent to an existing VPS flag vps\_all\_indpendent\_layers\_flag.

Decision (general constraints cleanup): Adopt the single\_layer\_constraint\_flag and no\_inter\_layer\_pred\_constraint\_flag (perhaps renamed to all\_layers\_independent\_constraint\_flag).

Aspect 4 proposes to add general constraint flags for having no VPS present and always having the PH in the SH. The second of these had been agreed previously at this meeting.

For a single-layer bitstream, the VPS is purely metadata and as agreed above, we will have a way to indicate a single-layer bitstream. Prohibiting VPS presence in this case would be sort of like prohibiting the presence of an SEI message, so a constraint flag to express this did not seem necessary. So no action was taken on the VPS part of aspect 4.

[JVET-R0341](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9985) AHG9: on constraint flag for local chroma QP control [Philippe de Lagrange, Karam Naser, Philippe Bordes, Fabrice Le Léannec (InterDigital)]

The constraint flags defined in the current VVC draft allow disabling local luma QP control, using no\_qp\_delta\_constraint\_flag. This contribution proposes several methods to allow constraint flags to disable local chroma QP control too.

The proponent suggested to focus only on option 2, which proposes a no\_chroma\_qp\_offset\_constraint\_flag.

Decision (general constraints cleanup): Adopt option 2.

This section was completed on Thursday 23 April at approximately 1715 UTC.

### Parameter sets cleanups (21)

#### General (1)

[JVET-R0343](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9987) AHG9: A summary of proposals on parameter sets cleanups [Hendry (LGE)]

This contribution is intended to provide a summary of the proposals on parameter sets cleanups submitted to this JVET meeting by the 3 April 2020 submission deadline.

It was 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.

**Summary of proposals on SPS cleanups:**

This section was discussed in AHG Session 1.1 Monday 6 April at 1440 UTC (GJS & YKW).

1. New condition for signalling of syntax elements
   1. When sps\_ptl\_dpb\_hrd\_params\_present\_flag is equal to 1, inter\_layer\_ref\_pics\_present\_flag is not present and inferred to be equal to 0 (JVET-R0156 proposal 2)

Is it possible for such a SPS to be referred to by a layer that has reference layers?

It was commented that JVET-R0205 is related.

This item was moved to 4.1.10.

* 1. Condition the presence of sps\_sublayer\_dpb\_params\_flag on the value of sps\_ptl\_dpb\_hrd\_params\_present\_flag, in addition to sps\_max\_sublayer\_minus1 (JVET-R0156 proposal 3) (JVET-R0170) (JVET-R0222 proposal 2) AHG Recommendation: Adopt.
  2. Condition that sps\_independent\_subpics\_flag is present only when there are at least two subpictures. (JVET-R0156 proposal 4)

MC wrap-around was discussed.

It was commented that item 1 of R0284 and item 1 of R0071 are identical or similar to this.

This item was moved to 4.2.1.1.

Discussed stopped for AHG Session 1.2 here on Monday 6 April at 1500 UTC (GJS & YKW), and resumed at the start of AHG Session 1.4 Monday 6 April at 2330 UTC (GJS & YKW).

* 1. Condition the presence of subpic\_info\_present\_flag by res\_change\_in\_clvs\_allowed\_flag (JVET-R0266 proposal 3). These cannot be used together currently, although there had been proposals to allow them to be used together. No support was expressed by non-proponents for this.
  2. Add new flag in SPS to indicate that intra-only (i.e., whether inter-coding is allowed). Use this flag to condition the presence of inter-coding related tools. (JVET-R0283 proposal 1) (JVET-R0335). The proponent said this could skip about 40 syntax elements (more than 5 times more than in HEVC), and drew an analogy to monochrome. It was commented that low-resolution still-picture coding might be the strongest argument for this. Another participant suggested that skipping the irrelevant syntax would ease encoder design. After seeing the syntax table, several participants expressed support for this, while others said this adds extra syntax that is not necessary for video and the bit savings seems too small to make a special provision for it. It was asked whether the syntax structure logic should be different if we do this. Data on this (with the encoder minimizing the necessary amount) was requested. An initial estimate was 23 bits per SPS.

It was later confirmed (Wednesday 8 April) that 23 bits in the SPS (and 4 in the PPS and 1 in the PH) could be saved in such a case. The quantity of data is not compelling; the argument is more a matter of the analogy to monochrome. It was commented whether the analogy is really apt, since there was already the chroma array type information in the SPS to use for that.

There is an all-intra constraint flag in the PTL structure, which currently controls only the slice level.

After discussion, there was not a consensus for this change.

See also R0332 on syntax grouping.

* 1. In a similar train of thought as point above, do the same for PPS (JVET-R0283 proposal 2). This was discussed further on Friday 24 April at 0550 (GJS), and the proponent considered the proposal unlikely to be acted upon and thus did not indicate to further discuss it.
  2. Add a constraint that sps\_ptl\_dpb\_hrd\_params\_present\_flag shall be equal to 1 when there is at least one OLS which has only one layer or VPS is not present? (JVET-R0275)?

It was said that this relates to some other proposals on SPS cleanup (R0191, R0156 aspect 1, R0108 proposal 3).

If VPS is not present, PTL would be absent if the flag is 0. R0156 aspect 1 and R0108 proposal 3 propose that if the sps\_video\_parameter\_set\_id is equal to 0, not to signal the flag and infer it to be equal to 1. It was commented that this could affect byte alignment of the PTL information. JVET-R0275 propose to constrain the flag for this. The motivation for not sending it was said to be to prevent the possibility of not having the PTL information at all. AHG Recommendation: To avoid changing byte alignment, the constraint approach was agreed in this case.

When the VPS is present and there is some OLS that has only one layer and the layer ID is the current layer’s ID, this case is proposed to be constrained in R0191 and R0275. AHG Recommendation: The constraint was also agreed to apply in this case.

V. Seregin agreed to provide text in an update of R0275 and to provide the software.

1. Infer the value of sps\_ccalf\_enabled\_flag to be equal to 0 when not present (i.e., when sps\_alf\_enabled\_flag is equal to 1 and ChromaArrayType is equal to 0) (JVET-R0105). This seemed to be what was already the intended behaviour. AHG Recommendation (expression of existing intent): Adopt.
2. Constraint the semantics of subpic\_info\_present\_flag such that when it is equal to 1, at least either pic\_width\_max\_in\_luma\_samples or the value of pic\_height\_max\_in\_luma\_samples shall be larger than the CTB size CtbSizeY. (JVET-R0156 part 2 of item 4). After study, this might affect extraction, so no action was taken on this.
3. Change sps\_reserved\_zero\_4bits to sps\_reserved\_one\_4bits to prevent the SPS start code emulation. (JVET-R0266 proposal 1). The case would be with an SPS ID of zero and monochrome and PTL info not present (only in a dependent layer). It was commented that our other reserved bits are zero and this seems somewhat ad hoc. There was no non-proponent interest in this, so no action was taken on it.

Discussion stopped for AHG session 1.4 here on Tuesday 7 April at 0115 UTC, and resumed for AHG Session 1.11 on Wednesday 8 April at 2100 UTC (GJS & YKW).

1. Consolidate two syntax elements, sps\_poc\_msb\_flag and poc\_msb\_len\_minus1 into a single syntax element poc\_msb\_len (JVET-R0266 proposal 2)

It was commented that this seems almost editorial. Another participant commented that having a flag could be desired editorially for having a clear way to disable the feature, and that there may have been a similar prior situation.

It was questioned whether the current semantics are really correct, i.e., whether the signalled MSBs are intended to be *all* of the MSBs of the POC or only some of them. Others confirmed that all “missing” MSBs are inferred to be 0, and that this is intentional. AHG Recommendation (ed.): The editor is asked to review whether this aspect of the semantics of poc\_msb\_val is sufficiently clear.

It was noted that with the proposal, the value 0 would be overloaded to have a different and special meaning. It would mean more than the name of the syntax element would imply. (The proposed semantics would need some clarification in this regard.) Since this could be confusing, no action was recommended on the proposal.

1. gdr\_enabled\_flag value constrained by no\_gdr\_constraint\_flag (JVET-R0266 proposal 5, JVET-R0178)

There was discussion of the possibility of having some NUTs that are GDR and some that are not. This is already disallowed.

AHG Recommendation (editorial expression of existing intent): Specify that no\_gdr\_constraint\_flag equal to 1 specifies that gdr\_enabled\_flag shall be equal to zero. no\_gdr\_constraint\_flag equal to 0 does not impose such a constraint.

1. Grouping syntax elements in SPS based on slice type (i.e. intra or inter) (JVET-R0332)

It was discussed whether we would want to do such a rearrangement regardless of whether we want to gate presence on whether inter pictures are present or not (see JVET-R0283 proposal 1 and JVET-R0335). Some participants said that some minor rearrangements might be OK, but wholesale restructuring would be undesirable. It was commented that software implementation would be desirable to make sure there are no overlooked dependencies. The proponent said they did implement it and could provide software for checking. It was asked for such software to be provided in a revision of the contribution. Support for this was expressed, as a more logical structuring of the syntax – the prior syntax may have been rather randomly ordered. This was further discussed on Friday 24 April at 0510 (GJS). Software had been provided in a revision of R0332 and a new contribution R0408 had been uploaded with a crosscheck. Decision (cleanup): Adopt syntax grouping of R0332.

**Summary of proposals on PPS cleanups:**

1. Require the value of pps\_conformance\_window\_flag to be equal to 0 when the picture width and height are the maximum picture width and height, and infer the values of the PPS conformance window syntax elements to be the same as those signalled in the SPS if the picture width and height are the maximum picture width and height and to be equal to 0 otherwise. (JVET-R0068 proposal 6) (JVET-R0262 proposal 1 and 2)

It was commented that there is already a constraint that in this case the window at the PPS level needs to be the same as the one at the SPS level; the question is only whether to require the flag to be 0 and to infer from the SPS level in this case. In the current draft, in this case, the window parameters are required to be sent in every PPS when non-zero and are required to always be the same.

There is also already a requirement that if the picture size in two PPSs is the same, their cropping windows must be the same. (These constraints are intended to ease RPR operation.)

One participant commented that having an inference rule that is conditional on a particular special case seems potentially confusing to implementers. Others said it only makes sense that if the parameters are required to have a particular value, that is the value that should be inferred and there shouldn’t be syntax capable of violating that constraint.

It was noted that this inference from the SPS prevent complete self-contained interpretation of the PPS content, although we already have some such dependencies.

AHG Recommendation: Adopt.

1. Add a new syntax element pps\_res\_change\_allowed\_flag in the PPS and use it to condition the presence of the conformance window and scaling window syntax elements (JVET-R0262 proposal 3). This is related to the previous item above. With the action taken on the previous item, this reduces to adding a flag that would skip two flags in the PPS. No action was taken on this, due to the action taken on the previous item.
2. Add a constraint for the cropping window offsets and scaling window offsets that at least one of the offsets is different than its default value when the flag that controls their presence is equal to 1 (JVET-R0115). It was commented that this extra constraint doesn’t really seem necessary, so no action was recommended on this.
3. Change the signalling for wraparound offset. Signal “picture width minus wraparound offset” instead of “wraparound offset” (JVET-R0162 proposal 1). In the 360° ERP case, this corresponds to sending the padding width rather than the pre-padded picture width. For the 360° CTC, this would save about 16 bits per PPS (sending a value of 16 instead of 4448). The current syntax seems obviously inefficient, so this was supported without any expressed misgivings. AHG Recommendation: Adopt.
4. Change the signalling of the PPS ID from ue(v) to u(6), as proposed in R0266 proposal 4. It was noted that this is the only parameter set ID that uses ue(v) coding for its ID. AHG Recommendation: Adopt.

**Summary of proposals on APS cleanups:**

1. Handling chroma related syntax elements in APS when ChromaArrayType is equal to 0
   1. To avoid having APS semantics depend on the SPS, move the constraints from the APS semantics to the PH and SH semantics of the relevant APS ID, in, such that the value of scaling\_list\_chroma\_present\_flag shall be equal to 0 when the value of ChromaArrayType is equal to 0.

It is also proposed to similarly move the constraint for alf\_chroma\_filter\_signal\_flag, alf\_cc\_cb\_filter\_signal\_flag, alf\_cc\_cr\_filter\_signal\_flag, and add a similar constraint for lmcs\_delta\_abs\_crs (JVET-R0074).

This is asserted to remove APS-to-SPS dependency in the semantics.

This is related to parts of contribution JVET-R0232.

It was asked whether there is really a problem with constraining APS content based on the SPS content. It was commented that this is probably not desirable, although only an editorial matter.

The contribution proposes a constraint move for the scaling list and ALF (purely editorial), and adding a constraint for LMCS.

LMCS contains only two variables (three bits) relevant to chroma. ALF contains only three flags relevant to chroma.

There was a comment about this approach forcing crs\_offset not to be 0.

It was commented that the constraints are not really necessary, as the presence of the chroma data in the APS is not necessarily harmful (although we have been trying to avoid sending irrelevant chroma syntax).

* 1. Add flags (i.e., alf\_chroma\_present\_flag and lmcs\_chroma\_present\_flag) to the APS and constraint them to be equal to 0 when ChromaArrayType is equal to 0 (JVET-R0177 proposal 1)

The LMCS part of this is related to part of contribution JVET-R0232.

* 1. Repurpose the chroma scaling list presence flag in the APS (i.e., aps\_chroma\_present\_flag) and use this flag to condition the presence of chroma presence flags in the APS. (JVET-R0177 proposal 2 and JVET-R0301)

The difference between “b” and “c” is basically only editorial.

This was discussed further on Friday 24 April at 0555 (GJS).

A similar contribution had been submitted in R0132, which had not been included in the R0343 summary due to the timing of its submission.

JVET-R0433 was submitted after offline study. It repurposes a chroma presence flag that had been in the scaling list data and uses it for all three APS types.

Decision (cleanup): Adopt R0433.

Discussion stopped here for AHG Session 1.12 Thursday 9 April at approximately 0115 UTC.

Discussion began here for JVET Track A Monday 20 April at approximately 1300 UTC (GJS).

1. Change the constraint on APS NAL units to have the same content within a picture unit to apply within a subpicture (JVET-R0149 proposal 1). This topic had been covered in a prior discussion.
2. Disallow interleaving of APS NAL units of different subpictures (JVET-R0149 proposal 2). This topic had been covered in a prior discussion.
3. Constrain suffix APS NAL units to be located after the last VCL NAL unit of the PU (JVET-R0201). See the notes in section 6.1.2.4.
4. Allow prefix and suffix APS NAL units with particular APS identifier and type to have different content (JVET-R0201). See the notes in section 6.1.2.4.
5. Constrain prefix APS NAL unit to be located before the first VCL NAL unit of the PU(JVET-R0201). See the notes in section 6.1.2.4.
6. Add a mode in PH to allow APS to be signalled within PH, like the mode of signalling PH in SH (JVET-R0273). See the notes in section 6.1.2.4.

**Later-added SPS cleanups:**

1. Change the value range of sps\_max\_sublayers\_minus1 from 0..vps\_max\_sublayers\_minus1 to 0..(sps\_video\_parameter\_set\_id ? vps\_max\_sublayers\_minus1 : 6). (JVET-R0125). See the notes in section .6.3.1.2.
2. Add a constraint on the value of sps\_max\_sublayers\_minus1 such that when sps\_video\_parameter\_set\_id is greater than 0 and vps\_all\_layers\_same\_num\_sublayers\_flag is equal to 1, sps\_max\_sublayers\_minus1 shall be equal to vps\_max\_sublayers\_minus1. (JVET-R0125).

After discussion, it appears that this would affect the removal of sublayers from a bitstream and the SPS is rewritten to reflect the actual content of what remains. In this case the SPS sps\_max\_sublayers\_minus1 would become less than vps\_max\_sublayers\_minus1. It was agreed that we don’t want to reflect the ability to do this.

Discussion stopped here for JVET Track A Monday 20 April at approximately 1328 UTC.

#### SPS cleanups (10)

[JVET-R0105](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9749) AHG9: On CC-ALF Signalling in SPS [S. Deshpande, A. Segall, J. Samuelsson, P. Cowan (Sharp)]

[JVET-R0125](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9769) AHG8/AHG9: On signalling max number of sublayers [B. Choi, S. Wenger, S. Liu (Tencent)]

Item 2 of this contribution belongs in this category.

[JVET-R0156](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9800) AHG8/AHG9: Signalling cleanup on SPS [B. Wang, S. Esenlik, A. M. Kotra, H. Gao, E. Alshina (Huawei)]

Items 1 and 3 this contribution belong to this category.

[JVET-R0170](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9814) AHG9: Removed Coding Redundant DPB Related Flag [K. Naser, F. Le Léannec, T. Poirier (InterDigital)]

[JVET-R019](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9835)1 AHG9: On miscellaneous updates for HLS signalling [Hendry, S. Paluri, S. Kim (LGE)]

Item 1 of this contribution belongs to this category.

[JVET-R0222](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9866) AHG9: SPS sublayer syntax cleanup [J. Luo, J. Chen, Y. Ye (Alibaba)]

[JVET-R0266](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9910) AHG9: Miscellaneous HLS topics [Y. He, Y-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Items 1-3, 5 of this contribution belong to this category.

[JVET-R0283](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9927) AHG9: Cleanup of inter predication HLS syntax elements [K. Naser, F. Le Léannec, M. Kerdranvat, P. de Lagrange (InterDigital)]

[JVET-R0332](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9976) AHG9: On syntax signalling order in SPS [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-R0408](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10055) Crosscheck of JVET-R0332 (AHG9: On syntax signalling order in SPS) [Z.-Y. Lin (MediaTek)] [late]

[JVET-R0335](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9979) AHG9: On SPS inter slice related syntaxes [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

#### PPS cleanups (5)

[JVET-R0068](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9712) AHG8/AHG9/AHG12: Miscellaneous HLS topics [Y.-K. Wang, L. Zhang, Z. Deng, J. Xu, K. Zhang, K. Fan (Bytedance)]

Item 6 of this contribution belongs to this category.

[JVET-R0115](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9759) AHG9: On signalling of cropping windows and scaling windows [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

[JVET-R0162](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9806) AHG9: PPS and SH syntax cleanup [J. Chen, J. Luo, Y. Ye, R.-L. Liao (Alibaba)]

Item 1 (wraparound offset signalling) of this contribution belongs to this category.

[JVET-R0262](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9906) AHG9: On PPS syntax [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-R0266](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9910) AHG9: Miscellaneous HLS topics [Y. He, Y-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Item 4 of this contribution belongs to this category.

#### APS cleanups (5)

[JVET-R0074](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9718) AHG9: Removal of APS semantics dependencies on SPS [Z. Deng, L. Zhang, Y.-K. Wang, K. Zhang (Bytedance)]

[JVET-R0177](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9821) AHG9: APS Cleanup [K. Naser, F. Le Léannec, T. Poirier, P. de Lagrange (InterDigital)]

[JVET-R0301](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9945) AHG12: on scaling\_list\_chroma\_present\_flag in APS [L. Li, X. Li, B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-R0433](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10095) AHG 9: Combination of JVET-R0177/R0301 and JVET-R0074 on APS Signalling and Semantics Cleanup [late]

[JVET-R0132](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9776) On signalling of chroma related APS [S. Iwamura, S. Nemoto, A. Ichigaya (NHK)] [not late for main meeting – check for more that are incorrectly marked late]

This is included in R0433, so there was no need for its separate presentation.

### Syntax for one slice per picture (14)

[JVET-R0406](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10053) AHG9: A summary of proposals on syntax for one slice per picture [Y.-K. Wang (Bytedance)]

Discussion began here for AHG Session 1.14 on Monday 13 April at 0500 UTC (GJS & YKW).

This contribution intends to provide a summary of the 13 proposals on syntax for one slice per picture submitted to this JVET meeting.

It is suggested that this summary, in terms of a list of design questions, is used for the reviewing of these proposals, such that the discussions can be in a more structured and efficient manner.

1. Add an SPS flag sps\_one\_slice\_per\_picture\_flag (or a different name with the same semantics: sps\_picture\_header\_in\_slice\_header\_flag). (R0060, R0118)
   1. When sps\_one\_slice\_per\_picture\_flag is equal to 1, skip the signalling of sps\_num\_subpics\_minus1 and sps\_independent\_subpics\_flag and infer the values. (R0060)
   2. When sps\_one\_slice\_per\_picture\_flag is equal to 1, skip the signalling of subpic\_info\_present\_flag. (R0118)

Currently we have a flag in the SH to indicate that all pictures in the CLVS have one slice per picture.

We also have a one\_slice\_per\_pic\_constraint\_flag (and similar for one tile, and one subpicture).

It was asked whether we have parsing dependencies on the general constraint flags. We do not.

In the current semantics of one\_slice\_per\_pic\_constraint\_flag equal to 1 there is no constraint that the PH be combined with the SH.

AHG Recommendation (cleanup): Add a “general\_pic\_header\_in\_slice\_header\_constraint\_flag” (or similar name). (constrained for sensibility with the existing flag, and constrain the combinations with the above syntax elements for sensibility, but do not add further constraints that are not necessary for sensibility). Text will be provided in a revision of R0118 and software is to be provided by B. D. Choi.

1. Skip the signalling of the 6 PPS flags rpl\_info\_in\_ph\_flag, dbf\_info\_in\_ph\_flag, sao\_info\_in\_ph\_flag, alf\_info\_in\_ph\_flag, wp\_info\_in\_ph\_flag, qp\_delta\_info\_in\_ph\_flag under certain condition. (R0060, R0113, R0124)
   1. Skip them when the existing PPS flag no\_pic\_partition\_flag is equal to 1, and infer their values (to be equal to something TBD) under this condition. (R0113)
   2. Skip them when a new PPS flag pps\_one\_slice\_per\_picture\_flag is equal to 1, and infer their values to be equal to 0 under this condition. (R0060)
      1. Also skip the PPS SEs pps\_num\_subpics\_minus1, rect\_slice\_flag, single\_slice\_per\_subpic\_flag, num\_slices\_in\_pic\_minus1, and loop\_filter\_across\_slices\_enabled\_flag (if this flag remains in the PPS) under this condition and infer the values. (R0060)
   3. Skip them when a new PPS flag all\_pic\_coding\_info\_present\_in\_ph\_flag is equal to 1, and infer their values to be equal to 1 under this condition. (R0124). This can be considered supplemental to item a.

Subitem “a” is straightforward sensibility cleanup. Subitems b and c are basically for coding efficiency savings (saving 5–10 bits) or bypassing unnecessary flexibility in the PPS level.

It was initially agreed to disallow random settings of these flags when the PH is in the SH.

When no\_pic\_partition\_flag is equal to 1 we already don’t send rect\_slice\_flag, single\_slice\_per\_subpic\_flag, num\_slices\_in\_pic\_minus1, and loop\_filter\_across\_slices\_enabled\_flag. And subpic\_id\_mapping\_in\_pps\_flag prevents sending pps\_num\_subpics\_minus1. One distinction that was pointed out is that the no\_pic\_partition\_flag does not distinguish the case with many tiles and one slice per picture.

It was suggested that the common case would be to send info in the PH unless flexibility is needed in the SH. However, for the RPL and WP, it (currently) matters where the data is signalled; for RPL, it helps to have the slice type, and for WP it helps to have the number of RPL active entries. For the other four, it doesn’t really matter one way or the other. Interacting with this question, there are proposals for signalling the number of active entries in the PH.

AHG recommendation (cleanup): When (pps\_)no\_pic\_partition\_flag is equal to 1, skip the 6 PPS flags rpl\_info\_in\_ph\_flag, dbf\_info\_in\_ph\_flag, sao\_info\_in\_ph\_flag, alf\_info\_in\_ph\_flag, wp\_info\_in\_ph\_flag, qp\_delta\_info\_in\_ph\_flag and infer them to be equal to 0. Text is provided in R0113 and software to be provided by its proponent. Any missing sensibility constraints may be added by the editor.

1. When slice headers referring to the PPS have (sh\_)picture\_header\_in\_slice\_header\_flag equal to 1, require alf\_info\_in\_ph\_flag to be equal to 1. (R0200)

Having this be equal to 1 instead of 0 is requested due to wanting the APS information to be early in the NAL unit. However, it was commented that the proposed requirement would be different than discussed for item 2 above.

No action was recommended for this.

1. When slice headers referring to the PPS have (sh\_)picture\_header\_in\_slice\_header\_flag is equal to 1, require rpl\_info\_in\_ph\_flag, dbf\_info\_in\_ph\_flag, sao\_info\_in\_ph\_flag, wp\_info\_in\_ph\_flag, qp\_delta\_info\_in\_ph\_flag to be equal to 1. (R0202)

AHG recommendation (cleanup): When (sh\_)picture\_header\_in\_slice\_header\_flag is equal to 1, require rpl\_info\_in\_ph\_flag, dbf\_info\_in\_ph\_flag, sao\_info\_in\_ph\_flag, wp\_info\_in\_ph\_flag, qp\_delta\_info\_in\_ph\_flag to be equal to 0.

(Consistency with item 2 suggests the value 0 rather than 1.)

See also item 15).

1. When (sh\_)picture\_header\_in\_slice\_header\_flag is equal to 1, regardless of the value of wp\_info\_in\_ph\_flag, pred\_weight\_table syntax structure is signalled in slice header and not as part of picture\_header syntax structure. (R0220)
   1. Or add a constraint such that (sh\_)picture\_header\_in\_slice\_header\_flag and wp\_info\_in\_ph\_flag shall not be both equal to 1 (technically equivalent to requiring the value of wp\_info\_in\_ph\_flag to be equal to 0 when slice headers referring to the PPS have picture\_header\_in\_slice\_header\_flag equal to 1). (R0220)

This is resolved by the action taken on item 4.

1. Skip the signalling of the SH syntax element (SE) slice\_address when the picture contains only one slice and infer its value. (R0060, R0104, R0162, R0189, R0202, R0210)
   1. Skip it when a new PPS flag pps\_one\_slice\_per\_picture\_flag is equal to 1. (R0060)
   2. Skip it when the existing SH flag picture\_header\_in\_slice\_header\_flag is equal to 1. (R0104, R0162, R0189, R0202, R0210)

This is already skipped when rect\_slice\_flag is 1 and the number of slices in the subpicture is 1. However, it is not skipped when the rect\_slice\_flag is equal to 0 (i.e., raster scan slices) and NumTilesInPic > 1.

It was suggested to only allow (sh\_)picture\_header\_in\_slice\_header\_flag is equal to 1 when (pps\_)rect\_slice\_flag is 1? It was commented that there is some other PPS syntax associated with that case that would need to be signalled. But that other syntax is minimal (just a PPS flag).

AHG recommendation (cleanup): Only allow (sh\_)picture\_header\_in\_slice\_header\_flag is equal to 1 when (pps\_)rect\_slice\_flag is 1.

1. Skip the signalling of the SH SE num\_tiles\_in\_slice\_minus1when the picture contains only one slice and infer its value. (R0060, R0104, R0202, R0210)
   1. Skip it when a new PPS flag pps\_one\_slice\_per\_picture\_flag is equal to 1. (R0060)
   2. Skip it when the existing SH flag picture\_header\_in\_slice\_header\_flag is equal to 1. (R0104, R0202, R0210)

This was resolved by the action recommended for item 6.

1. Skip the SH SE num\_tiles\_in\_slice\_minus1 when NumTilesInPic − slice\_address is not greater than 1. (R0210).

R0248 includes the same change (among other proposed changes).

AHG recommendation (cleanup): Adopt. Text and software are to be provided in a revision of R0210.

1. Even when skipping of signalling of the SH SE num\_tiles\_in\_slice\_minus1 as in the item above is not done, infer num\_tiles\_in\_slice\_minus1, when not present, to be equal to NumTilesInPic − 1. (R0060, R0104)

This was resolved by the action recommended for item 8.

1. Consider one of the following
   1. Skip the signalling of the SH SE slice\_subpic\_id when the SH flag picture\_header\_in\_slice\_header\_flag is equal to 1 infer its value. (R0189), or
   2. Add a constraint such that when subpic\_info\_present\_flag is equal to 1, the value of picture\_header\_in\_slice\_header\_flag shall be equal to 0 (technically equivalent to "When picture\_header\_in\_slice\_header is equal to 1, the value of subpic\_info\_present\_flag shall be equal to 0." but editorially the constraint should be expressed on picture\_header\_in\_slice\_header\_flag). (R0189, R0202)

AHG recommendation (cleanup): Adopt approach b. (There was some discussion of whether this is already part of the action taken on item 1.)

1. When picture\_header\_in\_slice\_header\_flag is equal to 1, skip the signalling of the SH SE num\_ref\_idx\_active\_override\_flag and infer its value to be equal to 0. (R0202)

This would be overriding the default number of active entries signalled in the PPS content.

It was discussed whether there is really a connection between the number of slices in the picture and the need to be able to change the number of active reference pictures used by that picture. It was commented that these are somewhat different issues.

It was said and confirmed that we have designed the PH syntax structure to be the same regardless of whether the PH is combined with the SH or not.

No action was recommended on this since the coupling seems unnecessary and the issue seems minor.

1. Add a constraint such that when slice headers referring to the SPS contain the PH syntax structure, separate\_colour\_plane\_flag shall be equal to 0. (technically equivalent to "When separate\_colour\_plane\_flag is equal to 1, the value of picture\_header\_in\_slice\_header\_flag shall be equal to 0.", but editorially the constraint should be expressed on picture\_header\_in\_slice\_header\_flag). (R0202)

It was remarked that this is somewhat hypothetical, since no profile supports this.

AHG recommendation (basically editorial cleanup): Adopt.

1. Change the text for determination of the first VCL NAL unit of an AU:
   1. As follows: (R0163)

If a PH NAL unit is present in a PU, let firstVclNalUnitInPic be the first VCL NAL unit that follows the PH NAL unit; otherwise let firstVclNalUnitInPic be the only one VCL NAL unit in a PU. firstVclNalUnitInPic is the first VCL NAL unit of an AU (and consequently the PU containing the VCL NAL unit is the first PU of the AU) when one or more of the following conditions are true:

* + - The value of nuh\_layer\_id of the VCL NAL unit is less than the nuh\_layer\_id of the previous picture in decoding order.
    - The value of ph\_pic\_order\_cnt\_lsb of the VCL NAL unit differs from the ph\_pic\_order\_cnt\_lsb of the previous picture in decoding order.
    - PicOrderCntVal derived for the VCL NAL unit differs from the PicOrderCntVal of the previous picture in decoding order.
  1. As follows: (R0124)

A VCL NAL unit is the first VCL NAL unit of an AU (and consequently the PU containing the VCL NAL unit is the first PU of the AU) when the VCL NAL unit is the first VCL NAL unit that follows a PH NAL unit or has picture\_header\_in\_slice\_header\_flag equal to 1 and one or more of the following conditions are true:

...

This issue had also been discussed in the ticket system for ticket #979, and a couple of approaches were discussed in that system. It was agreed that the current text has a bug. The three ways to fix it are all technically equivalent; the differences are only editorial.

AHG Recommendation (BF / expression of existing intent): Correct the text as described (with the editorial detail delegated to the editor).

Discussion stopped here for AHG Session 1.14 on Monday 13 April at 0915 UTC.

Discussion began here for JVET on 15 April at 1300 (UTC) (GJS, JRO, YKW).

1. Mandate the EOS NAL unit for easy detection of the first VCL NAL unit of a coded picture. (R0163)
   1. Replace the SH flag picture\_header\_in\_slice\_header\_flag with a variable derived based on the presence of the PH NAL unit. (R0163)

In the case of combined PH+SH, the PH NAL unit will not be present. At the transition between CLVSs, the proponent indicates that in order to determine that a new CLVS has begun, it may be necessary to parse SEs of the SH to identify the first VCL NAL unit of the new CLVS.

It was asked why we put the PH in the slice NAL unit instead of moving the slice NAL unit payload into the PH (and perhaps renaming the NUT). It was then explained that this would require increasing the number of picture NUTs to be able to convey random access information.

We are currently using the first bit of the SH to indicate whether a PH is combined into it or not.

It was noted that in HEVC it is also necessary to look at the first bit beyond the NAL unit header, where the first\_slice\_segment\_in\_pic\_flag is located. It was commented that this need has not been a significant problem for HEVC. The proponent pointed out that in VVC this bit is only needed at the transition between CLVSs.

It was commented that, in the RTP payload format for HEVC there is a use of the first\_slice\_segment\_in\_pic\_flag and it was not considered a problem, whereas a NAL unit may be a large chunk of data in that environment. Systems typically also support timestamps.

It was commented that it is generally necessary to check the PH presence bit anyway if NAL units may be lost.

It was commented that if we take action on this, it should be to require EOS only under the condition when it would be needed.

Other than the proponent, it was considered acceptable for the detection of the new CLVS in this circumstance to involve checking the PH presence bit in the SH, so no action was take on this.

1. Change the semantics of the 6 PPS flags rpl\_info\_in\_ph\_flag, dbf\_info\_in\_ph\_flag, sao\_info\_in\_ph\_flag, alf\_info\_in\_ph\_flag, wp\_info\_in\_ph\_flag, qp\_delta\_info\_in\_ph\_flag as follows (R0251) – removing some uses of “that do not contain a PH syntax structure” and changing a “may” to “shall” (italics only for notes emphasis below):

**rpl\_info\_in\_ph\_flag** equal to 1 specifies that reference picture list information is present in the PH syntax structure and not present in slice headers referring to the PPS that do not contain a PH syntax structure. rpl\_info\_in\_ph\_flag equal to 0 specifies that reference picture list information is not present in the PH syntax structure and may be present in slice headers referring to the PPS.

**dbf\_info\_in\_ph\_flag** equal to 1 specifies that deblocking filter information is present in the PH syntax structure and not present in slice headers referring to the PPS that do not contain a PH syntax structure. dbf\_info\_in\_ph\_flag equal to 0 specifies that deblocking filter information is not present in the PH syntax structure and may be present in slice headers referring to the PPS. When not present, the value of dbf\_info\_in\_ph\_flag is inferred to be equal to 0.

**sao\_info\_in\_ph\_flag** equal to 1 specifies that SAO filter information is present in the PH syntax structure and not present in slice headers referring to the PPS that do not contain a PH syntax structure. sao\_info\_in\_ph\_flag equal to 0 specifies that SAO filter information is not present in the PH syntax structure and may be present in slice headers referring to the PPS.

**alf\_info\_in\_ph\_flag** equal to 1 specifies that ALF information is present in the PH syntax structure and not present in slice headers referring to the PPS that do not contain a PH syntax structure. alf\_info\_in\_ph\_flag equal to 0 specifies that ALF information is not present in the PH syntax structure and may be present in slice headers referring to the PPS.

**wp\_info\_in\_ph\_flag** equal to 1 specifies that weighted prediction information may be present in the PH syntax structure and not present in slice headers referring to the PPS that do not contain a PH syntax structure. wp\_info\_in\_ph\_flag equal to 0 specifies that weighted prediction information is not present in the PH syntax structure and may be present in slice headers referring to the PPS. When not present, the value of wp\_info\_in\_ph\_flag is inferred to be equal to 0.

**qp\_delta\_info\_in\_ph\_flag** equal to 1 specifies that QP delta information is present in the PH syntax structure and not present in slice headers referring to the PPS that do not contain a PH syntax structure. qp\_delta\_info\_in\_ph\_flag equal to 0 specifies that QP delta information is not present in the PH syntax structure and *shall* be present in slice headers referring to the PPS.

Decision (Ed. BF/expression of existing intent): Adopt this change, except using “is” rather than “shall be”.

See also item 4).

[JVET-R0060](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9704) AHG9/AHG12: On CLVSs with one slice per picture [Y.-K. Wang, Z. Deng, L. Zhang, K. Zhang, J. Xu (Bytedance)]

[JVET-R0104](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9748) AHG9: On Raster-scan Slice Signalling [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

[JVET-R0113](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9757) AHG9: On Picture Parameter Set [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

Item 2 of this contribution belongs to this category.

Item 2 proposes that, when there is no picture partitioning, not to signal the PPS-level flags that indicate whether parameters are signalled in picture header or in slice header (e.g., rpl\_info\_in\_ph\_flag, sao\_info\_in\_ph\_flag, etc. – six flags) always send these in the SH. Infer them to be equal to 0. (JVET-R0113 proposal 2).

This is related to R0251 item 3.

[JVET-R0118](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9762) AHG9/AHG12: On signalling of subpicture partitioning in SPS [B. Choi, S. Wenger, S. Liu (Tencent)]

Item 1 of this contribution belongs to this category.

[JVET-R0162](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9806) AHG9: PPS and SH syntax cleanup [J. Chen, J. Luo, Y. Ye, R.-L. Liao (Alibaba)]

Item 3 (skip signalling of slice\_address) of this contribution belongs to this category.

[JVET-R0163](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9807) AHG9: On Picture Header [J. Chen, J. Luo, Y. Ye, R.-L. Liao (Alibaba)]

[JVET-R0189](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9833) AHG9: On picture\_header\_in\_slice\_header\_flag syntax element [Hendry, S. Kim, J. Nam, H. Jang, J. Lim (LGE)]

[JVET-R0200](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9844) AHG9: APS information signalling in Slice Header [G. Laroche, N. Ouedraogo, P. Onno (Canon)]

The second aspect (on alf\_info\_in\_ph\_flag) of item 2 of this contribution belongs to this category.

[JVET-R0202](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9846) AHG9: Syntax cleanups when Picture Header is in the Slice Header [G. Laroche, N. Ouedraogo, P. Onno (Canon)]

Items 2-4, and the num\_tiles\_in\_slice\_minus1 and slice\_address aspects of item 1 of this contribution belong to this category.

[JVET-R0210](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9854) AHG9: Cleanup of Picture Header Syntax Structure in Slice Header [S. Esenlik, B. Wang, A. Kotra, E. Alshina (Huawei)]

The num\_tiles\_in\_slice\_minus1 and slice\_address aspects of this contribution belong to this category.

[JVET-R0220](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9864) AHG9: Weight prediction syntax cleanup [J. Luo, J. Chen, Y. Ye (Alibaba)]

[JVET-R0251](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9895) AHG9: Fixes related to the picture header [M. Pettersson, R. Sjöberg, M. Damghanian, Z. Zhang, J. Enhorn (Ericsson)]

Item 3 of this contribution belongs to this category.

[JVET-R0124](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9768) AHG9: Clean-ups on picture header [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

Items 1 and 2 of this contribution belong to this category.

### Picture header and slice header (13)

[JVET-R0410](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10072) AHG9: A summary of proposals on PH and SH syntax [Y.-K. Wang, L. Zhang (Bytedance)]

Discussion began here for JVET on 15 April at 1410 (UTC) (GJS, JRO, YKW).

This contribution provides a summary of the 12 proposals on PH and SH syntax.

It was suggested that this summary, in terms of a list of design questions, be used for the reviewing of these proposals, such that the discussions can be in a more structured and efficient manner.

1. On allowed slice types in a picture
   1. Add a new PH flag ph\_multiple\_slice\_types\_in\_pic\_flag (this new flag is skipped when the PPS indicates that there is only one slice), and when this new flag is equal to 0, signal the slice type in the PH (by adding a new PH SE ph\_slice\_type) and remove the signalling of slice type in the SH. (R0052 methods 1 and 2)

One comment was that the name of such a flag should be different (e.g. adding “allowed”)

It was also commented that the semantics should have a “one-way” definition, and the proponent confirmed that the proposed semantics was “one-way”.

It was noted that setting this flag to 0 would eliminate the ability to use such a picture with merging if there would be multiple slice types in the merged picture.

The purpose of this change would be to save bits in the SH.

The bit savings did not seem sufficient to justify the reduction of functionality, and there was no clear problem with the current syntax, so no action was taken on this.

* + 1. In addition, remove the existing PH flag ph\_inter\_slice\_allowed\_flag. (R0052 methods 1 and 2)
       1. Derive the variables InterSliceAllowed and IntraSliceAllowed based on the values of the PH SEs ph\_multiple\_slice\_types\_in\_pic\_flag (new), ph\_intra\_slice\_allowed\_flag (existing), and ph\_slice\_type (new), and use these variables (instead of using the existing flags) for skipping intra-coding-specific PH SEs and inter-coding-specific PH SEs. (R0052 method 1)
    2. In addition, replace the existing PH flag ph\_inter\_slice\_allowed\_flag with a 2-bit indicator ph\_allowed\_slice\_types\_idc that specifies allowed slice types within a picture as follows (R0052 method 2), as shown below:

|  |  |
| --- | --- |
| ph\_allowed\_slice\_types\_idc | allowed values of slice types |
| 0 | 1, 2 (P, I) |
| 1 | 0, 2 (B, I) |
| 2 | 0, 1 (B, P) |
| 3 | 0, 1, 2 (B, P, I) |

* + - 1. Derive the variables BSliceAllowed, PSliceAllowed, and ISliceAllowed based on the values of the PH SEs ph\_multiple\_slice\_types\_in\_pic\_flag (new), ph\_slice\_type (new), and ph\_allowed\_slice\_types\_idc (new), and use these variables (instead of using the existing flags) for skipping intra-coding-specific PH SEs and inter-coding-specific PH SEs.
      2. Use the BSliceAllowed and PSliceAllowed for skipping the WP table in the PH.
    1. When ph\_multiple\_slice\_types\_in\_pic\_flag (new) is equal to 1:
       1. The slice type is signalled in the SH with ue(v) coding (as existing) if IntraSliceAllowed is equal to 1 and with u(1) coding otherwise. (R0052 method 1)
       2. If ph\_allowed\_slice\_types\_idc is equal to 3, the slice type is signalled in the SH with ue(v) coding (as existing). Otherwise, signal a one-bit slice\_type\_modified SE. (R0052 method 2)
    2. Add a new PPS flag pps\_multiple\_slice\_types\_in\_pic\_flag. (R0052)
  1. Add a new PH flag ph\_b\_slice\_allowed\_flag (this new flag is skipped when no inter slice is allowed in a picture). (R0061 and R0250)

One motivation for this is basically to have an indication of complexity characteristics; it was commented that this would be just a metadata purpose and could be conveyed with an SEI message or similar.

Another motivation was said to be not send the PH and SH SEs that are only relevant to B slices. A participant said the bit reduction is only 1 bit in the PH (adding one bit always to gate 2 bits saved in the special case) if there are no B slices in the CLVS. Another said that B slices would ordinarily be used when the encoder is emphasizing coding efficiency, so it may not be desirable to make special provisions for this use. No action was thus taken on this.

* + 1. Add a new SPS flag sps\_b\_slice\_allowed\_flag. (R0061)
       1. When it is known that a CLVS has no B slices (sps\_b\_slice\_allowed\_flag is equal to 0), skip the SPS flags sps\_weighted\_bipred\_flag, sps\_bdof\_enabled\_flag, sps\_smvd\_enabled\_flag, sps\_dmvr\_enabled\_flag, sps\_bcw\_enabled\_flag, and sps\_gpm\_enabled\_flag and infer the values. (R0061) – 5 flags in the SPS.

1. Skip the signalling of some PH SEs when it is known that a picture has no B slices (R0052 method 2, R0061, R0250, R0324)

Most of the sub-items in this item are no longer relevant per item 1 above.

* 1. When it is known that a picture has no B slices, skip the PH SEs ph\_collocated\_from\_l0\_flag, mvd\_l1\_zero\_flag, ph\_disable\_bdof\_flag, and ph\_disable\_dmvr\_flag and infer the values. (R0052 method 2, R0061, R0250, R0324)
     1. Skip them based on a new variable BSliceAllowed that is derived based on the values of PH SEs ph\_multiple\_slice\_types\_in\_pic\_flag (new), ph\_slice\_type (new), and ph\_allowed\_slice\_types\_idc (new). (R0052 method 2)
     2. Skip them based on a new PH flag ph\_b\_slice\_allowed\_flag (new). (R0061, R0250)
     3. Skip them when the following condition (based on existing SEs) is false (R0324):

rpl\_info\_in\_ph\_flag && num\_ref\_entries[ 0 ][ RplsIdx[ 0 ] ] > 1 &&  
num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] > 1

It was remarked that the correct condition would be rpl\_info\_in\_ph\_flag &&  
num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] > 0

It was commented that the inference expressed in the semantics may need refinement.

Decision (cleanup): Adopt this aspect, modified as suggested. Text was to be refined offline and uploaded in a revision.

Post-meeting note: After the meeting, it was found that, for mvd\_l1\_zero\_flag, ph\_disable\_bdof\_flag, and ph\_disable\_dmvr\_flag, the correct condition would be "!rpl\_info\_in\_ph\_flag | | num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] > 0", because when rpl\_info\_in\_ph\_flag is equal to 0, it is not possible at the PH level to determine whether the picture can have B slices, and there the ph\_mvd\_l1\_zero\_flag, ph\_disable\_bdof\_flag and ph\_disable\_bmvr\_flag need to be signalled in the PH.

* 1. Use the information that a picture has no B slices to skip the WP table in the PH. (R0052 method 2, R0250)
     1. The information is derived based on a new variable BSliceAllowed that is derived based on the values of ph\_multiple\_slice\_types\_in\_pic\_flag (new), ph\_slice\_type (new), and ph\_allowed\_slice\_types\_idc (new). (R0052 method 2)
     2. The information is derived based on a new PH flag ph\_b\_slice\_allowed\_flag. (R0250)
  2. When it is known that a picture has no B slices, skip the WP table SE num\_l1\_weights and infer the values. (R0052 method 2, R0061, R0324)
     1. Skip it based on a new variable BSliceAllowed that is derived based on the values of ph\_multiple\_slice\_types\_in\_pic\_flag (new), ph\_slice\_type (new), and ph\_allowed\_slice\_types\_idc (new). (R0052 method 2)
     2. Skip it based on a new PH flag ph\_b\_slice\_allowed\_flag. (R0061)
     3. Skip it when the following condition (based on existing SEs) is false (R0324):

rpl\_info\_in\_ph\_flag && num\_ref\_entries[ 0 ][ RplsIdx[ 0 ] ] > 1 &&  
num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] > 1

See the notes for 2.a.iii above, and should be amended in the same way.

Decision (cleanup): Adopt this aspect, modified as suggested. Text is to be refined offline and uploaded in a revision. It was noted that there are other proposals that interact with this (see the notes in section 6.1.10).

After review of those interacting proposals, this was confirmed on Friday 24 April at 0525 UTC (GJS).

1. Skip the SH SEI slice\_type based on new PH SE(s). (R0052 methods 1 and 2, R0061, R0250)

No action was taken on these; see the notes on items 1 and 2.

* 1. When ph\_multiple\_slice\_types\_in\_pic\_flag (new) is equal to 0, skip the SH SE slice\_type and infer it to be equal to ph\_slice\_type (new). (R0052 methods 1 and 2)
  2. When ph\_b\_slice\_allowed\_flag (new) and ph\_intra\_slice\_allowed\_flag (existing) are both equal to 0, skip the SH SE slice\_type and infer it to be equal to 1. (R0061, R0250)
     1. Furthermore, skip the SH SEI slice\_type when the SH flag picture\_header\_in\_slice\_header\_flag (existing) is equal to 1. (R0250)

1. Skip ph\_inter\_slice\_allowed\_flag and infer its value to be equal to 0
   1. When the PH flag gdr\_or\_irap\_pic\_flag is equal to 1 and the PH flag gdr\_pic\_flag is equal to 0 and layer\_id is equal to 0 (i.e., the picture is an IRAP picture). (R0112)
   2. When the PH flag gdr\_or\_irap\_pic\_flag is equal to 1 and the PH flag gdr\_pic\_flag is equal to 0 (i.e., the picture is an IRAP picture), and vps\_independent\_layer\_flag[ GeneralLayerIdx[ nuh\_layer\_id ] ] is equal to 1. (R0278)

Note that this VPS flag is inferred to be equal to 1 if the VPS is not present.

Regarding item a, it was noted that layer\_id equal to 0 does not have the special meaning that it has in HEVC.

It was asked whether we have syntax in the PH or SH that depends on the VPS. The RPL syntax does contain a dependency, but it is not a parsing dependency, and in a part that is only needed when inter-layer referencing is used. This would be the only use of VPS information for parsing the PH.

It was noted that another variation could be to use sps\_vps\_id equal to 0 instead of vps\_independent\_layer\_flag[ GeneralLayerIdx[ nuh\_layer\_id ] ] is equal to 1.

The bit savings would be very minimal, so no action was taken on this.

Decision (sensibility constraint): Require ph\_inter\_slice\_allowed\_flag to be equal to 0 under the condition described above for R0278.

It was asked whether this constraint might be harmful to BEAM extraction usage, and this did not seem to be a problem.

1. Change the semantics of gdr\_or\_irap\_pic\_flag as follows (R0112) – formerly “the current picture may or may not be a GDR or an IRAP picture.”:

**gdr\_or\_irap\_pic\_flag** equal to 1 specifies that the current picture is a GDR or IRAP picture. gdr\_or\_irap\_pic\_flag equal to 0 specifies that the current picture is not a GDR picture and may or may not be an IRAP picture.

This is intended as a clarification of existing semantics intent.

Decision (expression of existing intent): Adopt this item.

It was commented that perhaps instead of using gdr\_or\_irap\_pic\_flag, it may be simpler to just have two flags: irap\_pic\_flag and gdr\_pic\_flag. (The presence of one could be conditioned on the other.) The current notion is to allow a system to check just one bit to determine whether random access is possible or not. This can be studied offline.

1. Do either of the following two (R0192):
   1. When GDR is enabled (i.e., gdr\_enabled\_flag is equal to 1), a non-zero value is signalled in SPS to be used as an offset to be added into the equation for deriving the POC of the recovery point picture.
   2. Change the syntax element (ph\_)recovery\_poc\_cnt to become recovery\_poc\_cnt\_minus1.

The basic idea of this is that having (ph\_)recovery\_poc\_cnt equal to 0 is equivalent to having an IRAP picture, and that the signalling could be made more efficient by disallowing this use.

It was noted that GDR is not envisioned to be used with BEAM applications.

It was commented that some encoders that use GDR pictures might just never want to indicate IRAP.

It was commented that an encoder might hypothetically pre-decide to use GDR but, after encoding the picture, determine that there was no need for a non-zero recovery POC count.

The bit savings for approach b would be very minimal, and there seemed to be no strong need for action.

Approach “a” (with the offset allowed to be 0) could provide a bit savings at the PH level.

It was commented that a variation of this would be to allow the offset in the PH to be signed (and require the sum to be greater than or equal to 0, and maybe use unsigned coding in the PH if the SPS offset is zero).

An encoder would only use the proposed approach if it is certain that it would never use a recovery POC offset less than a particular value.

It was commented that although some PH bit savings could be provided, it was undesirable to complicate the scheme with the SPS offset concept.

No action was taken on this.

1. When gdr\_pic\_flag is equal to 1, skip the PH SE ph\_inter\_slice\_allowed\_flag infer it to be equal to 1. (R0198)

Given that we allow the recovery POC delta to be zero for a GDR picture as noted above, no action was taken on this.

1. When gdr\_or\_irap\_pic\_flag is equal to 1 and gdr\_pic\_flag is equal to 0 (i.e., the picture is an IRAP picture), add a new PH flag idr\_pic\_flag. (R0198)
   1. When sps\_idr\_rpl\_present\_flag is equal to 0 and idr\_pic\_flag is equal to 1, RPL signalling is skipped in the PH, even when the value of rpl\_info\_in\_ph\_flag is equal to 1. (R0198)

This would save about 1 bit in the PH (adding one bit and removing two).

This is related to the earlier discussion noted in discussion of item 5 above, additionally distinguishing between CRA and IDR (without using the NAL unit type of the slice NAL units).

This can be studied offline with item 5 above.

1. Rename the syntax elements pic\_sign\_data\_hiding\_enabled\_flag, sps\_bdof\_pic\_present\_flag, sps\_dmvr\_pic\_present\_flag and sps\_prof\_pic\_present\_flag to ph\_sign\_data\_hiding\_enabled\_flag, sps\_bdof\_control\_present\_in\_ph\_flag, sps\_dmvr\_control\_present\_in\_ph\_flag and sps\_prof\_control\_present\_in\_ph\_flag, respectively. (editorial) (R0251)

The is to consistently use “ph” rather than “pic” and to indicate the location of things controlled by presence flags.

Decision (Ed.): The editor requested to consider this.

1. Byte align before entry point offset fields for easier updating during encoding, and separate entry point offsets by one bit equal to one and divide into upper and lower bits to avoid start code emulation without the need for an emulation prevention byte. (R0165)

The proponent indicated that this would help encoders that need to go back and rewrite entry points after encoding the tiles or CTU rows, remarking also that emulation prevention bytes can interfere with this process.

The proposal also changes the coding of the list of entry points in order to prevent start code emulation within the list.

It was noted that entry points offsets are required for tiles and optional for WPP CTU rows. It was said that the rationale for offsets being mandatory for tiles was to be friendly to raster-scan-oriented decoding for some architectures.

We already have byte alignment with a bit equal to 1 at the transition between the entry point offsets and the payload data.

It was commented that separate buffers are ordinarily used in the encoder before writing out this data and that writing the offsets should not be a significant problem. The proponent indicated that separate buffers would not be necessary with the proposal and that such buffers could be quite large (e.g., a whole picture of coded data).

Making the offsets optional (reverting a decision of the previous meeting) was also suggested to be considered. Aside from other considerations, the offsets cost bits (and encoders may not use tiles).

Offsets were mandatory in HEVC.

It was commented that the encoded offset length could include the additional bits.

The proponent and several others expressed a preference for making the entry points optional.

Even if optional, the syntax could use the proposed scheme, but this was not requested.

There was discussion of the coding efficiency impact, which was not further discussed due to lack of time.

It was mentioned that there was also a discussion of potentially carrying entry point information at the system level (see AHG16 email discussion prior to the Brussels meeting). Conveying entry points in an SEI message was also mentioned as a possibility, but was not further discussed due to lack of time.

Decision (encoder complexity and coding efficiency): It was agreed to revert to making the entry point signalling optional.

1. Move the entry point syntax to the end of the slice header, i.e. behind the slice header extension. (R0298)

Decision (cleanup): Adopted.

1. Move the slice\_lmcs\_enabled\_flag to an earlier position, immediately after the ALF SEs in the SH, similarly as in the PH (R0200).

This aspect no longer needed to be discussed, as it was addressed in earlier discussions.

Discussion ended here on 15 April at 1715 (UTC).

[JVET-R0052](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9696) AHG9: Overhead reduction for picture header and slice header [S.-T. Hsiang, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-R0061](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9705) AHG9: On allowed slice types in a picture [L. Zhang, Y.-K. Wang, K. Zhang, Z. Deng (Bytedance)]

[JVET-R0250](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9894) AHG9: On B-slice signalling in the PH and derivation of slice\_type [M. Pettersson, R. Yu, R. Sjöberg, M. Damghanian, Z. Zhang, J. Enhorn (Ericsson)]

[JVET-R0112](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9756) AHG9: On picture header [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

[JVET-R019](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9836)2 AHG9: On signalling recovery point picture [Hendry (LGE)]

[JVET-R019](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9842)8 AHG9: On signalling of IDR or GDR picture flag in picture header [J. Nam, H. Jang, J. Lim, Hendry, S. Kim (LGE)]

[JVET-R0251](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9895) AHG9: Fixes related to the picture header [M. Pettersson, R. Sjöberg, M. Damghanian, Z. Zhang, J. Enhorn (Ericsson)]

Item 1 of this contribution belongs to this category.

[JVET-R0278](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9922) AHG8: On SPS sharing and slice type constraint [V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Item 2 (in section 3 of R0278) of this contribution belongs to this category.

[JVET-R0324](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9968) AHG9: On syntax signalling conditions in picture header [Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, W. Chen, X. Wang (Kwai Inc.)]

[JVET-R0165](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9809) AHG12: Entry point offsets avoiding start code emulation prevention byte [K. Abe, T. Toma, V. Drugeon (Panasonic)]

[JVET-R0298](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9942) AHG9: On order of syntax elements for entry point offsets [K. Suehring (HHI), R. Foray (Allegro DVT)]

[JVET-R0200](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9844) AHG9: APS information signalling in Slice Header [G. Laroche, N. Ouedraogo, P. Onno (Canon)]

Item 1 of this contribution belongs to this category.

### Mixed NAL unit types within a coded picture (11)

Discussion began here for JVET Track A on 18 April at 0715 UTC (GJS, YKW).

[JVET-R0414](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10076) AHG9: A summary of proposals on mixed NAL unit types within a coded picture [Y.-K. Wang (Bytedance)]

This contribution provides a summary of the 10 proposals on mixed NAL unit types within a coded picture.

It is suggested that this summary, in terms of a list of design questions, is used for the reviewing of these proposals, such that the discussions can be in a more structured and more efficient manner.

1. On the types of pictures with mixed NUTs and naming of NUTs:
   1. Don't define types of pictures with mixed NUTs, define subpicture types (one corresponding to each picture type) instead. (R0042)
      1. In addition, change the naming of the content of VCL NUTs as follows:

|  |  |  |
| --- | --- | --- |
| **Name of nal\_unit\_type** | **Content of NAL unit and RBSP syntax structure** | **NAL unit type class** |
| TRAIL\_NUT | Coded slice of a trailing picture *or subpicture*\* slice\_layer\_rbsp( ) | VCL |
| STSA\_NUT | Coded slice of an STSA picture *or subpicture*\* slice\_layer\_rbsp( ) | VCL |
| RADL\_NUT | Coded slice of a RADL picture *or subpicture*\* slice\_layer\_rbsp( ) | VCL |
| RASL\_NUT | Coded slice of a RASL picture *or subpicture*\* slice\_layer\_rbsp( ) | VCL |
| IDR\_W\_RADL IDR\_N\_LP | Coded slice of an IDR picture *or subpicture*\* slice\_layer\_rbsp( ) | VCL |
| CRA\_NUT | Coded slice of a CRA picture *or subpicture*\* silce\_layer\_rbsp( ) | VCL |
| GDR\_NUT | Coded slice of a GDR picture *or subpicture*\* slice\_layer\_rbsp( ) | VCL |
| \* indicates a property of a picture when mixed\_nal\_unit\_types\_in\_pic is equal to 0 and a property of the subpicture when mixed\_nal\_unit\_types\_in\_pic is equal to 1 | | |

* 1. Consolidate picture types into 5 types: IRAP, GDR, leading, trailing and STSA picture, including for pictures with mixed NUTs, through changing the naming of the content of VCL NUTs as follows (R0267):

|  |  |  |
| --- | --- | --- |
| **Name of nal\_unit\_type** | **Content of NAL unit and RBSP syntax structure** | **NAL unit type class** |
| TRAIL\_NUT | Coded slice of a trailing picture slice\_layer\_rbsp( ) | VCL |
| STSA\_NUT | Coded slice of an STSA picture *or a trailing picture* slice\_layer\_rbsp( ) | VCL |
| RADL\_NUT | Coded slice of a *leading or a trailing picture* slice\_layer\_rbsp( ) | VCL |
| RASL\_NUT | Coded slice of a *leading or a trailing picture* slice\_layer\_rbsp( ) | VCL |
| IDR\_W\_RADL IDR\_N\_LP | Coded slice of an IDR picture, *a leading or a trailing picture* slice\_layer\_rbsp( ) | VCL |
| CRA\_NUT | Coded slice of a CRA picture, *a leading or a trailing picture* silce\_layer\_rbsp( ) | VCL |
| GDR\_NUT | Coded slice of a GDR picture slice\_layer\_rbsp( ) | VCL |
| ... | ... |  |

Both proposals are essentially only editorial, as they are just expressions of the existing technical intent, and they would not change the intended output behaviour of a decoder or the conformance of a bitstream. They are just a matter of terminology.

One participant commented that the NAL unit types seem less useful to a decoder than seems desirable in the mixed case.

From a technical perspective, the table is more necessary for the other NAL unit types that are not shown above, as it specifies the RBSP syntax structure that corresponds to each NAL unit type.

It was commented that the “a” expression seems more clear and useful to the reader. Adding an explanatory footnote to the table was suggested, and suggested text for this was integrated above.

Decision (expression of existing intent): Adopt approach “a”, as amended.

1. On requiring subpic\_treated\_as\_pic\_flag[ ] to be equal to 1 for subpictures with different NUTs in a picture, replace the existing constraint on this specified only for the mixing of an IRAP NUT and another NUT with the following constaint to cover all allowed NUT mixes (R0042):

Any two neighbouring subpictures with different NAL unit types within a picture shall both have the subpic\_treated\_as\_pic\_flag[ ] equal to 1.

This was agreed to be the minimum we should do.

* 1. Add the following constraint on this for the mixing of RASL\_NUT and RADL\_NUT (R0270):

A RADL picture (i.e., a picture that contains one or more slices all with nal\_unit\_type equal to RADL\_NUT) may reference a RASL picture with mixed\_nalu\_types\_in\_pic\_flag equal to 1. When a slice of such a RADL picture refer to a RASL picture as an active reference picture, the following applies:

* + - The current subpicture (i.e., the subpicture that contains the slice) and the referenced subpicture of the RASL picture shall have subpic\_treated\_as\_pic\_flag[ i ] equal to 1.

Alternatively it was suggested that *always* when any two subpictures have different NAL unit types, subpic\_treated\_as\_pic\_flag[ ] shall be equal to 1 for all subpictures in the picture that contain at least one P or B slice. Decision (cleanup): Express this modified constraint (exact text to be provided by YKW).

1. On constraints on prediction relationship (through constraints on RPLs): Similar constraints for all different types of pictures and the same-layer pictures in the preceding and succeeding AUs are specified in the subpicture domain for all the different types of subpictures and the same-layer subpictures with the same subpicture index in preceding and succeeding AUs. (R0042)
   1. Add the following constraint for the mixing of RASL\_NUT and RADL\_NUT (R0270):

A RADL picture (i.e., a picture that contains one or more slices all with nal\_unit\_type equal to RADL\_NUT) may reference a RASL picture with mixed\_nalu\_types\_in\_pic\_flag equal to 1. When a slice of such a RADL picture refer to a RASL picture as an active reference picture, the following applies:

* + - The referenced subpicture of the RASL picture shall only contain slices with nal\_unit\_type equal to RADL\_NUT.

Item “a” was said to be resolved by the proposal in R0042.

It was commented that it should not be necessary to express the constraints both for pictures and for subpictures. If they are specified for subpictures, this may be sufficient.

Decision (expression of existing intent): Adopt as proposed in R0042.

1. On constraints on relative decoding order and output order:
   1. Similar constraints for all the different types of pictures and the same-layer pictures in the preceding and succeeding AUs are specified in the subpicture domain for all the different types of subpictures and the same-layer subpictures with the same subpicture index in preceding and succeeding AUs. (R0042)
   2. Similar intent as item 4.a, through the following text changes (R0136):

For a single-layer bitstream which include all picture with mixed\_nalu\_types\_in\_pic\_flag equal to 0 the following constraints apply:

Or for a single-layer bitstream which include one or more pictures with mixed\_nalu\_types\_in\_pic\_flag equal to 1, the following constrains apply to a bitstream of a subpicture sequence which could be extracted:

* + - Each picture, other than the first picture in the bitstream in decoding order, is considered to be associated with the previous IRAP picture in decoding order.
    - When a picture is a leading picture of an IRAP picture, it shall be a RADL or RASL picture.
    - ...

Decision (expression of existing intent): Adopt as proposed in R0042.

1. Replace the following constraint requiring that a subpicture with a different subpicture ID compared to the collocated subpicture in the previous picture in the CLVS needing to have IRAP NUTs (R0276):

When the current picture is not the first picture of the CLVS, for each value of i in the range of 0 to sps\_num\_subpics\_minus1, inclusive, if the value of SubpicIdVal[ i ] is not equal to the value of SubpicIdVal[ i ] of the previous picture in decoding order in the same layer, the nal\_unit\_type for all coded slice NAL units of the subpicture in the current picture with subpicture index i shall be equal to a particular value in the range of IDR\_W\_RADL to CRA\_NUT, inclusive.

to be as follows (basically to only allow reordering/change of the subpicture IDs at pictures that are not used for inter-prediction reference):

For each value of i in the range of 0 to sps\_num\_subpics\_minus1, inclusive, if the value of SubpicIdVal[ i ] is not equal to the value of SubpicIdVal[ i ] of a reference picture, such reference picture shall not be used for predicting the slice NAL units of the subpicture in the current picture with subpicture index i.

This is a relaxation to allow change of subpicture ID for non-reference pictures.

After offline study, this was discussed further on Friday 24 April at 0525 (GJS).

Editorially, it was commented that this should be rephrased, in the spirit of:

For each value of i in the range of 0 to sps\_num\_subpics\_minus1, inclusive, if the value of SubpicIdVal[ i ] is not equal to the value of SubpicIdVal[ i ] of a reference picture, the active entries of the RPL of the coded slices in the i-th subpicture of the current picture shall not include that reference picture.

An example use case that was discussed is 360° real-time streaming with a background LTRP.

It was commented that the use of this may involve a higher degree of coordination of the encoding than in most BEAM uses. Another participant said the potential use case seems hypothetical and not likely to be commonly used. The proponent said the use of this feature is voluntary for the encoder, so it would not pose a problem if an encoder chose not to take advantage of the slightly greater flexibility.

Decision (cleanup): Adopt with editorial clarification as described.

1. On signalling and semantics of the mixed NUT flag:
   1. Move the mixed\_nalu\_types\_in\_pic\_flag from the PPS to the PH. (R0085, R0315)
      1. Condition it under "if( !gdr\_or\_irap\_pic\_flag )" in the PH. (R0085, R0315)
      2. Add a constraint such that when subpic\_info\_present\_flag is equal to 0 or sps\_num\_subpics\_minus1 is equal to 0, the value of mixed\_nalu\_types\_in\_pic\_flag shall be 0. (R0085)

It was asked why the flag should be moved. The proponent said the desire was to minimize the number of PPSs. It was asked whether this would require changing the PH for BEAMing, and proponent suggested to define this flag as a “one way” constraint. However, a “one way” definition would reduce the ability to clearly identify non-mixed pictures – an encoder could just label everything as mixed. This had been previously considered in the context of Q0284.

No action was thus taken on this.

* 1. Add an SPS flag to indicate presence of pictures with mixed NUTs in the CLVS. (R0085, R0267, R0315)
     1. When item 5.a is done, use this new SPS flag to gate the flag moved to the PH. (R0085, R0315)

It was noted that there is a general constraint flag for this already, and the move of a flag to the PH was not done per item “a” above, so no action was taken on this.

* 1. Specify the semantics of mixed\_nalu\_types\_in\_pic\_flag to be one-way, as follows (R0315):

**mixed\_nalu\_types\_in\_pic\_flag** equal to 1 specifies that each picture referring to the PPS has more than one VCL NAL unit and the VCL NAL units *may* not have the same value of nal\_unit\_type. mixed\_nalu\_types\_in\_pic\_flag equal to 0 specifies that each picture referring to the PPS has one or more VCL NAL units and the VCL NAL units of each picture refering to the PPS have the same value of nal\_unit\_type.

It was commented that there is a constraint that IRAP pictures shall have the mixed flag equal to 0. The proponent said that there should still be a constraint that if all NAL units of a picture have an IRAP (maybe or GDR) NUT, then the mix flag shall be 0.

Another participant said the IRAP case is not the only one that is of concern; leading pictures are also assisted by having two-way semantics. A mixture of RADL and RASL subpictures would be expected to result in RASL behaviour, and currently the output flag is set without checking all subpictures.

It was discussed whether rewriting of the PH would be needed for BEAMing.

The proponent said that BEAMing with merging an IRAP with a non-IRAP would involve having two picture headers in source content and selecting the one with the mixing flag equal to 1.

No action was taken, as most participants desired “two way” indication assurance for the mixture flag behaviour.

1. Disallow the mix of an IRAP NUT and a leading picture NUT. (R0203)

It was said that BEAMing is generally intended only with alignment of GOP structures such that the decoding order and output order of pictures in the source bitstreams are aligned.

Decision (an overlooked sensibility constraint): Adopt.

Discussion stopped here for JVET Track A on 18 April at 0915 (UTC).

Discussion began here for JVET Track A Monday 20 April at approximately 1300 UTC (GJS).

1. Allow mixing of more than two NUTs within a coded picture. (R0203). The constraint of only two had been imposed out of conservatism, and after further study, appeared not to be necessary. Multisource bitstream merging was discussed. There was no reason identified to have this constraint. Decision (cleanup): Adopt.
2. On mixing of RASL\_NUT with another NUT, do either of the following two options (R0267)
   1. Prohibit mixing of RASL\_NUT with another NUT.
   2. Add a new PPS or PH flag to indicate the presence of mixing of RASL\_NUT with another NUT.

The concept is mix bitstreams that have aligned CRAs for which some bitstream has RADL and another has RASL. It was originally intended for such a mixed picture to be treated as a RASL picture. There is a PPS flag to indicate that the picture is mixed, and the POC indicates that the picture is a leading picture.

There was discussion of a mixing of RASL and trailing picture (because of differing IRAP periods, esp. mixing open GOP and closed GOP) – see the prior contribution JVET-Q0396. Such a picture is treated as an ordinary trailing picture (associated with a different IRAP than in the source bitstream of the RASL picture).

Except for identifying an IRAP picture based on a PPS flag and the NUT of the first VCL NAL unit, the decoder does not need to care about the different NUTs of a picture in terms of the decoding process – the mixture only affects whether to output the decoded result or not. In the IRAP case, there is a PPS flag that indicates whether there is a mixture, and if there is a mixture, the picture is not an IRAP picture.

There seemed to be no need for the extra prohibition or additional flag as proposed, so no action was taken on this.

1. On treating a picture with mixed RASL\_NUT and RADL\_NUT in the output of the decoding process and bitstream conformance tests (R0270)
   1. A picture with mixed RASL\_NUT and RADL\_NUT is treated as a RASL picture during the decoding process, i.e., regardless of whether a RASL picture has slices with nal\_unit\_type equal to RADL\_NUT, the RASL picture is not output when the associated IRAP picture has NoOutputBeforeRecoveryFlag equal to 1.
   2. A picture with mixed RASL\_NUT and RADL\_NUT is treated as a RADL picture in bitstream conformance tests, i.e., only those RASL pictures for which all slices have nal\_unit\_type equal to RASL\_NUT associated with the first IRAP picture are removed from the bitstream to be decoded when the alternative HRD timing is used in the particular bitstream conformance test. These pictures can still serve as references for other pictures that are to be output, so they need to be kept in the bitstream.

Decision (expression of existing intent): Adopt (both aspects).

As an off-topic matter, there was discussion of whether the decoding process for GDR should output “partially dirty” pictures that precede the recovery point. It was commented that this is commonly done, but our standard says these are not output (and it may say that they shall not be output, just as the area outside a cropping window is also not output). This issue is for further study.

It was commented that there are two potential uses of GDR – one is trying to tune in rapidly, which is not always intended. The other use is to just keep “glass to glass” latency at a minimum while enabling (potentially slow) random access.

1. Add the following paragraph in the general decoding processs in clause 8.1.1 (R0120):

When mixed\_nalu\_types\_in\_pic\_flag is equal to 1 and at least one VCL NAL unit of a picture has nal\_unit\_type equal to CRA\_NUT, HandleCraAsCvsStartFlag and NoOutputBeforeRecoveryFlag for the picture are both set equal to 0.

The intent is that a mixed picture is not treated as an IRAP picture. Instead, it is treated as a trailing picture. This is agreed as the existing design intent. However, the proponent said this may not be sufficiently clear to the reader, and this is a valid concern.

It was commented that the identified flag variables are not used under these circumstances, so specifying values for them is not necessary or helpful, as they have no effect.

The editor may consider adding clarifying text about this (e.g., in one or more NOTEs), to make sure it is clear to the reader, but no normative action seemed necessary.

1. Change the semantics of gdr\_or\_irap\_pic\_flag as follows such that when mixed\_nalu\_types\_flag is equal to 1 the no\_output\_of\_prior\_pics\_flag can be signalled for a non-IRAP and non-GDR picture that contains at least one IRAP or GDR subpicture ([JVET-R0124](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9768)):

**gdr\_or\_irap\_pic\_flag** equal to 1 specifies that the current picture is a GDR or IRAP picture *or a picture with mixed\_nalu\_types\_in\_pic\_flag equal to 1 and VCL NAL units with NAL unit type equal to IDR\_W\_RADL, IDR\_N\_LP or CRA\_NUT*. gdr\_or\_irap\_pic\_flag equal to 0 specifies that the current picture may or may not be a GDR or IRAP picture.

(italics for added phrase)

It was commented that this does not seem quite correct because the gdr\_or\_irap\_pic\_flag flag has “one way” semantics.

It was commented that we don’t allow a mixture of IDR and CRA NAL unit types within a picture.

It was suggested to add a constraint that when mixed\_nalu\_types\_in\_pic\_flag is equal to 1 (i.e., a mixed picture) gdr\_or\_irap\_pic\_flag shall be equal to 0. Such a PH should be available from the one of the pre-merged picture, so rewriting the PH content should not be necessary.

This was further discussed on Friday 24 April at 0605 UTC (GJS) after offline study. No action was recommended since the use case seemed too hypothetical.

Discussion stopped here for JVET Track A Monday 20 April at 1605 UTC (GJS).

[Ed. Search/replace “(R0” and “ R0”.]

[JVET-R0042](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9686) AHG8/AHG9/AHG12: On mixed subpicture types within a picture [Y.-K. Wang (Bytedance)]

[JVET-R0136](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9780) AHG9/AHG12: Improvements on sps\_independent\_subpics\_flag and nal\_unit\_type constraint [M. Katsumata, M. Hirabayashi, T. Suzuki (Sony)]

Item 2 of this contribution belongs to this category.

[JVET-R027](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9920)6 AHG9: On IRAP NAL constraint for reordered subpictures [V. Seregin, Y. He, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-R0085](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9729) AHG9: On signalling the mixed NAL unit type flag [L. Chen, S.-T. Hsiang, O. Chubach, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-R0203](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9847) AHG9/AHG12: On combination of NAL unit types in a picture [Hendry, S. Kim (LGE)]

[JVET-R0267](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9911) AHG9/AHG12: On mixed NAL unit types [Y. He, M. Coban, V. Seregin, A.K. Ramasubramonian, M. Karczewicz (Qualcomm)]

Topics other than item 3 belong in this category.

[JVET-R027](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9914)0 AHG9: On mixing of RASL and RADL NAL unit types [Hendry, S. Kim (LGE), R. Skupin, Y. Sanchez, K. Suehring (HHI)]

[JVET-R0315](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9959) AHG9: On mixed nal unit type signalling and PPS cleanup [M. Coban, V. Seregin, Y. He, Y.-J. Chang, M. Karczewicz (Qualcomm)]

[JVET-R0120](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9764) AHG9: On mixed NAL unit types [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

[JVET-R0124](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9768) AHG9: Clean-ups on picture header [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

Item 3 of this contribution belongs to this category.

### RPL, WP, and collocated picture signalling (11)

Discussion began here for Track A on 18 April at 1300 (UTC) (GJS, YKW).

[JVET-R0411](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10073) AHG9: A Summary of Proposals Related to Reference Picture Lists, Weighted Prediction, and Collocated Picture Signalling [S. Deshpande (Sharp)]

This contribution intends to provide a summary of proposals on reference picture lists, weighted prediction and collocated picture signalling.

It is suggested that this summary be used for the reviewing of these proposals, such that the discussions may be done in a more structured and efficient manner.

**Related to RPL signalling**

1. Modify the current RPL active entries override signalling/ derivation?
   1. Two approaches for determining the number of active entries in the PH
      1. Allow signalling the RPL active entries override information in picture header? (JVET-R0102) or
      2. Derive the number of RPL active entries in picture header to be default active entries (JVET-R0059 item 1)
   2. Modify the RPL override signalling condition in slice header?:
      1. Update if conditioning in the slice header to be based on using !rpl\_info\_in\_ph − consistent with other cases where information is either in slice header or picture header. Depends on having number of active entries in picture header (see 1.a above) (JVET-R0059, JVET-R0102)
      2. Remove only “rpl\_info\_in\_ph\_flag | | ( ( nal\_unit\_type != IDR\_W\_RADL && nal\_unit\_type !=IDR\_N\_LP ) | | sps\_idr\_rpl\_present\_flag ) ) &&” conditioning in the slice header to not signal the override flag for I-slices (JVET-R0277 item 1).
      3. Remove only “rpl\_info\_in\_ph\_flag | |” conditioning in the slice header (JVET-R0255 item 2)

This is one of six things that can be signalled either in the PH or SH. For the other five, they can be signalled in one place or the other. This one has partial signalling in the PH, where an RPL can be signalled in the PH but the number of active entries can only be signalled in the SH. There is a flag in the SH, gated by a condition, for whether to override the default number of active entries.

It was commented that the case for mixed subpicture types should be considered, where there may be more of a need for slice-level customization.

Regardless of rpl\_info\_in\_ph\_flag, the num\_ref\_idx\_active\_override\_flag is sent in the SH.

The idea is that an RPL can be sent in the PH in order to share that info even if the number of active entries might be desired to be different for each slice.

There is an interaction between this and the weighted prediction (WP) information. It was commented that there are some syntax elements sent in the PH for WP that need to be sent when the WP information is in the PH but not when it is sent in the SH.

There is also an interaction with collocated picture information.

It was said that the WP and collocated picture information could be simplified if action is taken on this.

An example was discussed in which the number of active entries is sent in the SH and WP information is sent in the PH. This is allowed in the current specification. This would not be possible with the proposed change.

It was asked whether it makes sense to not send RPL information in the PH but send WP in the PH. This did seem like a strange combination.

It was commented that there is a bug in collocated picture identification, such that some action is needed. This is the topic of item 13 below.

This was further discussed on 22 April at 1800 after offline study (GJS & YKW).

Decision (expression of existing intent): Adopt item 1.b.ii, removal of a condition per JVET-R0277 item 1.

For 1.a, the suggestion after offline study was to keep num\_lX\_weights in the weighted prediction table but condition their presence additionally on rpl\_info\_in\_ph\_flag.

A participant commented that this removes the ability to have a common RPL order established in the PH with a different number of active entries in different slices. (Note that the RPS of all slices is required to be the same.) A suggested common case is to put the temporally closest pictures at the beginning of the RPL. A default number of active entries can also be indicated in the PPS.

However, a proponent said that there are various interactions that are made inconvenient by not having the number of active entries in the PH, such that the design would be substantially “cleaner” as proposed to be modified.

Another participant (who had a related contribution at the previous meeting) indicated that it is a matter of what is considered more common whether the proposed change is desirable or not.

In the absence of a clear determination of which approach is better, and given that the basic concept had been discussed at the previous meeting, no action was taken on item 1.a.

1. Skip the signalling of the ltrp\_in\_header\_flag[ listIdx ][ rplsIdx ] syntax element when the ref\_pic\_list\_struct( listIdx, rplsIdx ) syntax strucure is directly included in the PH or SH instead of in the SPS? (JVET-R0059)

The flag would be containing information that is known from the rplsIdx variable in this case.

Decision (sensibility): Skip this flag when its value is known/constrained as proposed.

1. Add and remove RPL constraints related to num\_ref\_entires and NumRefIdxActive as follows? (JVET-R0138)

The proposes to remove the following:

When the current slice is a P slice, the value of NumRefIdxActive[ 0 ] shall be greater than 0.

When the current slice is a B slice, both NumRefIdxActive[ 0 ] and NumRefIdxActive[ 1 ] shall be greater than 0.

And add the following

The value of num\_ref\_idx\_active\_minus1[ i ] shall be less than num\_ref\_entries[ i ][ RplsIdx[ i ] ], inclusive.

When slice\_type is equal to P or B, num\_ref\_entries[ 0 ][ RplsIdx[ 0 ] ] shall be equal to greater than 0.

When slice\_type is equal to B, num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] shall be equal to greater than 0.

When nal\_unit\_type is equal to IDR\_W\_RADL or IDR\_N\_LP, num\_ref\_entries[ i ][ RplsIdx[ i ] ] shall be equal to 0 for each i equal to 0 or 1.

This is intended to be essentially editorial. However, it was commented that it is not editorial. As proposed, it removes constraints that are necessary (i.e., that a P slice shall have at least one active entry in the RPL, and a similar constraint for a B slice). The second and third aspects that are proposed to be added were said to be redundant.

The existing text contains a statement that “For each i equal to 0 or 1, num\_ref\_entries[ i ][ RplsIdx[ i ] ] shall not be less than NumRefIdxActive[ i ]”.

No action appeared appropriate for this.

1. Add the following RPL related constraints? (JVET-R0253 item 2, 3)
   1. When ph\_inter\_slice\_allowed\_flag is equal to 1 and rpl\_info\_in\_ph is equal to 1, num\_ref\_entries[ 0 ][ RplsIdx[ 0 ] ] shall be greater than 0.

It was commented that ph\_inter\_slice\_allowed\_flag has a “one way” definition, and thus it would be possible to have only I slices that violate this constraint and that this case would not be a problem and would be reasonable to do this in anticipation of merging usage.

It was also commented that this is unnecessary due to the existing statement that “When the current slice is a P slice, the value of NumRefIdxActive[ 0 ] shall be greater than 0.”

No action was thus taken on this.

* 1. In JVET-R0250 it is proposed to add a ph\_inter\_B\_slice\_allowed\_flag. If such a flag is adopted, add following constraint?:When ph\_inter\_B\_slice\_allowed\_flag is equal to 1 and rpl\_info\_in\_ph is equal to 1, num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] shall be greater than 0.

Item “b” did not need to be discussed due to other actions of the meeting.

1. Conditionally signal (sps\_)inter\_layer\_ref\_pics\_present\_flag and infer it to be equal to 0 when not signalled? (JVET-R0156 item 2, JVET-R0205)
   1. Condition is: sps\_ptl\_dpb\_hrd\_params\_present\_flag is equal to 0 (JVET-R0156 item 2)
   2. Condition is: sps\_video\_parameter\_set\_id is greater than 0 (JVET-R0205)

Or modify existing constraint: When sps\_video\_parameter\_set\_id is equal to 0, the value of inter\_layer\_ref\_pics\_present\_flag *shall be* equal to 0.

The proponent of R0156 said part of the motivation was to reduce the need for complicated conformance requirements to be expressed.

The second variation of item b is pointing out basically a small editorial error in the current text.

This interacts with item 10 below, which proposes allowing SPS sharing between independent and dependent layers.

Decision (cleanup): Adopt approach “b”, conditioning the presence of the flag.

Discussion stopped here for JVET Track A on 18 April at 1500 UTC.

Discussion began here for JVET Track A Monday 20 April at approximately 1605 UTC (GJS).

1. Change the reference picture list structure semantics by replacing the parameters ph\_rpl\_idx[ listIdx ] and slice\_rpl\_idx [ listIdx ] with rpl\_idx[ listIdx ]? (JVET-R0255 item 1)

The ref\_pic\_list\_struct( listIdx, rplsIdx ) syntax structure may be present in an SPS, in a PH syntax structure, or in a slice header. Depending on whether the syntax structure is included in an SPS, a PH syntax structure, or a slice header, the following applies:

– If present in a PH syntax structure or a slice header, the ref\_pic\_list\_struct( listIdx, rplsIdx ) syntax structure specifies reference picture list listIdx of the current picture (the picture containing the slice).

– Otherwise (present in an SPS), the ref\_pic\_list\_struct( listIdx, rplsIdx ) syntax structure specifies a candidate for reference picture list listIdx, and the term "the current picture" in the semantics specified in the remainder of this clause refers to each picture that 1) has a PH syntax structure [*Removing: “containing ph\_rpl\_idx[ listIdx ] equal to an index into the list of the ref\_pic\_list\_struct( listIdx, rplsIdx ) syntax structures included in the SPS”*] or one or more slices containing rpl\_idx[ listIdx ] equal to an index into the list of the ref\_pic\_list\_struct( listIdx, rplsIdx ) syntax structures included in the SPS, and 2) is in a CVS that refers to the SPS.

It was noted that we don’t have ph\_rpl\_idx and slice\_rpl\_idx anymore, so there was a clear error in the text.

Decision (obvious editorial bug fix): Adopt.

1. Modify the inference of rpl\_idx [ i ] when not present: if rpl\_sps\_flag[ i ] is equal to 1 and rpl1\_idx\_present\_flag is equal to 0, the value of rpl\_idx[ 1 ] is inferred to be equal to rpl\_idx[ 0 ], otherwise the value of rpl\_idx[ i ] is inferred to be equal to 0. (JVET-R0255 item 3)?

**rpl\_idx**[ i ] specifies the index, into the list of the ref\_pic\_list\_struct( listIdx, rplsIdx ) syntax structures with listIdx equal to i included in the SPS, of the ref\_pic\_list\_struct( listIdx, rplsIdx ) syntax structure with listIdx equal to i that is used for derivation of reference picture list i of the current picture. The syntax element rpl\_idx[ i ] is represented by Ceil( Log2( num\_ref\_pic\_lists\_in\_sps[ i ] ) ) bits. When not present, the value of rpl\_idx[ i ] is inferred to be equal to 0. The value of rpl\_idx[ i ] shall be in the range of 0 to num\_ref\_pic\_lists\_in\_sps[ i ] − 1, inclusive. When rpl\_sps\_flag[ i ] is equal to 1 and num\_ref\_pic\_lists\_in\_sps[ i ] is equal to 1, the value of rpl\_idx[ i ] is inferred to be equal to 0. *When not present, if* rpl\_sps\_flag[ i ] is equal to 1 and rpl1\_idx\_present\_flag is equal to 0, the value of rpl\_idx[ 1 ] is inferred to be equal to rpl\_idx[ 0 ]*, otherwise the value of rpl\_idx[ i ] is inferred to be equal to 0*.

[*Removing: “When not present, the value of rpl\_idx[ i ] is inferred to be equal to 0.” and “When rpl\_sps\_flag[ i ] is equal to 1 and num\_ref\_pic\_lists\_in\_sps[ i ] is equal to 1, the value of rpl\_idx[ i ] is inferred to be equal to 0.”*]

Decision (expression of existing intent): Adopt.

1. Repurpose rpl1\_idx\_present\_flag to indicate the presence RefPicList1 related syntax elements and not only the presence of rpl\_sps\_flag[ 1 ] and rpl\_idx[ 1 ]? (JVET-R0277 item 3)

It was noted that lists can be conveyed in the SPS.

It was commented that this would specialize the use of this flag for a particular low-delay use case, and would not be appropriate for some uses, including RA and LB CTC, where the same index is used for L0 and L1 even though the content of the lists are different. This would tie the two lists together rather than just the indexes.

It was remarked that this would be a substantial change.

No action was taken on this.

1. Add a constraint for reference pictures to be the same for all slices in a picture: Set of reference pictures consisting of RefPicList[ 0 ] and RefPicList[ 1 ] entries shall be the same for all VCL NALs of a picture.? (JVET-R0277 item 4)

It was commented that there is such a constraint in 8.3.2, using a local variable setOfRefPics, so no action was needed on this.

1. Remove a constraint that inter-layer prediction flag shall be equal to 0 for independent layers and add the following quoted condition to the derivation of the reference picture lists RefPicList[ 0 ] and RefPicList[ 1 ] to add inter-layer reference pictures only for dependent layers:? (JVET-R0278 item 1, section 2)

else if( !vps\_independent\_layer\_flag[ GeneralLayerIdx[ nuh\_layer\_id ] ]

The proponent said sharing should not be a problem and it would be nice to just use one SPS in a multilayer bitstream rather than needing multiple SPSs. Historically, we had been using a single SPS in multilayer experiments before the constraint was adopted.

It seemed that hypothetically this is something that we could do but it would involve having inter-layer RPL information in an extracted single-layer bitstream, which we had been trying to avoid. It also changes the decoding process for RPLs, including for single-layer bitstreams, and this is undesirable as a matter of stability.

The proponent said the extra bits in the syntax would just be ignored by a single-layer decoder.

Others commented that the sharing benefit would be small, just saving one SPS for a multilayer bitstream. No action was taken on this item.

**Related to Weighted Prediction**

1. In the weighted prediction syntax pred\_weight\_table( ), remove the syntax elements num\_l0\_weights and num\_l1\_weights by instead deriving and using in its place number of active entries – this depends on having number of active entries in picture header (see 1.a above)? (JVET-R0059- item 1b, JVET-R0102). This depends on item 1.a above, for which no action was taken; thus, no action was taken for this.

Or: Condition the presence of num\_l1\_weights, and derivation of NumWeightsL1 by repurposing rpl1\_present\_flag when using it as proposed in #7 above. (JVET-R0277 item 3). See item 7 above for the notes about this.

**Related to collocated picture signalling**

1. In the syntax condition for signalling of the collocated picture in the PH, replace "num\_ref\_entries[ 0 ][ RplsIdx[ 0 ] ]" and "num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ]" with "NumRefIdxActive[ 0 ]" and " NumRefIdxActive[ 1 ]" respectively - Depends on having number of active entries in picture header (see 1.a above)? (JVET-R0059)

Proposed text:

When ph\_collocated\_from\_l0\_flag is equal to 1, ph\_collocated\_ref\_idx refers to an entry in reference picture list 0, and the value of ph\_collocated\_ref\_idx shall be in the range of 0 to *NumRefIdxActive[ 0 ]* − 1, inclusive.

When ph\_collocated\_from\_l0\_flag is equal to 0, ph\_collocated\_ref\_idx refers to an entry in reference picture list 1, and the value of ph\_collocated\_ref\_idx shall be in the range of 0 to *NumRefIdxActive[ 1 ]* − 1, inclusive.

This depends on item 1.a above, for which no action was taken; thus, no action was taken for this.

1. Modify the condition for signalling ph\_collocated\_ref\_idx as follows (replacing num\_ref\_entries[ X ][ RplsIdx[ X ] ] with NumRefIdxActive[ X ]) – which depends on having number of active entries in picture header (see 1.a above)? (JVET-R0059)

if( ( ph\_collocated\_from\_l0\_flag && NumRefIdxActive[ 0 ] > 1  
 num\_ref\_entries[ 0 ][ RplsIdx[ 0 ] ] > 1 ) | |  
 ( !ph\_collocated\_from\_l0\_flag && NumRefIdxActive[ 1 ] > 1 ) )

This depends on item 1.a above, for which no action was taken; thus, no action was taken for this.

1. slice\_collocated\_from\_l0\_flag for P slices:
   1. Add the following constraint? (JVET-R0059, JVET-R0253 item 1)

When ph\_temporal\_mvp\_enabled\_flag and rpl\_info\_in\_ph\_flag are both equal to 1 and there is at least one P slice in the picture, the value of ph\_collocated\_from\_l0\_flag shall be equal to 1? (JVET-R0059)

OR

It is a requirement of bitstream conformance that slice\_collocated\_from\_l0\_flag shall be equal to 1 when slice\_type is equal to P (JVET-R0253 item 1).

These two are technically equivalent.

* 1. When not present, infer slice\_collocated\_from\_l0\_flag to be equal to 1 for P-slices? (JVET-R0277 item 2)

It was said that we currently have a bug for P slices. The inference of slice\_collocated\_from\_l0\_flag is incorrect when the RPL is signalled in the PH and the slice\_collocated\_from\_l0\_flag is inferred to be equal to 0, which doesn’t make sense.

If we try to just infer the flag to be equal to 0 in this case, we need to consider the possibility that the index into the list is not a valid position in list 0. There is already a constraint that the index must be valid in this case. And the collocated picture needs to be the same for all slices, so this means that the same picture must be at the same position in both lists in this case.

It was commented that depending on the “extra when” in the semantics might be not as clear as other ways expressing that constraint.

Both approaches would allow a picture that is all B slices to use a collocated picture that is not in list 0.

Both approaches would be valid. It was suggested that approach “a” is easier to understand. Approach “a” is a bit more constrained, although not in a way that seemed clearly helpful.

Both approaches seem straightforward intuitive about what the decoder should do.

The only reason approach “a” might be easier to understand is that it implies the above-described complicated constraint, but that constraint is already in the standard regardless of whether inference or signalling is used. The current design already allows the flag to have different values in different slices.

The minimum change to fix the bug is approach b. It fixes the bug without introducing any further constraint.

Decision (bug fix): Adopt approach b.

Discussion stopped here for JVET Track A Monday 20 April at approximately 1715 UTC (GJS).

Discussion began here for JVET Friday 24 April at approximately 0615 UTC (GJS).

**Related to ph\_temporal\_mvp\_enabled\_flag:**

1. Modify the existing constraint in the slice header semantics on the collocated picture by only keeping the 0-valued-RprConstraintsActive[ ][ ] aspect as follows? (JVET-R0059)

It is a requirement of bitstream conformance that [*Removing: “the values of pic\_width\_in\_luma\_samples and pic\_height\_in\_luma\_samples of the reference picture referred to by slice\_collocated\_ref\_idx shall be equal to the values of pic\_width\_in\_luma\_samples and pic\_height\_in\_luma\_samples, respectively, of the current picture, and”*] RprConstraintsActive[ slice\_collocated\_from\_l0\_flag ? 0 : 1 ][ slice\_collocated\_ref\_idx ] shall be equal to 0.

*NOTE – The above constraint requires the collocated picture to have the same spatial resolution and scaling window offsets as the current picture.*

This is just to simplify the semantics to remove some redundant aspects. It does not change technical constraints.

Editor action item: The editor is suggested to consider this suggested editorial improvement.

1. Constraint on ph\_temporal\_mvp\_enabled\_flag:
   1. Replace the existing constraint on the value of ph\_temporal\_mvp\_enabled\_flag with a NOTE, with the addition of the scaling window offsets to be also the same? (JVET-R0059)

**ph\_temporal\_mvp\_enabled\_flag** specifies whether temporal motion vector predictors can be used for inter prediction for slices associated with the PH. If ph\_temporal\_mvp\_enabled\_flag is equal to 0, the syntax elements of the slices associated with the PH shall be constrained such that no temporal motion vector predictor is used in decoding of the slices. Otherwise (ph\_temporal\_mvp\_enabled\_flag is equal to 1), temporal motion vector predictors may be used in decoding of the slices associated with the PH. When not present, the value of ph\_temporal\_mvp\_enabled\_flag is inferred to be equal to 0. [*Removing: “When no reference picture in the DPB has the same spatial resolution as the current picture, the value of ph\_temporal\_mvp\_enabled\_flag shall be equal to 0.”*]

*NOTE – The value of ph\_temporal\_mvp\_enabled\_flag has to be equal to 0 when no reference picture in the DPB has the same spatial resolution and scaling window offsets as the current picture.*

* 1. Add a constraint considering the offsets that are applied to the picture size for scaling ratio calculation in the bitstream conformance of ph\_temporal\_mvp\_enabled\_flag? (JVET-R0323 items 1)

When no reference picture in the DPB has the same spatial resolution *and the same offsets that are applied to the picture size for scaling ratio calculation as the current picture*, the value of ph\_temporal\_mvp\_enabled\_flag shall be equal to 0.

This is just to simplify the editorial expression. It does not change technical constraints.

Editor action item: The editor is suggested to consider these suggested editorial improvements.

1. Add a bitstream conformance on ph\_temporal\_mvp\_enabled\_flag to force its value to 0 when there is no common reference picture existing in the reference picture lists of the all the slices associated with the coded picture? (JVET-R0323 item 2)

When there is no common reference picture existing among all the slices associated with the PH, the value of ph\_temporal\_mvp\_enabled\_flag shall be equal to 0.

This is just to simplify the semantics to remove some redundant aspects. It does not change technical constraints.

Editor action item: The editor is suggested to consider this suggested editorial improvement. Perhaps a NOTE would be all that is needed, if any action is needed.

Discussion of these topics on JVET Friday 24 April ended at approximately 0625 UTC (GJS).

[JVET-R0059](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9703) AHG9: Cleanups on RPL and related signalling [Y.-K. Wang, Z. Deng, L. Zhang, K. Zhang, J. Xu (Bytedance)]

[JVET-R0323](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9967) AHG9: On TMVP enabling flag in picture header [Y.-W. Chen, X. Xiu, T.-C. Ma, H.-J. Jhu, W. Chen, X. Wang (Kwai Inc.)]

[JVET-R0102](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9746) AHG9: On Reference Picture List Override Signalling [S. Deshpande, T. Chujoh, T. Ikai, J. Samuelsson, A. Segall (Sharp)]

[JVET-R0138](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9782) AHG9: Some constraints of num\_ref\_entries [T. Chujoh, T. Ikai (Sharp)]

[JVET-R0156](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9800) AHG8/AHG9: Signalling cleanup on SPS [B. Wang, S. Esenlik, A. M. Kotra, H. Gao, E. Alshina (Huawei)]

Item 2 of this contribution belongs to this category.

[JVET-R0205](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9849) AHG9: On signalling of inter\_layer\_ref\_pics\_present\_flag [T. Nishi, K. Abe, V. Drugeon (Panasonic)]

[JVET-R0253](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9897) AHG9: Three restrictions when RPL is present in PH [R. Yu, M. Pettersson, R. Sjöberg, M. Damghanian, Z. Zhang, J. Enhorn (Ericsson)]

[JVET-R0255](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9899) AHG9: Fixes related to RPL [M. Pettersson, R. Sjöberg, M. Damghanian, Z. Zhang, J. Enhorn (Ericsson)]

[JVET-R027](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9921)7 AHG9: On reference picture list signalling [V. Seregin, M. Coban, Y. He, M. Karczewicz (Qualcomm)]

[JVET-R027](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9922)8 AHG8: On SPS sharing and slice type constraint [V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Item 1 (in section 2 of R0278) of this contribution belongs to this category.

### Signalling of virtual boundaries (4)

Discussion began here for JVET Track A on 21 April at 0715 (UTC) (GJS & YKW).

[JVET-R0121](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9765) AHG9/AHG12: On virtual boundary signalling with subpictures [B. Choi, S. Wenger, S. Liu (Tencent)]

This contribution proposes to relocate the virtual boundary syntax elements from PH to PPS, so that picture-level updates of virtual boundary information are possible, when a picture is partitioned into multiple subpictures and the subpicture ID mapping information is updated by PPS within a coded video sequence.

The subpicture ID mapping information is in the PPS.

Our design philosophy has been to avoid needing to rewrite PHs for BEAMing. The proponent asserted that the location of the virtual boundary in the PH does not seem consistent with that.

However, the motivation for having the virtual boundary in the PH has been GDR. As proposed here, every picture in the GDR case might need a different PPS.

The virtual boundary is currently sent either in the SPS or PH.

Note that the virtual boundary is not for when the image boundary is aligned with the subpicture boundary.

It was commented that the proposal would not be good for the GDR case, and the current syntax seems good enough, so no action was taken on this.

[JVET-R0191](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9835) AHG9: On miscellaneous updates for HLS signalling [Hendry, S. Paluri, S. Kim (LGE)]

Item 4 of this contribution belongs to this category.

It is proposed to constrain that when sps\_virtual\_boundaries\_enabled\_flag is equal to 1 and sps\_virtual\_boundaries\_present\_flag is equal to 0, there shall be at least one picture header in the CLVS with ph\_virtual\_boundaries\_present\_flag equal to 1.

It was remarked that this constraint seems unnecessary and might interfere with potential extraction or splicing cases or encoder choices or low-delay operation cases, so no action was taken on this.

[JVET-R0256](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9900) AHG9: Virtual boundaries in increasing order using u(v) [M. Damghanian, M. Pettersson, R. Sjöberg, Z. Zhang, J. Enhorn, R. Yu, J. Ström (Ericsson)]

This contribution proposes constraining the virtual boundaries to be signalled strictly in left to right and top to bottom order for VVC. The proponents claim that there are currently no ordering constraints for the virtual boundaries in the VVC specification and that arbitrary order therefore is allowed. The proponents further claim that there is no benefit from allowing arbitrary order and that a cleaner design would be to enforce an order from lower values to higher.

This contribution further proposes to change the signaling from u(13) to u(v) with the length depending on the picture width and height. The proponents say that u(v) was originally used for virtual boundary signaling but that this was changed to u(13) in Gothenburg (July 2019).

The number of boundaries is a 2-bit syntax element, so there are never more than 3 of them in each direction.

The picture is processed from left to right (top to bottom), so the decoder would presumably want them in that order.

Proposal 1, adding constraints:

* Constrain the virtual boundary syntax elements to be signalled in order from left to right for vertical virtual boundaries and from top to bottom for horizontal virtual boundaries.

It was commented that if we do this, perhaps we should structure the syntax to send deltas instead of values so that it is not possible to express a violation of the constraint.

It was commented that since there are at most 3 of these, it doesn’t matter what order they are sent in and we should just not worry about it. No action was thus taken on this.

Proposal 2, alternative signalling:

* Change the signalling of the virtual boundaries from u(13) to u(v) in SPS and PH, where v is derived from the maximum picture size for syntax elements in the SPS and derived from the picture size for syntax elements in the PH.

Proposals 1 and 2 are assessed by the proponents to be independent.

JVET-R0266 aspect 6 is about the same thing. It proposes to use ue(v) to avoid the decoder needing to derive the number of bits that will be used for it from the width/height maxima. The proponent of R0256 said u(v) would probably be more bit efficient.

It was commented that the reason for u(13) was a historical accident and that u(v) seems like a straightforward approach.

It was commented that extraction should not change the parsing and could cause a problem with u(v).

Picture width and height already use ue(v).

There was a problem with the proposal for very small picture widths (e.g. a picture width of 8 or less).

Decision (cleanup): Code virtual boundary positions using ue(v). The proponent of R0266 can provide the software.

[JVET-R0266](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9910) AHG9: Miscellaneous HLS topics [Y. He, Y-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Item 6 of this contribution belongs to this category.

Discussion stopped here for JVET Track A on 21 April at 0830 (UTC).

### Hypothetical reference decoder (HRD) (9)

Discussion began here for JVET Track A on 19 April at 0500 (UTC) (GJS & YKW).

[JVET-R0342](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9986) AHG9: A Summary of Proposals Related to HRD [S. Deshpande (Sharp)]

This contribution intends to provide a summary of proposals on core aspects of HRD (including HRD operation, related SEI message signalling and sub-bitstream extraction).

The following proposals are covered in this summary: JVET-R0094, JVET-R0100, JVET-R0101, JVET-R0103, JVET-R0264, JVET-R0295, JVET-R0297, JVET-R0413.

It is suggested that this summary be used for the reviewing of these proposals, such that the discussions may be done in a more structured and efficient manner.

**Related to HRD Signalling and operation:**

1. Signal a fixed DPB output time offset for each temporal sublayer, controlled by a presence flag, within the buffering period SEI message and use these offsets to calculate picDpbOutputDelta[ i ]? (JVET-R0094)

See the notes for that contribution.

1. Not signal and infer dui\_sublayer\_delays\_present\_flag[ bp\_max\_sublayers\_minus1 ] to be 1, to make sure du\_spt\_cpb\_removal\_delay\_increment[ bp\_max\_sublayers\_minus1 ] which is used for inference of other syntax is always signalled in DUI SEI message? (JVET-R0100 Proposal 1)

Decision (sensibility cleanup): Adopt this aspect.

1. Signal the for loop for syntax elements dui\_sublayer\_delays\_present\_flag[ i ] and du\_spt\_cpb\_removal\_delay\_increment[ i ] in the reverse order or signal du\_spt\_cpb\_removal\_delay\_increment[ bp\_max\_sublayers\_minus1 ] before other du\_spt\_cpb\_removal\_delay\_increment[ i ] for i < bp\_max\_sublayers\_minus1? (JVET-R0100 Proposal 2)

No need for action was identified for this aspect.

1. Add missing inference rules for the alternative timing information related syntax elements cpb\_alt\_initial\_cpb\_removal\_delay\_delta[ i ][ j ], cpb\_alt\_initial\_cpb\_removal\_offset\_delta[ i ][ j ] which are used for HRD operation? (JVET-R0101 Proposal 1)

Decision (expression of existing intent): Adopt this aspect.

1. Fix asserted bugs related to unspecified or missing length of u(v) coded syntax elements by referring to correct length syntax elements? (JVET-R0101 Proposal 2)

Decision (editorial bug fix): Adopt this aspect.

1. Not signal du\_common\_cpb\_removal\_delay\_flag, du\_common\_cpb\_removal\_delay\_increment\_minus1[ i ], num\_nalus\_in\_du\_minus1[ i ] and du\_cpb\_removal\_delay\_increment\_minus1[ i ][ j ] in picture timing SEI message when there is only one DU in an AU and condition the duCpbRemovalDelayInc variable derivation? (JVET-R0103 Proposal 1)

Decision (sensibility cleanup): Adopt this aspect.

1. Perform the editorial fixes for the CPB operation section to define and use AU and DU related variable names correctly? (JVET-R0103 Proposal 2)

Decision (editorial bug fixes): Adopt.

1. Apply an asserted editorial clarification of what n0…n5 mean for the number of conformance tests in Annex C? (JVET-R0297)

Decision (editorial bug fixes): Adopt.

1. Fix an asserted bug for the inference rule for syntax elements in the syntax structure sublayer\_hrd\_parameters( ) to use syntax from SPS or VPS as appropriate instead of always using sps\_max\_sublayers\_minus1? (JVET-R0297)

Decision (editorial bug fixes): Adopt.

1. Fix an asserted bug for n3 specifying number of conformance test for IRAPs that are not CRAs with associated RASL pictures and alternative timing? (JVET-R0297)

This was requested be refined in offline work to account for GDR. The contribution was revised to account for this. This was further discussed on 24 April at 0630 UTC (GJS).

Decision (expression of existing intent): Adopt.

1. Fix an asserted bug in the derivation of InitialCpbRemovalDelay in C.2.3 (Timing of DU removal and decoding of DU) aligning it with derivation in C.2.2 (Timing of DU arrival) to account for alternative timing? (JVET-R0297)

Decision (editorial bug fixes): Adopt.

1. Fix an asserted bug by adding missing text to update values of CpbDelayOffset and DpbDelayOffset in C.2.3 -Timing of DU removal and decoding of DU? (JVET-R0297)

Decision (editorial bug fixes): Adopt.

1. Fix an asserted bug in equation C.11 for derivation of NominalRemovalTime[ n ], to account for CpbDelayOffset? (JVET-R0297)

Decision (editorial bug fixes): Adopt.

1. Signal a separate set of alternative buffering delay parameters for VCL HRD and for NAL HRD and use them for HRD operation? (JVET-R0413)

There had been a previous contribution JVET-Q0219 proposal #1 that discussed this, and further study had been conducted.

Decision (bug fix): Adopt.

**Related to sub-bitstream extraction:**

1. Apply following quoted modifications to sub-bitstream extraction process? (JVET-R0264)

“When (pps\_)mixed\_nalu\_types\_in\_pic\_flag is equal to 0”, remove from outBitstream all NAL units for which all of the following conditions are true:

– nal\_unit\_type is not equal to IDR\_W\_RADL, IDR\_N\_LP, or CRA\_NUT.

– nuh\_layer\_id is equal to LayerIdInOls[ targetOlsIdx ][ j ] for a value of j in the range of 0 to NumLayersInOls[ targetOlsIdx ] − 1 inclusive, “but not equal to OutputLayerIdInOls[ targetOlsIdx ][ j ] for a value of j in the range of 0 to NumOutputLayersInOls[ targetOlsIdx ] − 1 inclusive”.

– TemporalId is greater than or equal to NumSubLayersInLayerInOLS[ targetOlsIdx ][ j ].

This is intended as a correction for expression of existing intent. It was agreed that something needs to be done for the mixed NAL unit type issue, but not as proposed. After offline study, the contribution was revised to account for this. This was further discussed on 24 April at 0635 UTC (GJS).

After the offline study, a participant commented that adding a use of the PPS content in the sub-bitstream extraction process (rather than just using NAL unit types) seemed undesirable. Another option would be to add a constraint that when max\_tid\_il\_ref\_pic\_plus1 is equal to 0 (which means that only the IRAP pictures in the reference layer would be allowed to be used for reference) it would be prohibited to have mixtures of IRAP and non-IRAP NAL units in the picture.

Decision (bug fix): Add a constraint that when max\_tid\_il\_ref\_pic\_plus1 is equal to 0 (which means that only the IRAP pictures in the reference layer would be allowed to be used for reference) it would be prohibited to have mixtures of IRAP and non-IRAP NAL units in the picture.

1. Use the bit rate indicated in general\_hrd\_parameters( ) and ols\_hrd\_parameters( ) of the OLS for derivation of the subpicture bit rate variables SubpicBitRateVcl and SubpicBitRateNal in the subpicture level information SEI message in Section D.7.2? (JVET-R0295)

There had been an equivalent proposal at the previous meeting Q0395.

The proponent said that the method that had been incorporated at the previous meeting could potentially result in CPB overflow. Another participant asked if the modification could produce underflow. The proponent said that the scheme follows what the encoder has expressed in the syntax.

It was commented that some of the discussion at the previous meeting may have been before acting on subpicture HRD modelling as currently specified, and that now that we have this, the proposal makes sense.

Decision (bug fix): Adopt.

1. Apply asserted simplification changes to the subpicture extraction process Annex C.7 to constrain subpictures in multi-layer bitstreams to be aligned in terms of boundary position and subpicture ID across layers? (JVET-R0295)

It was discussed whether the alignment of boundaries that is assumed in the proposal is fundamentally part of our current design, and it was noted that a contribution R0058 had some relationship to this. However, it was commented that the proposal is compatible with contribution R0058.

This was further discussed in the closing plenary on 24 April at 1440 (GJS & JRO) after the discussion of R0058.

Prior to the adoption of R0058, the draft did not allow the subpicture IDs to be different across different layers. In that context, the proposal is purely editorial, as basing the extraction process on the subpicture IDs provides the same extraction.

Editor action item: The editor is asked to consider rephrasing the subpicture extraction process to use subpicture IDs or indexes in order to simplify the description. If the editorial expression is simpler after accounting for the R0058 aspect, it is suggested to use this expression.

1. Fix an asserted bug which rewrites the cbr\_flag[ tIdTarget ][ j ] to 1 for all CPBs when sli\_cbr\_constraint\_flag is equal to 1 in subpicture extraction process? (JVET-R0295)

Decision (expression of existing intent): Adopt this aspect.

1. Also perform several assertedly minor fixes (e.g. #903) and editorial improvements in Annex C.6 (Sub-bitstream extraction process) and C.7 (subpicture sub-bitstream extraction process)? (JVET-R0295)

Decision (editorial bug fixes): Adopt this aspect.

Discussion stopped here for JVET Track A on 19 April at 0700 (UTC).

[JVET-R0094](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9738) AHG9: DPB output time offsets for temporal sublayers [V. Drugeon, K. Abe (Panasonic)]

This contribution was discussed in JVET Track A on 19 April at 0510 (UTC) (GJS & YKW).

It is proposed to signal a fixed DPB output time offset for each temporal sublayer, controlled by a presence flag, within the buffering period SEI message and use these offsets to calculate picDpbOutputDelta[ i ].

It is asserted there is an issue in the calculation of DPB output times for temporal scalable bitstreams, such that this issue may cause the DPB output time to be lower than the CPB removal time for some pictures when the highest decoded temporal sublayer is not the highest temporal sublayer in the bitstream (i.e. when a temporal sub-bitstream is decoded). The proposed change consists of shifting the sequence of DPB output times by a fixed offset for the given highest decoded temporal sublayer. It is proposed to signal this offset per temporal sublayer within the buffering period SEI message.

It was commented that if we do not do this, we would be forced to indicate a higher DPB output time when the highest temporal sublayer is present so that it works for all sublayers.

It was asked why we had not encountered the asserted issue for previous temporal scalability designs.

It was commented that there are some differences between how temporal scalability was handled. HEVC used a scalable nesting SEI message for temporal scalability, whereas VVC has a loop of sublayers in the BP and PT SEI messages and DUI.

This was further discussed in JVET on 24 April at 0650 UTC (GJS). After offline study, it had been concluded that possible approaches using either the BP SEI message or the PT SEI message were equivalent. It was commented that the BP SEI message is sent less frequently and it seemed more like the appropriate place to deal with this.

Decision (bug fix): Adopt.

[JVET-R0100](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9744) AHG9: On Decoding Unit Information Signalling [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

[JVET-R0101](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9745) AHG9: On Alternative Timing Information Signalling [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

[JVET-R0103](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9747) AHG9: On Picture Timing Information Signalling and HRD [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

[JVET-R0264](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9908) AHG9: On sub-bitstream extraction [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-R0295](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9939) AHG12: On subpicture conformance [R. Skupin, Y. Sanchez, K. Suehring, T. Schierl (HHI)]

[JVET-R0297](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9941) AHG9: HRD bug-fixes and editorial clarifications [Y. Sanchez, R. Skupin, K. Suehring, T. Schierl (HHI)]

[JVET-R0413](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10075) AHG9: On Parameters for HRD Timing Information [S. Deshpande (Sharp)] [late]

### DCI, VUI, and SEI (7)

Discussion began here for JVET on 24 April at 0716 (UTC) (GJS).

[JVET-R0090](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9734) AHG9: On Video Usability Information [V. Drugeon (Panasonic)]

In the current specification text, the parsing of the VUI syntax structure has a dependency on two external variables (GeneralProgressiveSourceFlag and GeneralInterlacedSourceFlag), which is undesirable. It is suggested to signal these two external variables as syntax elements within the VUI syntax structure. Currently the corresponding information is signalled within the general\_constraint\_info syntax structure. It is suggested to either move this information from the general\_constraint\_info syntax structure to the VUI syntax structure, or at least repeat the information within the VUI syntax structure.

Decision (bug fix): Adopt (moving the two flags into the VUI specification as proposed), but expressing the constraint on the presence of the frame-field information SEI message in the VVC spec.

[JVET-R0190](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9834) Post-filter hint based on ALF classification [H.-B. Teo, H.-W. Sun, C.-S. Lim (Panasonic)]

This contribution is a further follow-up proposal on JVET-Q0319 and JVET-P0179. In the case when the ALF module is disabled through a bitstream header, a post-filter hint based on ALF SEI is decoded. The proposed SEI message is used to enable the ALF module to filter the reconstructed image for output using the accompanied ALF filter flags and filter coefficients. This contribution provides three examples of possible application cases and their benefit (sharpening, Bokeh effect, and adaptive denoising). Two alternative aspects of ALF SEI signalling were proposed: Aspect 1 uses an APS id to refer to the APS containing the filter coefficients, Aspect 2 signals the filter coefficients in the SEI message itself. Source code for encoder and decoder implementations was reported to be available.

Characteristics of approaches as described by the proponent:

|  |  |  |  |
| --- | --- | --- | --- |
| **Num** | **Pre-filter** | **HEVC post-filter hint** | **Proposed** |
| 1 | Separate module | Separate module | Built-in to VVC |
| 2 | Determined by content provider, but typically:  Picture level on/off  No classification  1 set of filters | Picture level on/off | CTU level on/off |
| 3 | No classification | 4x4 level luma block classification |
| 4 | 1 set of filters for luma  1 set of filters for Cb  1 set of filters for Cr | Up to 25 sets of luma filters  1 set of filters for Cb  1 set of filters for Cr |
| 5 | Sharpening original source | At same bit rate, smaller QP used compared to pre-filter | At same bit rate, smaller QP used compared to pre-filter |

ALF ordinarily has CTU-level control (on/off and filter selection). This proposal does not have CTU-level control.

Additional use cases were described. At previous meetings, only the sharpening case had been described.

It was commented that it seems better use the same syntax but not use the APS mechanism to convey the filtering parameters (approach 2). The approach #1 was not in the previous proposals.

It was suggested to consider this for inclusion when a draft of SEI messages is developed.

There was discussion of whether the prior post-filter hint SEI message had been considered of significant interest in applications. It did not seem that this had been very widely used.

[JVET-R0260](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9904) AHG9: On decoding capability information [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

This contribution proposes to move decoding dapability information (DCI) from parameter set to an SEI message, as the information is not necessary for decoding process. The proposed DCI SEI message carries the preferred decoding capability information applied to the entire bitstream.

The proposal also suggests to change the DCI syntax.

It was noted that DCI is optional and that can be at the same place in the bitstream as an SEI message.

A technical benefit would be to avoid using a NAL unit type for DCI.

It was commented that the primary purpose of the DCI is for the system layer, for which it is important that the information can be easily located in the bitstream. The scope of the DCI is also broader than for an SEI message, or at least for the SEI messages that we have currently specified.

It was commented that although this seemed like it might be feasible, it does not seem necessary, so no action was taken on this.

The proponent indicated that it was not necessary to consider the proposed change of the syntax, in view of the above.

[JVET-R0308](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9952) AHG8: Implementation of multi-layer decoding and output independent layer composition in VTM [E. Thomas (TNO)]

This is a software/showcase relating to R0307.

This contribution describes a software implementation in the VTM project implementing a merging and decoding of multiple independent layers into a single output decoded picture. The spatial relationship between these independent layers is described by expressing the top, right, bottom and left neighbour layer relative to each layer. This information is signalled in the bitstream (see JVET-R0307 for normative aspect of the signalling). The contribution further explains the different steps implemented in the VTM decoder to construct the final output decoded picture.

[JVET-R0307](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9951) AHG8/AHG9: Positioning information SEI message of output independent layers [E. Thomas (TNO)]

This contribution presents a multi-party video conferencing use case where a multi-layer bitstream with independent layers can be used. Each participant views can constitute an independent layer of a single multi-layer bitstream which forms a mosaic or also called grid view.

This contribution proposes defining a new SEI message to signal the positioning information of each output layer for a given output layer set.

In addition, the associated contribution JVET-R0308 provides the software implementation in VTM corresponding to the presented scenario that is:

1. Implementation of a multi-layer decoding support
2. Composition into a single picture of independent output layers of the same output layer set

It was commented that sample aspect ratio could be important to consider.

It was commented that various compositing syntax methods could conceivably be used.

The compositing scheme could have some rectangles not occupied.

There were several previous contributions relating to this concept.

There was some interest expressed in the concept of a compositing layout signalled in an SEI message.

One justification given for the syntax approach was the ability to remove layers without changing the relative positioning of the remaining layers.

The approach was described as using a 4-neighbour connected graph.

It was commented that video mixing is sometimes conducted but typically in a somewhat different way.was suggested to consider this for inclusion when a draft of SEI messages is developed.

Further study was encouraged, including study of the available software. The changes to support this in the software was said to be relatively minimal. The proponent said they could also provide example bitstreams.

[JVET-R0359](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10003) AHG 17: Illustration of the film grain characteristics SEI message for VVC [Sean McCarthy, Fangjun Pu, Taoran Lu, Peng Yin, Walt Husak, Tao Chen (Dolby)]

Considered similarly in JCT-VC and the parent bodies [add notes]. Software will be uploaded in a revision of the contribution and the software coordinator is requested to review it.

[JVET-R0455](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10117) AHG17: Cross-check report of JVET-R0359 on Illustration of the film grain characteristics SEI message for VVC [P. de Lagrange, E. François (InterDigital)] [late]

[JVET-R0384](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10029) Alternative film grain characteristics SEI message [A. Norkin (Netflix)]

Considered similarly in JCT-VC at the parent level [add notes].

[JVET-R0456](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10118) Crosscheck of JVET-R0384 on Alternative film grain characteristics SEI message [A. M. Tourapis (Apple)] [late]

Discussion of the contributions in this section on Friday 24 April ended at 0845 UTC.

### HLS editorial inputs (1)

[JVET-R0249](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9893) AHG9: Proposed structural text changes to HLS in the VVC specification [M. Pettersson, R. Sjöberg, M. Damghanian, Z. Zhang, J. Enhorn (Ericsson)]

This contribution was discussed on 22 April at 1740 (GJS & YKW).

The first two items are purely editorial, and were already well agreed and had been incorporated into side activity during. The third aspect is almost, but not quite, editorial. The purpose of the contribution is purely to improve readability.

This contribution proposes the following changes to the VVC specification (which do not really change the structure of the standard, but are proposed for consistency and readability):

1. Replace ‘slice\_’ prefix for slice header syntax elements by ‘sh\_’, except for slice\_address and slice\_type which are proposed to be renamed to sh\_slice\_address and sh\_slice\_type, respectively. (editorial)
2. Rename syntax elements in VPS, SPS, PPS, PH, SH to ensure that the names of all syntax elements in these places start with ‘vps\_’, ‘sps\_’, ‘pps\_’, ‘ph\_’ and ‘sh\_’, respectively. (editorial)
3. Change disable flags to enable flags throughout the VVC specification, i.e. change the following syntax elements to enable flags (normative, but only because the bits for these flags in the bitstream are inverted):
   * pps\_deblocking\_filter\_disabled\_flag
   * ph\_deblocking\_filter\_disabled\_flag
   * slice\_deblocking\_filter\_disabled\_flag
   * ph\_disable\_bdof\_flag
   * ph\_disable\_dmvr\_flag
   * ph\_disable\_prof\_flag
   * scaling\_matrix\_for\_lfnst\_disabled\_flag (related to other contributions)
   * slice\_ts\_residual\_coding\_disabled\_flag (related to R0483, R0485, and R0486)

Proposed changes 1 and 2 are claimed to make it possible to see the scope and placement of syntax elements from their names alone. Proposed change 3 is claimed to align all enable/disable flags so that a ‘1’ always means enable and ‘0’ always means disable, thereby improving readability.

Specification text on top of JVET-Q2001-vE for replacing the disable flags with enable flags is provided with the contribution.

It was commented that in most cases (e.g. for the deblocking flags and for the mode flags that are only present when a feature is enabled at a higher level) the flag names are to imply enabling by default and that there are various related contributions under consideration that might be complicated by these changes). It was thus agreed to take no action on this aspect.

Editorial action item: The editor is asked to consider renaming ph\_disabled\_xxx\_flag to ph\_xxx\_disabled\_flag.

## AHG12: high-level parallelism and coded picture regions (52)

### Subpictures (26)

#### General (1)

[JVET-R0415](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10077) AHG12: A summary of proposals on subpictures [Hendry (LGE)]

Discussion began here for JVET on 16 April at 1315 (UTC).

1. Condition sps\_independent\_subpics\_flag on "sps\_num\_subpics\_minus1 > 0". (JVET-R0071 #1, JVET-R0156 #4, JVET-R0284 #1)

It was asked whether, in the case of extraction, there would be value in knowing the original value of the loop\_filter\_across\_subpic\_enabled\_flag. In this case the parameters wouldn’t be sent anyway in the current syntax.

This would save only one bit in the SPS.

It was commented that (at least after other actions of the meeting), subpic\_treated\_as\_pic\_flag and loop\_filter\_across\_subpic\_enabled\_flag have no effect.

We would need to establish inference if these flags are used for anything.

This relates to #2 and #3 below.

The motivation is just cleanup to make it more clear what the logical relationships are.

Decision (cleanup): Adopt this aspect.

1. When sps\_independent\_subpics\_flag is not present, it is inferred to be equal to 1 (JVET-R0071 #1, JVET-R0156 #4, JVET-R0136 #1)

After the action on item #1, this is editorial; see the notes for item #3 below.

1. Change the inference of subpic\_treated\_as\_pic\_flag[ i ] when not present.
   1. Infer it to be equal to 1 (JVET-R0071 #2)
   2. Keep the current inference, which is to infer it to 0 (JVET-R0284 #1)

Previously the inference would affect the ability to use wrap-around, but that dependence was agreed to be removed earlier in the meeting. Inference to 1 seems more logical, although it does not make a functional difference. At this point, it seems to be a purely editorial matter.

Decision (Ed.): It is suggested for the editor to specify inference of the value 1 for sps\_independent\_subpics\_flag and the value 1 for subpic\_treated\_as\_pic\_flag[ i ] and the value 0 for loop\_filter\_across\_subpic\_enabled\_pic\_flag[ i ] when not present.

1. Change the inference of loop\_filter\_across\_subpic\_enabled\_pic\_flag[ i ] when not present.
   1. Infer it to be equal to 0 (JVET-R0071 #3)

This is just editorial, as was the case for item #3 above; see notes for item #3.

1. Infer single\_slice\_per\_subpic\_flag to be equal to 1 when no\_pic\_partition\_flag is equal to 1 (JVET-R0071 #4).

This is just editorial, but the suggested change seems logical.

Decision (Ed.): It is suggested for the editor to specify inference of the value 1 for single\_slice\_per\_subpic\_flag when not present.

1. Condition the presence of sps\_ref\_wraparound\_enabled\_flag such that it is present only when sps\_independent\_subpics\_flag is equal to 0. When not present, infer the value to be equal to 0. (JVET-R0284#2).

This item was no longer valid after an agreement reached earlier in the meeting.

1. Order of slices in PPS signalling and in picture. It is asserted that there is problem since the order of slices signalled in PPS may be different from the order of slices in decoding order.

Example 1



Example 2 (an example that has subpictures that contain only partial tiles, which would be disallowed by the constraint below)

Is it a problem? if yes, the following are proposed fixes:

* 1. Introduce constraints to ensure that the slice signalling order in the PPS and the slice coding order within the bitstream are the same. (JVET-R0091 #1)

The proposed constraint:

The signalling order of slices in the PPS shall follow the decoding order of slice NAL units. Let slice A be signalled by the syntax elements slice\_width\_in\_tiles\_minus1[ sA ], slice\_height\_in\_tiles\_minus1[ sA ], num\_exp\_slices\_in\_tile[ sA ] and exp\_slice\_height\_in\_ctus\_minus1[ sA ] and let slice B be signalled by the syntax elements slice\_width\_in\_tiles\_minus1[ sB ], slice\_height\_in\_tiles\_minus1[ sB ], num\_exp\_slices\_in\_tile[ sB ] and exp\_slice\_height\_in\_ctus\_minus1[ sB ]. If coded slice NAL unit A precedes coded slice NAL unit B in the bitstream, then sA shall be less than sB.

In order for item 7.a to work, the following constraints are also needed:

One or both of the following conditions shall be fulfilled for each subpicture and tile:

– All CTUs in a subpicture belong to the same tile

– All CTUs in a tile belong to the same subpicture

* 1. Introduce a mapping between the two indexing orders (JVET-R0091 #2, JVET-R0238). In addition, definition of subpicture-level slice index is updated in the spec text (JVET-R0238)

It was commented that the constraint approach could prohibit a hypothetical use encountered in one subpicture out of 96 in an example 360° use case.

We had previously agreed not to prohibit the hypothetical use unless we had a reason to prohibit it, but the potential need to introduce a mapping may be such a reason.

It was commented that there is some text in the draft currently about a subpicture-level slice index, and an equation expressing such an index is not currently specified clearly in the text.

The mapping proposed in R0238 is to specify a mapping from a subpicture-level slice index to a picture-level slice index.

It was commented that if the constraint approach is taken, some encoders might violate it. However, the constraint only requires slice order to follow the order in the header syntax, which would arguably be strange to violate.

In fact the difference between JVET-R0091 #2 and JVET-R0238 was only editorial.

The proponent of JVET-R0091 preferred the constraint approach.

Decision (cleanup): Adopt the constraint approach of JVET-R0091 option 1. (The editor has discretion over the manner of expression in the text.)

1. Alignment on subpic\_treated\_as\_pic\_flag value across layers (JVET-R0118 #2, JVET-R0186 #3)

Other aspects of subpictures are required to be aligned across layers.

This is only in regard to SNR scalability.

It was commented that this corresponds to item 1)b of document R0058 in section 6.1.1; see the notes for that topic.

1. Move the signalling of no\_pic\_partition\_flag to be earlier than the signalling of pps\_num\_subpics\_minus1. When the value of no\_pic\_partition\_flag is equal to 1, pps\_num\_subpics\_minus1 is not present and inferred to be equal to 0 (JVET-R0186 #1)

This is primarily motivated by a desire for logical structuring of the syntax.

It was commented that this is also a similar aspect in R0088.

Decision (cleanup): Adopt this aspect.

1. Constrain the value of single\_slice\_per\_subpic\_flag to be equal to 0 when no\_pic\_partition\_flag is equal to 0, the number of tiles in picture is equal to 1, and the number of subpictures is equal to 1 (JVET-R0186 #2)

The intent was for this to only apply when the number of slices is equal to 1.

In the combination that is proposed to be prohibited, it would be possible to indicate the same behaviour using no\_pic\_partition\_flag equal to 1.

This constraint is not strictly necessary, but the proponent suggests prohibiting it because it seems like a strange syntax combination. There was no clear need for action on this, so no action was taken on this.

1. When the maximum picture width and height are both less than or equal to one CTB size, sps\_num\_subpics\_minus1 is not signalled and inferred to be 0 (JVET-R0239 #5)

Such a usage would seem extremely rare in practice, and no action was taken on this.

1. Signal a flag sps\_raster\_scan\_order\_subpics\_flag in the SPS to specify whether subpictures are ordered in raster scan order in the bitstream. (JVET-R0257 #1)

Raster scan ordering of subpictures, which is a unique ordering of subpictures in the bitstream, is claimed to be useful for extraction and merging purposes and to provide a hook for, e.g., external use.

* 1. Use the above flag to skip the signalling of the top-left position of the subpictures in the SPS when sps\_raster\_scan\_order\_subpics\_flag is equal to 1. (JVET-R0257 #2)

This would provide a shortcut for a mode to specify a raster scan order for the subpictures.

It was suggested not to provide the raster indication purely as metadata, without a syntax shortcut.

It was commented that specifying the shortcut would involve adding more text details to specify the special case and that this seems unnecessary, esp. due to our late stage in the development.

It was agreed that raster order would be common, and raster scan slices have a provision for this.

Using a VUI flag was suggested. However, it was noted that VUI is currently only being used for picture format interpretation purposes (colour interpretation and field indication).

Using a general constraint flag was suggested. These are, at least currently, being used as feature disabling indicators rather than as SEI-like metadata.

No action was taken on this.

1. Enable signalling of subpicture with filler / uncoded slices. (JVET-R0337, JVET-R0151)

It is asserted that such feature can be used for efficient coding when subpictures do not completely fill up a picture, by providing completely unused regions. The feature is asserted to be useful for V-PCC, 360° video, and layered coding applications.

If such support is agreed, the following changes to the text are proposed:

* 1. A flag sps\_filler\_slice\_present\_flag / (or sps\_allow\_uncoded\_subpics\_flag) is signalled when subpic\_info\_present\_flag is equal to 1. When the flag is equal to 1, signal subpic\_treated\_as\_filler\_slice\_flag[ i ] (or subpic\_is\_uncoded\_flag[ i ]). (JVET-R0337, JVET-R0151)
  2. Decoding of filler slice in subpicture can be “normative” or “non-normative” (JVET-R0337)

There have been previous related contributions. In some variations this involves only a metadata indication. In previous discussion there had been a suggestion for some later development of metadata.

R0151 proposes SPS-level specification of subpictures that have no coded slices in the entire CLVS, and also an ability to have a PPS specification of areas with no coded slices in the picture.

Several example use cases are described in R0151. Viewport-dependent streaming was mentioned as another potential use.

The standard currently requires coding all regions of the picture (although this may involve coding regions as basically entirely skipped – e.g., planar prediction with no residual or inter prediction with no residual).

It was commented that the “normative” approach is basically a coding efficiency proposal, possibly with a complexity benefit for software decoders (depending somewhat on what is defined to be the normative output of the decoding process).

What R0337 refers to as “non-normative” is a metadata indicator that accompanies content that is coded in the ordinary manner.

These are proposing a significant added feature that, in some variations, would have a large impact on the standard and its concepts of normative behaviour for output. It was agreed that we are too late in the standard development process to add such a feature. The metadata approach could be developed as a later-standardized SEI message. No immediate action was taken on this. Later development of an SEI message approach is for further study.

1. Signalling pps\_num\_subpics\_minus1 in PPS as mandatory, to avoid asserted parsing dependency on SPS (on single\_slice\_per\_subpic\_flag when pps\_num\_subpics\_minus1 is not present). (JVET-R0117 #1)

The contributor said this did not need consideration, as there is no actual parsing dependency (just a constraint).

1. Change the signalling of subpicture layout in unit of integer multiples units of CtbSizeY (JVET-R0135)
   1. Option 1: signal subpic\_unit\_num\_ctus\_minus1 syntax element that is the number of CtbSizeY in the subpicture layout. All syntax elements of subpicture layout use the same in units.
   2. Option 2: signal subpic\_unit\_num\_ctus\_x\_minus1 and subpic\_unit\_num\_ctus\_y\_minus1 syntax elements that are the number of CtbSizeY in the subpicture layout. The first syntax element indicate the units for the subpic\_ctu\_top\_left\_x[ i ] and subpic\_width\_minus1[ i ], and the second for the subpic\_ctu\_top\_left\_y[ i ] and subpic\_height\_minus1[ i ]
   3. Option 3: combine Option 1 with Option 2 and two options can be selected.

This is proposing a shortcut method of signalling subpicture layout for bit savings in the SPS (as a generalization of the current syntax with width/height multiple). It was commented that we had previously considered something somewhat similar in spirit. The proponent said in the example shown in Fig. 7 of the draft standard, about 100 bits could be saved in SPS-level signalling.

It was asked whether the scheme had been implemented in software, and it had not. The bit savings estimate was based on calculation.

It was asked how this works if the picture width/height is not an exact multiple of the unit width/height.

Some participants commented that introducing such a concept at this stage would run a risk of introducing bugs, especially since this had not been tested. Saving bits at the SPS level is generally not considered very important. Some other participants noted that in this case the bit savings at the SPS level could be substantial in some uses and found it conceptually simple.

A further generalization was suggested in the discussion, which would be to use such a scaling factor in additional parts of the syntax.

This was further discussed on 23 April at 0800 (UTC). Software had been provided in a -v4 of the contribution. The contribution had been revised to prohibit the use of the shortcut unless the picture is an exact multiple of the scaled number of CTUs in width/height. One participant said they had had cross-checked the scheme and said it seemed to work properly, but they thought most encoders would just not use the shortcut. They had some concern they had found a problem in the draft for the subpicture extraction process and that the scaling factor was missing in some other part of the text, and noted that it can only be used in the limited case with exactly uniform units. However, some other participants said it was straightforward and could save a lot of signalling in some example cases and volunteered to help with the editorial work. Several participants expressed support for approach “b”. The functionality is not changed – it is just a signalling shortcut. The opinions were rather mixed and the issue seemed minor. In the interest of stability, no action was taken.

1. Change the signalling of slice\_subpic\_id as follows: (JVET-R0087)
   * Add a flag called slice\_subpic\_info\_present\_flag
   * Replace subpic\_info\_present\_flag to condition the presence of slice\_subpic\_id
   * The value of slice\_subpic\_info\_present\_flag is the same as subpic\_info\_present\_flag

The motivation was said to be to remove a parsing dependency in the slice level on something in the SPS. It was noted that we have many such parsing dependencies; this is an ordinary part of our design. No action was taken on this.

1. Move the signalling of subpic\_id\_mapping\_in\_pps\_flag, pps\_num\_subpics\_minus1, pps\_subpic\_id\_len\_minus1, and pps\_subpic\_id[ i ] to be present only when (pps\_)no\_pic\_partition\_flag is equal to 0 (JVET-R0088)

This contribution was said to be related to R0186. Aspect 1 of the contribution belongs to this category. It was commented that even when there is no partitioning of the picture, the extraction case would require the possibility of signalling subpicture ID mapping when a single subpicture is extracted. Thus, no action was taken on this.

Discussion stopped here for JVET on 16 April at 1715 (UTC) (GJS, JRO, YKW).

Discussion began here for JVET Track A on 21 April at 0835 (UTC) (GJS & YKW).

1. Add a constraint that the value of subpic\_treated\_as\_pic\_flag[ ] shall be equal to 1 when the value of SubpicIdVal[ ] of the subpicture is changed from the previous picture (JVET-R0126)

It is intended to guarantee that only independently coded subpictures can be relocated by subpicture ID remapping in PPS.

It was commented that there is already an IRAP constraint for collocated subpicture ID changes.

It was asked whether there is some reason that makes it necessary to establish this proposed further constraint. It was not clear that this constraint would be necessary for the decoder, so no action was taken on it.

1. Add subpicture ID mapping signalling override mechanism (JVET-R0265)
   1. Remove subpic\_id\_mapping\_explicitly\_signalled\_flag in SPS
   2. Repurpose subpicture ID mapping flag in PPS (i.e., change subpic\_id\_mapping\_in\_pps\_flag to subpic\_id\_mapping\_override\_in\_pps\_flag). When it is equal to 1, subpicture ID is overridden in PPS.

The basic idea is to have subpicture IDs always in the SPS (either derived or explicitly signalled) and the ability to override some or all of them in the PPS. This is so that some of them (the ones earlier in the list) can be overridden while not overriding all of them. The basic motivation is to save PPS bits.

It was commented that an extra constraint is also missing from the proposal.

It was commented that the way this is proposed, with overriding at the beginning of the list (those at the left and top of the picture), the syntax/approach does not seem very “clean”, and this loses an ability to not send the mapping in the SPS. Thus no action was taken on this.

1. On subpicture Id and subpicture Idx in sub-bitstream extraction
   1. Use the subpicture index instead of the subpicture ID in the subpicture sub-bitstream extraction process (JVET-R0068 #5). This is because the subpicture index corresponds to a position in the picture, but the ID can change within a CLVS.

It was said that this could make the extraction process specification simpler.

It was also commented that this could avoid a potential problem with having some ID not appearing in the bitstream, whereas spatial positions should never be unexpectedly absent.

Decision (cleanup): Adopt.

* 1. Derive subpicIdx similar to CurrSubpicIdx for each slice, right after the definition of subpicId (JVET-R0294). This is proposed as a bug fix for the existing approach, and is no longer relevant after the action on subitem “a”.

Discussion stopped here for JVET Track A on 21 April at 0915 UTC.

Discussion began here for JVET Track A on 21 April at 1730 UTC (GJS & YKW).

1. On subpicture size and picture size rewriting for sub-bitstream extraction.

A bug is asserted exist in the current spec for rewriting of picture size during sub-bitstream extraction process. The root of the problem is when the subpicture is located at the bottom and/or right border of a picture that has a size that is not a multiple of the CTU size because subpicture size (i.e., width and height) is expressed in CtbSize, instead of luma samples.

* 1. Change the sub-bitstream extraction process with different calculation for picture size when the subpicture is the right most subpicture or the bottom subpicture in the original bitstream (JVET-R0092)
  2. Derive the subpicture width and height in luma samples and update the rewriting process of picture width and height (JVET-R0294)

Subpicture size is sent in CTU units.

The difference between the “a” and “b” approaches is only editorial.

Decision (spec bug fix / expression of existing intent): Adopt as proposed. The editorial difference can be worked out by the editor. No impact on the software.

1. Add a constraint such that no subpicture can be located completely outside of the conformance cropping window. (JVET-R0093 #1, JVET-R0294).

There are already constraints that when subpictures are used the picture size cannot change, and the conformance cropping window also cannot change.

This would require rewriting if an encoder wants to select a cropping window that doesn’t include anything from a subpicture.

It was commented that such a picture region might be usable for inter-layer reference.

A conforming bitstream needs to have a conformance window that is not empty.

If a subpicture is completely outside the conformance window, and if it is extractable (the subpic boundary treaing as picture boundary flag is equal to 1), but does it need to be included in the conformance test that use a subpicure sub-bitstream extraction process?

If a subpicture completely outside of the conformance window is extacted but in the extracted sub-bitstream there is a valid conformance window, would it be a problem? Seems not. However, this would be strange as this impose conformance requirement beyond what's was required to be conforming by the original encoder.

HEVC includes both the conformance window and the default display window. The latter can be used for the purpose of something inside the conformnce window but not intended to be displayed together with other stuff inside the conformance window but not in the default display window.

Decision (sensibility cleanup): Adopt.

1. Define rewriting process for conformance cropping window for sub-bitstream extranction process (JVET-R0093 #2, JVET-R0294)
   1. The conformance cropping window offsets of the full picture are kept or not depending on where the subpicture is located within the full picture. If the subpicture is located in the middle of the picture, the conformance cropping window offsets for the subpicture are set to zero (JVET-R0093 #2)
   2. Copy all offset values that cross the subpicture to be extracted. If a subpicture lies completely inside the conformance window, no conformance window shall be signalled (JVET-R0294)

The difference between 23.a and 23.b are basically only editorial.

Decision (expression of existing intent): Adopt. The editor was requested to figure out the exact wording based on the proposed changes.

1. Handling of decoded picture hash SEI msg (JVET-R0294, JVET-R0242):
   1. Option 1: The following applies: (JVET-R0294)
      * Decoded picture hash SEI messages are removed during extraction
      * Decoded picture hash SEI messages are allowed to be nested inside of scalable nesting SEI messages, if subpicture nesting is signalled in the scalable nesting SEI message
      * Decoded pictures hash SEI messages that are nested in a scalable nesting SEI message and associated with subpicId are extracted into the output bitstream
   2. Option 2: extended decoded pciture hash SEI msg with hashes for each subpicture (JVET-R0294)
   3. Option 3: add a separate standardalone SEI message. (JVET-R0242)

With a subpicture specific hash signalled, subpicture sub-bitstream extraction process would be easy. Otherwise the picture-level decoded picture hash SEI messages have to be discarded during the sub-bitstream extraction.

The identfication of which SEI message conveys the picture-level or subpicure-level information can be determined by the container of the SEI message (nested or non-nested) or by using a separate SEI message.

In production encoding and actually applications, people don't send the decoded picture hash SEI messages in the bitstream. The SEI message has really been included for debugging purposes during the development of the standard.

Option 1 is really proposing to change the extraction process to utilize the existing scalable nesting SEI message and the existing decoded picture hash SEI message in the extraction process.

Software is provided in JVET-R0242. The software coordinator took a look and said it was good.

Decision (cleanup): Adopt option 1.

1. Information contribution on successful experiments carried out for implementation of subpicture-based system. The experiment included the following steps (JVET-R0148):
   1. Encoding several bitstreams, each with one subpicture per picture, using the VTM encoder
   2. Merging selected encoded bitstreams into a bitstream with multiple subpictures, using a merger software developed by the authors
   3. Decoding the bitstream having multiple subpictures, using the VTM decoder

It was said that the experiments demonstrated that the subpictures design was mature.

If there is sufficient interest, the merger software could be considered to be donated, e.g., to be included as part of the VTM reference software.

Why to turn off ALF, LMCS, and SAO? The encoding used the VTM encoder, but indepednently for the "small" pictures.

Discussion stopped here for JVET Track A on 216 April at 1900 (UTC) (GJS & YKW).

#### General and misc. subpicture aspects (11)

[JVET-R0071](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9715) AHG12: Some cleanups on subpicture signalling [Z. Deng, Y.-K. Wang, L. Zhang, K. Zhang (Bytedance)]

[JVET-R0091](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9735) AHG9: Issue with slice indexing [V. Drugeon (Panasonic)]

[JVET-R0151](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9795) AHG6/AHG12: Uncoded subpictures and potential applications [J. Sauer (RWTH Aachen Univ.)]

[JVET-R0156](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9800) AHG8/AHG9: Signalling cleanup on SPS [B. Wang, S. Esenlik, A. M. Kotra, H. Gao, E. Alshina (Huawei)]

Item 4 of this contribution belongs to this category.

[JVET-R0238](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9882) AHG12: A fix on subpicture-level slice indexing [K. Zhang, L. Zhang, Y.-K. Wang, Z. Deng, K. Fan, J. Xu, H. Liu (Bytedance)]

[JVET-R0093](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9736) AHG12: Subpictures and conformance cropping window [V. Drugeon (Panasonic)]

Item 1 of this contribution belongs to this category.

[JVET-R0136](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9780) AHG9/AHG12: Improvements on sps\_independent\_subpics\_flag and nal\_unit\_type constraint [M. Katsumata, M. Hirabayashi, T. Suzuki (Sony)]

Item 1 of this contribution belongs to this category.

[JVET-R0186](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9830) AHG12: On misc updates for picture partitioning signalling [Hendry, S. Paluri, S. Kim (LGE)]

[JVET-R0257](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9901) AHG12: Raster scan order flag for subpictures [M. Damghanian, R. Sjöberg, M. Pettersson, Z. Zhang, J. Enhorn, J. Ström, R. Yu (Ericsson)]

[JVET-R0284](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9928) AHG12/AHG9: On independent subpicture signalling [Y.-J. Chang, Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-R0337](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9981) AHG12: Subpicture with filler slice for merged stream [K. Kawamura, S. Naito (KDDI)]

#### Subpicture layout signalling (4)

[JVET-R0117](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9761) AHG9/AHG12: On signalling of subpicture and slice in PPS [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-R0118](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9762) AHG9/AHG12: On signalling of subpicture partitioning in SPS [B. Choi, S. Wenger, S. Liu (Tencent)]

Item 2 of this contribution belongs to this category.

[JVET-R0135](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9779) AHG12: On subpicture layout signalling [M. Katsumata, M. Hirabayashi, T. Suzuki (Sony)]

[JVET-R0482](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10144) Crosscheck of JVET-R0135 (AHG12: On subpicture layout signalling) [K. Abe (Panasonic)] [late]

[JVET-R0239](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9883) AHG9: Cleanups on signalling of tiles, slices, and subpictures [K. Zhang, L. Zhang, Y.-K. Wang, Z. Deng, J. Xu, H. Liu (Bytedance)]

Aspect 1 is no longer relevant because of the action taken for R0062. For aspects 2 and 5, see the the notes for R0415.

Aspects 3 and 4 were discussed on 24 April at 0900 UTC (GJS).

Aspect 3: When num\_exp\_tile\_columns\_minus1 is equal to PicWidthInCtbsY − 1, tile\_column\_width\_minus1[ i ] is not signalled and inferred to be 0. Likewise, when num\_exp\_tile\_rows\_minus1 is equal to PicHeightInCtbsY − 1, tile\_row\_height\_minus1[ i ] is not signalled and inferred to be 0. This aspect is for an unusual “corner case”, and it was agreed that no action is needed for it.

Aspect 4: The semantis of exp\_slice\_height\_in\_ctus\_minus1[ i ] is clarified that exp\_slice\_height\_in\_ctus\_minus1[ i ][ num\_exp\_slices\_in\_tile[ i ] − 1 ] is used to derive the uniform slice height, instead of specifying the height of the (num\_exp\_slices\_in\_tile[ i ] − 1) -th slice.

Decision (editorial bug fix / expression of existing intent): Adopt aspect 4.

#### Subpicture ID signalling (4)

[JVET-R0087](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9731) AHG12: Modification of subpicture information in slice header [W. Lim, G. Bang (ETRI)]

[JVET-R0088](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9732) AHG12: Modification of subpicture information in PPS [W. Lim, G. Bang (ETRI)]

Item 1 of this contribution belongs to this category.

[JVET-R0126](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9770) AHG9/AHG12: On signalling of subpicture ID [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-R0265](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9909) AHG9/AHG12: On subpicture ID mapping signalling [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

#### Subpicture based bitstream extraction and merging (6)

[JVET-R0068](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9712) AHG8/AHG9/AHG12: Miscellaneous HLS topics [Y.-K. Wang, L. Zhang, Z. Deng, J. Xu, K. Zhang, K. Fan (Bytedance)]

Item 5 of this contribution belongs to this category.

[JVET-R0092](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9736) AHG12: Subpicture size calculation for subpicture extraction [V. Drugeon (Panasonic)]

[JVET-R0093](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9736) AHG12: Subpictures and conformance cropping window [V. Drugeon (Panasonic)]

Item 2 of this contribution belongs to this category.

[JVET-R0294](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9938) AHG12: On subpicture extraction [K. Suehring, R. Skupin, Y. Sanchez, T. Schierl (HHI)]

[JVET-R0242](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9886) AHG9/AHG12: Decoded subpicture hash SEI message [J. Boyce, L. Xu (Intel)]

[JVET-R0148](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9792) AHG12: Subpicture merging experiments [A. Hallapuro, M. Homayouni, A. Aminlou, M. M. Hannuksela (Nokia)]

### Slices and tiles (19)

#### Tile signalling (6)

[JVET-R0053](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9697) AHG9: Signalling tile partitioning [S.-T. Hsiang, C.-M. Tsai, Y.-W. Huang, S.-M. Lei (MediaTek)]

Items 1 and 2 of this contribution belong in this category.

This was discussed in AHG Session 1.2 Monday 6 April at 1600 UTC (GJS & YKW).

This contribution proposes three high-level syntax modifications related to signalling tile partitioning of the coded picture, summarized as follows:

1. The number of explicitly provided tile column widths or tile row heights is proposed to be allowed to be equal to 0. When no\_pic\_partition\_flag is equal to 0 and the coded picture contains only one tile, the proposed method can infer the tile column width and the tile row height to be equal to the picture width and the picture height, respectively, without signalling the syntax elements tile\_column\_width\_minus1[ 0 ] and tile\_row\_height\_minus1[ 0 ] for deriving the tile column width and the tile row height.

R0285 and R0080 are said to contain the same proposal. It is a syntax optimization to avoid signalling tile width or height if the picture is not split into tiles in the corresponding dimension. It was commented that this is consistent with another use of avoiding explicit signalling. It was commented that for uniform tile size signalling, this would increase the signalling that is needed. No action on this was recommended; although it saves a few bits in the PPS in some cases, it adds more in another case that some participants expect to be more common.

1. pps\_log2\_ctu\_size\_minus5 is proposed to be signalled in the picture parameter set (PPS) only when rect\_slice\_flag is equal to 0, single\_slice\_per\_subpic\_flag is equal to 0 and num\_slices\_in\_pic\_minus1 is greater than 0.

A participant commented that it is nice to know pps\_log2\_ctu\_size\_minus5, even in other conditions where it is not necessary for parsing. Since it is only two bits, it does not seem important to avoid sending this. No action was recommended on this.

1. (pps\_)loop\_filter\_across\_tiles\_enabled\_flag is proposed to be signalled only when the number of the tiles in the coded picture is greater than 1.

At the previous meeting, it was planned that we would move this flag to the SPS (see notes for JVET-Q0120).

R0113 and an aspect of R0197 are proposing this in principle as well.

It was asked whether bitstream merging would be affected by this, and it was commented that PPSs need to be rewritten in that case anyway.

The initial AHG Recommendation was to confirm the move to the SPS, but this was overturned as noted under JVET-R0069.

This was further discussed on 22 April at 1715 (GJS & YKW).

Decision (cleanup): Adopt conditioning presence of loop\_filter\_across\_tiles\_enabled\_flag per JVET-R0113 aspect 1 (avoiding redundant signalling without change of functionality).

[JVET-R0062](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9706) AHG12: A cleanup on uniform tile and rectangular slice partitioning [L. Zhang, Z. Deng, K. Zhang, Y.-K. Wang (Bytedance)]

Discussed in AHG Session 1.2 Monday 6 April at 1515 UTC (GJS & YKW).

This contribution proposes the following changes related to uniform tile and rectangular slice partitioning:

1. In the equation (Eqn. 23) for derivation of tile columns parameters, replace the loop count "i < num\_exp\_tile\_columns\_minus1" with "i  <=  num\_exp\_tile\_columns\_minus1", such that the value of the last explicitly signalled tile\_column\_width\_minus1[ i ] specifies the width of at least one tile column. The semantics of tile\_column\_width\_minus1[ i ] is updated accordingly.
2. In the equation (Eqn. 24) for derivation of tile rows parameters, replace the loop count "j < num\_exp\_tile\_rows\_minus1" with "j  <=  num\_exp\_tile\_rows\_minus1", such that the value of the last explicitly signalled tile\_row\_height\_minus1[ i ] specifies the height of at least one tile row. The semantics of tile\_row\_height\_minus1[ i ] is updated accordingly.
3. In the equation (Eqn. 30) for derivation of in-tile rectangular slices parameters, replace the loop count "j < num\_exp\_slices\_in\_tile[ i ] − 1" with "j < num\_exp\_slices\_in\_tile[ i ]", such that for each value of i, the value of the last explicitly signalled exp\_slice\_height\_in\_ctus\_minus1[ i ][ j ] specifies the height of at least one rectangular slice in the tile containing the i-th rectangular slice.

The basic desire is to prevent the ability of the encoder to express syntax that seems strange and confusing. It was said that the strange case is not uncommon.

This proposal was viewed favourably. One participant said this is essentially editorial. There is not really a bug – just a lack of prohibiting something strange that is asserted to be useless. The proposal would just prohibit the encoder from signalling silly values that would result in the same decoded result as sensible values. It was said there are other related proposals. AHG Recommendation (cleanup): Adopt.

[JVET-R0080](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9724) AHG12: On signalling of tile and slice [Y.-U. Yoon, D. H. Park (KAU), J. H. Do (ETRI), J.-G. Kim (KAU)]

Discussed in AHG Session 1.2 Monday 6 April at 1650 UTC (GJS & YKW).

VVC (Draft 8) includes signalling for tile and slices in PPS.

This contribution proposes two modifications on signalling of tile and slice information in the PPS as follows.

* Proposal 1: It is proposed to change the condition for signalling the syntax element of tile\_idx\_delta\_present\_flag. When the value of num\_slices\_in\_pic\_minus1 is greater than 1 instead of 0, the syntax element of tile\_idx\_delta\_present flag is signalled.

This would save one bit when there are only two rectangular slices in the entire picture. Although the savings is very minor, the change is trivial. JVET-R0211 item 1 proposes this as well.

AHG Recommendation: Adopt.

* Proposal 2: It is proposed to replace the syntax element of num\_exp\_tile\_columns\_minus1 and num\_exp\_tile\_rows\_minus1 as num\_exp\_tile\_columns and num\_exp\_tile\_rows, respectively. When a picture is not partitioned into multiple tiles in rows or columns, the value of num\_exp\_tile\_columns or num\_exp\_tile\_rows is signaled as 0. Then, the syntax element of tile\_column\_width\_minus1 or tile\_rows\_height\_minus1 is not signaled and inferred to be equal to PicWidthInCtbsY-1 or PicHeightInCtbsY-1.

Proposal 2 is the same as item 1 of R0053; see the notes for that item.

After discussion of this contribution, the AHG discussed JVET-R0054, which has been moved to section4.9, and then continued with the topic below.

[JVET-R0157](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9801) AHG9/AHG12: Signalling cleanup on PPS [B. Wang, S. Esenlik, A. M. Kotra, H. Gao, E. Alshina (Huawei)]

Item 2 of this contribution belongs to this category.

Discussed in AHG Session 1.6 Tuesday 7 April at 1520 UTC (GJS & YKW).

It is proposed to skip signalling of tile width and height when the picture width or height is less than or equal to the CTU size. It was noted that a similar provision is applied for subpicture signalling and in the SPS syntax. This would save two bits in each relevant dimension.

It was remarked that something this is also proposed in the 2nd aspect of proposal R0239, with a somewhat simpler editorial expression.

One participant said this seemed like an unnecessary complication for a corner case. In the subpicture case the syntax element is a u(v) rather than ue(v), and it was a somewhat different circumstance.

However, another participant said it was strange to send something and have semantics saying it shall be in the range of 0 to 0.

Software had been provided and the proponent said they had tested it.

No action was recommended on this since the issue is for a very minor corner case.

An editorial bug fix is also proposed for when num\_exp\_tile\_columns\_minus1 is equal to 0; however this aspect was no longer relevant due to an action taken on R0062.

[JVET-R0221](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9865) AHG9: Clean-up of tile signalling [J. Luo, J. Chen, Y. Ye (Alibaba)]

Discussed in AHG Session 1.6 Tuesday 7 April at 1555 UTC (GJS & YKW).

In VVC draft 8, the syntax allows indicating a sum of tile widths/heights that is wider than the picture width/height. It is asserted that the constraints of tile partitioning is not straightforward. If the sum of signalled tile widths/heights is larger than picture width/height, the current derivation could cause invalid CTU addresses being added to a slice. In this contribution, it is proposed to add two conformance constraints to make the conformance requirements on tile partitioning cleaner, such that invalid CTU address would not be included in a slice. In the second version, the conformance requirement on tileColBd and tileRowBd is added.

Q0359 was a related proposal of the last meeting. The proponent reported that there was still an editorial error in the constraint expression.

This is an editorial bug fix proposal.

AHG Recommendation (expression of existing intent): The editor is asked to ensure that the text adequately expresses the necessary constraints, such that tiles, slices, and subpictures are a proper partitioning of the picture (no overlaps, no gaps, no CTUs that are outside the picture).

[JVET-R0285](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9929) AHG12: On tile information signalling [Y.-J. Chang, Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Discussed in AHG Session 1.6 Tuesday 7 April at 1625 UTC (GJS & YKW).

In this contribution, there are two proposed changes to the signalling of tile information:

* Replace num\_exp\_tile\_columns\_minus1 and num\_exp\_tile\_rows\_minus1 with num\_exp\_tile\_columns and num\_exp\_tile\_rows.
* Change the range of num\_exp\_tile\_columns\_minus1 to be 0 to PicWidthInCtbsY − 2, inclusive, and the range of num\_exp\_tile\_rows\_minus1 to be 0 to PicHeightInCtbsY − 2, inclusive.

The first aspect is the same as in R0053 item 1 and R0080; see notes elsewhere on that.

The second aspect has a somewhat similar spirit to R0062. It is intended to prohibit the encoder from sending something explicitly that could be inferred instead. However, it would not be a strictly necessary change.

“Method 1” would tighten the constraint on num\_exp\_tile\_columns(rows)\_minus1. It was commented that “Method 2” seemed like unnecessary complication for a corner case. In “Method 2”, a shortcut is proposed for when the number of tiles columns or rows is equal to the number of CTUs in the picture width or height.

No clear need for action was identified, so no action was taken.

#### Rectangular slice signalling (11)

[JVET-R0088](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9732) AHG12: Modification of subpicture information in PPS [W. Lim, G. Bang (ETRI)]

Item 2 of this contribution belongs to this category.

Discussed in AHG Session 1.6 Tuesday 7 April at 1655 UTC (GJS & YKW).

This contribution proposes to modify syntax elements related to subpicture and slice in PPS. The number of subpictures and slices are dependent according to the current VVC specification. In PPS, those syntax elements are signalled regardless of each other. The following two proposals are described in this document.

Proposal 1) Subpicture-related syntax elements are signalled in PPS when a picture partitioned which refers to the PPS.

Proposal 2) Signaling difference between the number of slices and the number of subpictures instead of the number of slices.

Proposal 2 is to save some bits for signalling in the PPS. It was commented that this is for something sent only once per PPS. It was commented that the number of subpictures, which this uses, is not always available in the PPS.

Proposal 2 was said to be the same as the second item of R0117, in which item 1 proposes to make the number of subpictures unconditionally present in the PPS.

Several participants commented that it seems undesirable to couple the subpicture and slice signalling and use differential signalling, e.g., as the number of bits saved is minimal. Even without the issue of whether the number of subpictures is always present or not, this was expressed.

Another contribution R0162 was said to also be related, which proposes to change num\_slices\_in\_pic\_minus1 to num\_slices\_in\_pic\_minus2.

Q0332 was also somewhat similar, and it was concluded at the time that it would not provide a bit savings or be substantially beneficial.

The AHG recommended no action on R0088 item 2.

[JVET-R0162](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9806) AHG9: PPS and SH syntax cleanup [J. Chen, J. Luo, Y. Ye, R.-L. Liao (Alibaba)]

Item 2 (num\_slices\_in\_pic\_minus2 signalling) of this contribution belongs to this category.

Discussed in AHG Session 1.6 Tuesday 7 April at 1710 UTC (GJS & YKW).

This proposes to change num\_slices\_in\_pic\_minus1 to num\_slices\_in\_pic\_minus2 in PPS. Aside from a small bit savings (which is not the main motivation), this would prevent a duplicate way of expressing the same thing.

A participant commented that the semantics of single\_slice\_per\_subpic\_flag is “one way”, and if this was adopted that would need to be changed, so there would be only one way to express that. It was commented that this seems similar in spirit to the action on each\_layer\_is\_an\_ols\_flag. Both of these flags are intended as shortcuts for particular cases and making the constraint two-way might make it easier to understand. However, another participant said that although we wanted to have the shortcut, we should not force it to be used just because it is applicable. Another participant said there was a difference between the situation for the each\_layer\_is\_an\_ols\_flag.

At least one subpicture in all pictures referring to the PPS would need to have at least two slices in it if this is adopted. It is noted that the slice layout is determined in the PPS, so this may not be a significant burden.

There seemed to be no clear need for action, and some participants disliked the removal of flexibility of expression. Others (including the original proponent of the shortcut) thought the two-way constraint would be more sensible and consistency with each\_layer\_is\_an\_ols\_flag is desirable.

Discussion stopped here for AHG session 1.6 Tuesday 7 April at 1715 UTC, and resumed here with AHG Session 1.10 on Wednesday 8 April at 1530 UTC]

After offline study and further discussion, there continued to be mixed opinions.

[JVET-R0111](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9755) AHG9/AHG12: Vertical slice boundaries [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

Discussed in AHG Session 1.10 Wednesday 8 April (GJS & YKW).

This contribution provides an analysis of using subpictures for server-side composition. It is asserted that it would be beneficial to be able to merge bitstreams from several different sources into a combined bitstream composed of multiple different subpictures. The contribution details some of the parameters and settings that needs to be aligned between different sources in order to support this use case and includes a proposal for one modification asserted to improve feasibility and reduce implementational burden; to allow a tile to include multiple slices *either* vertically or horizontally (which is different from the current VVC draft where only horizontally structured slices are allowed within a tile).

In summary, the following changes are proposed:

* A new syntax element, vertical\_slice\_boundaries\_flag, for indicating if a tile is split vertically or horizontally.
* Modification to CTU scan derivation to include two cases depending on the value of the proposed flag.
* Update to syntax and decoding process since a vertical slice boundary is no longer required to be aligned with a vertical tile boundary.
* Replace the level limit on number of vertical tile boundaries with a limit on the sum of vertical tile boundaries and vertical slice boundaries.

The proposal would avoid having the encoder need to pre-segment the content into more tiles when authoring the content (which also has a coding efficiency penalty).

This would be a significant design change, as it would require the decoder to track vertical boundary positions that would be different for different rows. There had been an objection to this at the previous meeting as a burden on decoder implementation. It was commented that this would have a significant impact on hardware design.

It was commented that the previously proposed dependent slices concept of N0497 is an alternative approach to provide some degree of similar functionality.

It was commented that there has been usage of MCTSs and a need for highly coordinated encoding in past practice.

Especially given the late stage at which we are in this design process, there were strong objections to the proposed change, so no action was taken on this.

[JVET-R0129](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9773) AHG9/AHG12: On CTU row based slice chunks of a slice within a tile [L. Chen, C.-W. Hsu, C.-C. Chen, Y.-L. Hsiao, C.-Y. Chen, T.-D. Chuang, C.-M. Tsai, Y.-W. Huang, S.-M. Lei (MediaTek)]

Discussed in AHG Session 1.10 Wednesday 8 April at 1630 UTC (GJS & YKW).

This contribution proposes to specify CTU row-based slice chunks of a slice within a tile in decoding order. The slice chunks in sequence of a slice are delivered and decoded sequentially. Each slice chunk is proposed to be contained in a single NAL unit. It is claimed that no essential new requirements are needed in the decoding process. It is claimed that the proposed slice chunks can meet ultra-low latency requirements with better coding efficiency than conventional slices. It is reported the BD-rate savings of the proposed slice chunks compared against the conventional slices are 4.52%, 3.55%, 3.64%, and 4.93% for short length (1 sec) Class A1 (4K), Class A2 (4K), Class B (1080p), and Class E (720p), respectively, when the encoding latency is one CTU row. Proposed reference software was claimed to be ready and cross-checked and was attached in the uploaded proposal package.

This would be something like a special case of the dependent slice segment concept of HEVC. The proponent said dependent slice segments was a useful feature of HEVC, while another participant said they had seldom encountered this feature in practice.

Especially given the late stage at which we are in this design process, there were strong objections to the proposed change, so no action was taken on this.

[JVET-R0349](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9993) Crosscheck of JVET-R0129: AHG9/AHG12: On CTU row based slice chunks of a slice within a tile [J. Chen, J. Luo, Y. Ye (Alibaba)] [late]

[JVET-R0157](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9801) AHG9/AHG12: Signalling cleanup on PPS [B. Wang, S. Esenlik, A. M. Kotra, H. Gao, E. Alshina (Huawei)]

Item 1 of this contribution belongs to this category.

Discussed in AHG Session 1.10 Wednesday 8 April (GJS & YKW).

Item 1 proposes the following cleanups for the PPS, when considering mixed NAL unit types: When mixed\_nalu\_types\_in\_pic\_flag is equal to 1, no\_pic\_partition\_flag is proposed not to be signalled but inferred to be equal to 0 and rect\_slice\_flag is proposed not to be signalled but inferred to be equal to 1.

The motivation was said to be primarily to ensure that an invalid combination is not indicated in the PPS.

There was discussion of the desired relative order of mixed\_nalu\_types\_in\_pic\_flag and no\_pic\_partition\_flag.

It was commented that mixed\_nalu\_types\_in\_pic\_flag does not affect the decoding process, and this would make the syntax depend on it. It was also commented that no\_pic\_partition\_flag is an important property and it would be undesirable to omit it even when this is hypothetically possible. It was commented that it would be common in a BEAM application to not need to change any aspect of the PPS other than to flip that flag, so semantic constraints were suggested to be sufficient, so no action was recommended on this.

Editor action item: The editor was asked to check and make sure that the constraints (which we believe are already expressed in some form) are sufficiently clear to the reader.

[JVET-R0187](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9831) AHG12: On signalling for picture with one tile and multiple slices [Hendry, S. Paluri, J. Zhao, S. Kim (LGE)]

Discussed in AHG Session 1.10 Wednesday 8 April (GJS & YKW).

It is asserted that in the current picture partitioning signalling scheme when there is only one tile and the slices are rectangular slices, the syntax elements num\_slices\_in\_pic\_minus1 and tile\_idx\_delta\_present\_flag are not needed. In such situation, the number of slices in the picture can easily be known from the derived variable NumSlicesInTile[ 0 ] and the value of tile\_idx\_delta\_present\_flag is never be used.

Furthermore, it is asserted that by not signalling num\_slices\_in\_pic\_minus1 in the described scenario above, it would be possible to avoid having the encoder signal an incorrect value for num\_slices\_in\_pic\_minus1), i.e. a value that is different from the derived value (i.e., NumSlicesInTile[ 0 ]).

This contribution proposed to omit the signalling of num\_slices\_in\_pic\_minus1 and tile\_idx\_delta\_present\_flag when no\_pic\_partition\_flag is equal to 0, NumTilesInPic is equal to 1, and rect\_slice\_flag is equal to 1.

It was commented that this might prevent having tiles that are split into a signalled number of slices.

No action was planned on this unless offline study determines otherwise.

Discussion stopped here for AHG Session 1.10 on Wednesday 8 April at 1715 UTC.

[JVET-R0188](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9832) AHG12: On signalling of rectangular slice height and width [Hendry, S. Kim, S. Paluri (LGE)]

Discussion began here for Track A on 18 April at 1520 (UTC) (GJS & YKW).

This contribution proposed replacing one condition (i.e., not signalling the syntax element when there is only one tile column or row) in the signalling of slice\_width\_in\_tiles\_minus1[ i ] and slice\_height\_in\_tiles\_minus1[ i ]. The replacement conditions are as follows:

1. When the first tile of a rectangular slice is one of the tile(s) at the last tile column of the picture, the syntax element slice\_width\_in\_tiles\_minus1[ i ] is not present and inferred to be equal to 0.
2. When the first tile (i.e., the tile at the top-left corner) of a rectangular slice is one of the tile(s) at the last tile row of the picture, the syntax element slice\_height\_in\_tiles\_minus1[ i ] is not present and inferred to be equal to 0.

It is remarked that the information about the first tile of a rectangular slice, the last tile column and the last tile row are already available in the current VVC working draft.

In the first revision of this contribution the proposed spec text was updated to remove unnecessary part and editorial update was made.

It was commented that the same condition is already evaluated for some other similar cases.

It was commented that R0211 item 3 and R0209 have the same method.

The proposal does not seem to complicate the syntax structure, just generalizes the use of inference of 0 when the syntax element is already required to be equal to 0.

Decision (sensibility cleanup): Adopt.

[JVET-R0209](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9853) AHG12/AHG9: On signalling of rectangular slices [S. Esenlik, B. Wang, A. M. Kotra, E. Alshina (Huawei)]

See the notes for R0118.

[JVET-R0211](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9855) AHG12: Cleanups on rectangular slices signalling [B.-K. Lee (Xris)]

This contribution proposes to some cleanup changes on rectangular slice signalling in the PPS. It has 4 items.

For item 1, see the notes for R0080.

For item 3, see the notes for R0188.

For item 2, it is proposed to infer the value of tile\_idx\_delta\_present\_flag if NumTileColumns is equal to 1 or NumTileRows is equal to 1.

It was commented that item 2 needed to be adjusted to account for item 1.

The proposal would replace “if( num\_slices\_in\_pic\_minus1 > 0 )” with “if( num\_slices\_in\_pic\_minus1 > 1 && NumTileColumns > 1 && NumTileRows > 1 )” for the presence of tile\_idx\_delta\_present\_flag.

Some participants that this is adding more checks in order to optimize for a corner case. Others said it did not seem like that obscure a case and that the same condition is already evaluated in the same syntax table.

It would only be saving one bit when its value is known. It does not affect other syntax.

This is also proposed in R0247 item 1.

This change did not seem necessary, so no action was taken on it.

Item 4 was withdrawn.

[JVET-R0241](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9885) AHG12: A direct signalling method of rectangular slice partitioning [K. Zhang, L. Zhang, Y.-K. Wang, Z. Deng, J. Xu, H. Liu (Bytedance)]

In the current VVC text, rectangular slice partitioning is signalled based on the tile partitioing. It is asserted that because a rectangular slice may be a rectangular region comprising several tiles, or it may be a rectangular region inside a tile, the current signalling method of rectangular slice partitioning incorporates quite a lot of logic to handle the two cases in a single scheme. In this contribution, it is proposed to signal a slice directly by its top-left postion and width/height, in a similar way as signalling of subpictures.

It was commented that the current syntax was designed to enforce certain constraints. These constraints could be violated by the proposed alternative syntax. The amount of data needed to be sent might also increase.

The proponent said that even with the current scheme, some constraints need to be expressed.

Tiles can only be split horizontally. It was commented that the proposal might allow this. Some constraint would need to be expressed about that if we want to retain that constraint.

In the interest of stability of the text and enforcing constraints by the syntax structuring, no action was taken on this.

[JVET-R0247](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9891) AHG9: Signalling rectangular slice partitioning [S.-T. Hsiang, C.-W. Hsu, O. Chubach, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

Item 1 of this contribution belongs to this category, and that item is also in R0211; see the notes for that contribution.

Discussion stopped here for JVET Track A on 18 April at 1615 (UTC).

#### Raster-scan slices (2)

Discussion began here for Track A on 22 April at 1415 (UTC) (GJS & YKW).

[JVET-R0047](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9691) AHG9/AHG12: On slice address for raster scan slices in a picture [L. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

This contribution proposes an optimization to derive slice address for raster scan slices in a picture.

In V2 of this contribution, the software is attached.

For raster scan slices, we signal both a slice address and the number of tiles in the slice (minus 1). The proposal is to infer the slice address from the ending position of the previous slice in decoding order.

Conceptually, with this approach, we would not need to have had slice addresses sent in AVC (if the decoder would parse the previous slice to figure out how many macroblocks were in it).

It was commented that this would remove the ability to decode a slice independently, and would thus have packet loss implications.

We currently have a syntax and decoding process such that any slice can be decoded separately and independently of all other slices in the picture – a property shared by AVC and HEVC (and probably MPEG-2 and H.263). This proposal would remove that property.

It was commented that in some systems, packets can arrive out of order. The proponent said this can be handled at a different layer.

No action was taken on this.

[JVET-R0248](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9892) AHG9: Supporting multiple slices within one tile for raster-scan slice mode [S.-T. Hsiang, L. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

This contribution proposes three modifications related to signalling slice partitioning of the coded picture, summarized as follows:

1. Support a slice that consists of one or more consecutive complete CTU rows within one tile in raster-scan slice mode. Two syntax elements, **num\_rows\_in\_slice\_idc** and **tile\_row\_id**, are designed for this.
2. When slice\_address is equal to ( NumTilesInPic − 1 ), the syntax element **num\_tiles\_in\_slice\_minus1** is not coded and is inferred to be equal to 0.
3. A new syntax element **multiple\_slices\_in\_tile\_enabled\_flag** is signalled in the picture parameter set (PPS) to specify whether it is allowed to further partition a tile into more than one slice for pictures referring to the PPS.

It is asserted that a finer granularity of partitioning units is desirable when partitioing of each coded slice is adaptively determined during encoding and signalled in raster-scan slice mode. Software for this proposal is attached in the proposal package.

In version 2 of this contribution, a software bug is fixed, and partial simulation results are provided.

In version 3 of this contribution, the full simulation results are provided.

The motivation is to provide a finer granularity.

It was commented that this would basically proposes to back a functionality that was removed previously.

It was asked why such a functionality would be desired instead of the rectangular scan mode. The proponent indicated that the motivation is to avoid needing to signal the layout in the PPS.

The proposal to add such functionality was not considered desirable due to the late stage of work, so no action was taken on this.

### Control of loop filtering across subpicture/tile/slice boundaries (7)

Discussion continued here for Track A on 22 April at 1440 (UTC) (GJS & YKW).

[JVET-R0044](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9688) AHG9: On subpicture boundary handling [J. Li, K. Abe (Panasonic)]

This contribution proposes to change the behaviour of loop filter on subpicture boundary when subpicture is treated as picture, i.e., to always disable loop filter across subpicture boundaries between independent subpictures and enable loop filter across subpicture boundaries between dependent subpictures.

It was commented that if an encoder wants to indicate such behaviour, it can already do this. It would couple the inter prediction process with the post-decoding filtering process. This seemed undesirable, so no action was taken on this.

[JVET-R0053](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9697) AHG9: Signalling tile partitioning [S.-T. Hsiang, C.-M. Tsai, Y.-W. Huang, S.-M. Lei (MediaTek)]

Item 3 of this contribution belongs to this category. See the notes in section 6.2.2.1 for JVET-R0053.

[JVET-R0113](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9757) AHG9: On Picture Parameter Set [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

Item 1 of this contribution belongs to this category. See the notes in section 6.2.2.1 under JVET-R0053.

[JVET-R0069](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9713) AHG12: Control of loop filtering across subpicture/tile/slice boundaries [L. Zhang, Y.-K. Wang, K. Zhang (Bytedance), Hendry, N. Park, H. Jang, J. Nam, S. H. Kim, J. Lim (LG Electronics)]

This contribution proposes to confirm the two conditionally agreed items, i.e., the following:

1. Remove the PPS flag loop\_filter\_across\_slices\_enabled\_flag.
2. Move loop\_filter\_across\_tiles\_enabled\_flag from PPS to SPS. Note that this flag is not signalled for each subpicture.

Thirdly, this contribution also proposes to close a topic that was left open for determination at this meeting. It is proposed that the loop\_filter\_across\_tiles\_enabled\_flag moved from PPS to SPS is renamed to be loop\_filter\_across\_boundaries\_within\_subpics\_enabled\_flag, and it is used to control whether loop filters are applied across tile and slice boundaries inside subpictures (not to control filtering across tile and slice boundaries that are also subpicture boundaries).

In the latest VVC draft text, in-loop filtering across subpicture, tile, and slice boundaries is controlled by the following syntax elements:

* loop\_filter\_across\_subpic\_enabled\_flag[ i ]: for controlling of deblocking, SAO, and ALF across subpicture boundaries, signalled in the SPS, one for each subpicture.
* loop\_filter\_across\_tiles\_enabled\_flag: for controlling of deblocking, SAO, and ALF across tile boundaries, signalled in the PPS, just one (thus applicable to all tiles in all pictures referring to the PPS).
* loop\_filter\_across\_slices\_enabled\_flag: for controlling of deblocking, SAO, and ALF across slice boundaries, signalled in the PPS, just one (thus applicable to all slices in all pictures referring to the PPS).

One participant said that rectangular slices can be used generally rather than tiles, and argued against both aspects 1 and 2.

For aspect #1, the plan to remove the (pps\_)loop\_filter\_across\_slices\_enabled\_flag had been because it was considered unnecessary since we have subpictures as an alternative. It was discussed whether we want to assume that encoders would use subpictures, and was suggested not to remove this encoder flexibility. See also JVET-R0109, which requested to retain this flag.

It was agreed to *not confirm* the prior planned action for aspect #1 due to this concern.

The second aspect had initially been agreed to be recommended in an AHG pre-meeting, but it was agreed to overturn that recommendation.

For aspect #2, it is noted that the tile partitioning is established at the picture level, so it was commented that it would be strange to put the control over the boundaries only at a higher level.

It was thus agreed to *not confirm* the prior planned action for aspect #2 for this reason.

Contributions R0069, R0109, R0197, R0247 are all related.

There was discussion to consider changing the semantics for the existing flags.

The meaning of the various flags ultimately is (in the output text of the previous meeting) that whenever something indicates that filtering across a tile/slice/subpicture/virtual boundary is off, it is off, regardless of whether it may appear to be turned on by something else (except that ALF and SAO can be off for one side of a subpicture boundary and on for the other side of the boundary).

Concerns were expressed about the third aspect as well, as it would change the concept of all flags having “veto power”. So no action was taken on that aspect either.

[JVET-R0109](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9753) AHG9/AHG12: On tile, slice, and related loop filter control flags [L. Chen, C.-W. Hsu, C.-M. Tsai, O. Chubach, Y.-W. Huang, S.-M. Lei (MediaTek)]

See the notes for R0069.

[JVET-R0197](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9841) AHG12: On signalling of loop filter across tiles and slices enabled flags [N. Park, J. Nam, H. Jang, J. Lim, Hendry, S. Kim (LGE)]

In the current VVC draft, the flags loop\_filter\_across\_tiles\_enabled\_flag and loop\_filter\_across\_slices\_enabled\_flag are signalled when it is specified that there is picture partitioning, regardless whether tiles and / or slices are present. It is asserted that loop\_filter\_across\_tiles\_enabled\_flag is not needed when there is only one tile in the picture and, likewise, loop\_filter\_across\_slices\_enabled\_flag is not needed when there is no tile that is divided into more than one rectangular slice.

This contribution proposed the following:

* Condition the presence of (pps\_)loop\_filter\_across\_tiles\_enabled\_flag to be present only when NumTilesInPic is greater than 1.
* Condition the presence of (pps\_)loop\_filter\_across\_slices\_enabled\_flag to be present only when there is at least one tile that is divided into more than one rectangular slice.

It is remarked that no action needs to be taken if contribution JVET-R0069 is adopted.

The first aspect would not be possible if the flag is moved to the SPS. This aspect relates to other contributions discussed in section 6.2.2.1 under JVET-R0053 (item 3); see notes there.

For the second aspect, it was pointed out that this would not allow disabling filtering across slice boundaries that contain multiple tiles that have filtered tile boundaries (in the raster scan slice and rectangular slice cases).

[JVET-R0247](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9891) AHG9: Signalling rectangular slice partitioning [S.-T. Hsiang, C.-W. Hsu, O. Chubach, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

Item 2 of this contribution belongs to this category.

This proposes to condition the presence of (pps\_)loop\_filter\_across\_slices\_enabled\_flag on the number of slices in a coded picture or subpicture when known, as follows:

if( !rect\_slice\_flag | | single\_slice\_per\_subpic\_flag | | num\_slices\_in\_pic\_minus1 > 0 )

It was asked why we would send the flag when single\_slice\_per\_subpic\_flag. This preserves a flexibility of enabling a PPS-level decision to disable the filter when it would enabled by the SPS-level.

The middle condition would not be needed if the SPS-level flag has sole control over the filtering of the subpicture boundary as proposed in R0069. However, no action was taken on that.

The intent is only to avoid signalling when clearly irrelevant, not to change any functionality.

Decision (cleanup): Adopt.

Discussion of this section stopped for Track A on 22 April at 1730 (UTC).

## AHG8: layered coding and resolution adaptivity (28)

### Scalability specific HLS (26)

#### General scalability HLS topics (8)

Discussion began here for Track A on 17 April at 1300 (UTC) (GJS, YKW).

[JVET-R0046](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9690) AHG8: Temporal sublayer requirements for multi-layer referencing [C.-Y. Lai, O. Chubach, C.-Y. Chen, T.-D. Chuang, Y.-W. Huang, S.-M. Lei (MediaTek)]

In the adopted JVET-Q0398, the goal of max\_tid\_il\_ref\_pics\_plus1[ i ] is to achieve decoding a higher layer without full decoding of all temporal sublayers of a lower layer when inter-layer prediction is used. However, only the reconstructed pictures are considered in JVET-Q0398, while picture parameter set (PPS), adaptation parameter set (APS), and reference picture list (RPL) are not considered in this document. In this contribution, two aspects are proposed to change this aspect of the current design in VVC Draft 8.

The first aspect is to add bitstream conformance requirements for PPS-related syntax elements and APS-related syntax elements in picture header (PH) or slice header according to max\_tid\_il\_ref\_pics\_plus1[ i ].

The second aspect is to add a bitstream conformance requirement for the RPL construction.

The contributor said this contribution is compatible with R0193.

It was commented that since PSs can be conveyed by external means, it may not be possible to require them to be associated with a particular AU or PU.

Subclause C.6 of HEVC for subbitstream extraction was discussed. There was a sentence saying to “Remove from outBitstream all NAL units for which all of the following conditions are true”. It was discussed whether this should be “all NAL units” or “all VCL NAL units”, and generally what happens to PSs in this extraction process.

AfterA offline study, the first aspect was further discussed on 23 April at 0825; modified text was provided in a revision of the contribution. Instead of adding constraints, the description of the bitstream extraction process was changed.

Decision (expression of existing intent): Adopt aspect 1.2 per -v4 version of the contribution.

For the second aspect, to make the specification clearer, and to avoid confusion in the decoding process for RPL construction, it is proposed to add a bitstream conformance requirement as follows.

Decision (expression of existing intent): Add a requirement of bitstream conformance that the picture referred to by each ILRP entry in RefPicList[ 0 ] or RefPicList[ 1 ] of a slice of the current picture shall be an IRAP picture or shall have TemporalId less than or equal to Max(0, max\_tid\_il\_ref\_pics\_plus1[ refPicVpsLayerId ] − 1), with refPicVpsLayerId equal to the value of the nuh\_layer\_id of the referenced picture.

[JVET-R0066](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9710) AHG8/AHG9: On DPB memory allocation and derivation of NoOutputOfPriorPicsFlag [Y.-K. Wang (Bytedance)]

This contribution proposes the following changes related to DPB memory allocation and the derivation of the variable NoOutputOfPriorPicsFlag:

1. The maximum values of chroma\_format\_idc and bit\_depth\_minus8 for all pictures of all layers are signalled in the VPS.
2. The setting of the value of the variable NoOutputOfPriorPicsFlag is updated as follows:
   1. To use the maximum picture width and height values for all pictures of all layers signalled in the VPS instead of the values for a single layer.
   2. To use the maximum values of chroma\_format\_idc and bit\_depth\_minus8 for all pictures of all layers signalled in the VPS instead of the values for a single layer.
   3. To not use the value of the separate\_colour\_plane\_flag.
3. Both the semantics of no\_output\_of\_prior\_pics\_flag and the use of this flag in the setting of NoOutputOfPriorPicsFlag are specified in an AU-specific manner (instead of in a PU-specific manner), and the value of no\_output\_of\_prior\_pics\_flag, when present, is required to be the same for all pictures in an AU.

The following issues were observed in the existing scalability design in the latest VVC text (in JVET-Q2001-vE/v15):

1. Currently, the maximum values of picture width and height for all pictures of all layers are signalled in the VPS, to enable the decoder to properly allocate the memory for the DPB. Like the picture width and height, the chroma format and the bit depth, currently specified by the SPS syntax elements chroma\_format\_idc and bit\_depth\_minus8, respectively, also affect the size for a picture storage buffer in the DPB. However, the maximum values of the chroma\_format\_idc and bit\_depth\_minus8 for all pictures of all layers are not signalled.
2. Currently, the setting of the value of the variable NoOutputOfPriorPicsFlag has the following issues:
   1. It involves the change of the value of pic\_width\_max\_in\_luma\_samples or pic\_height\_max\_in\_luma\_samples. However, the maximum values of picture width and height for all pictures of all layers should be used instead.
   2. It involves the change of the value of chroma\_format\_idc or bit\_depth\_minus8. However, the maximum values of chroma format and bit depth for all pictures of all layers should be used instead.
   3. It involves the change of the value of separate\_colour\_plane\_flag. However, the separate\_colour\_plane\_flag is only present and used when chroma\_format\_idc is equal to 3, which specifies the 4:4:4 chroma format, while for the 4:4:4 chroma format, the value of separate\_colour\_plane\_flag being equal to 0 or 1 does not affect the buffer size needed for storing a decoded picture. Therefore, the setting of NoOutputOfPriorPicsFlag should not involve the change of the value of separate\_colour\_plane\_flag.
3. Currently, the no\_output\_of\_prior\_pics\_flag is signalled in the PH for IRAP and GDR pictures, and both the semantics of this flag and its use in the process for setting the value of NoOutputOfPriorPicsFlag are specified in a manner that no\_output\_of\_prior\_pics\_flag is layer specific or PU specific. However, since the DPB operation is OLS specific or AU specific, both the semantics of no\_output\_of\_prior\_pics\_flag and the use of this flag in the setting of NoOutputOfPriorPicsFlag should be specified in an AU-specific manner.

This contribution tries to address the above issues.

A participant asked whether we believe having extensibility for chroma format and bit depth is actually important.

There is currently a constraint that dependent layers shall have the same chroma format and bit depth.

It was suggested that the syntax could provide support for future support of this feature even if this type of scalability is currently not allowed.

It was commented that the syntax change and associated semantics could be useful even without support for this type of scalability, as independent layers can have different chroma formats and bit depths.

It was commented that the AU-based concept is definitely needed if we drop the constraint that the AU is complete.

Decision (cleanup): Adopt (all three aspects).

[JVET-R0067](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9711) AHG8/AHG9: On the derivation of PictureOutputFlag [Y.-K. Wang (Bytedance), M. M. Hannuksela (Nokia)]

The current text for the derivation of the variable PictureOutputFlag normatively specifies a specific picture output behavior for an AU when the picture of the only output layer is not present (due to e.g. loss or layer down-switching). However, that piece of the specification assertedly has multiple issues.

This contribution proposes some changes to address the asserted issues, by either keeping the picture output behavior normatively specified but changed with the asserted issues fixed, or only describing it in a NOTE while in the specified normative picture output behavior the value of PictureOutputFlag for a current picture is set equal to 0 whenever the current picture does not belong to an output layer.

The authors initially suggested a preference for the normative output approach. Some others suggested that the decoder should be given some discretion if it encounters a “strange” situation, such as having a single target output layer and encountering an AU in which that layer is missing.

It was commented that the output behaviour in R0274 for ols\_mode\_idc modes 0 and 1 should be written to clarify that it is specifying behaviour at the AU level and that the picture output flag should also be considered. If that is clarified, the proposed normative in R0067 is the same as proposed in R0274.

Contribution R0123 was noted to be related, and essentially the same as the non-normative approach proposed here.

It was commented that mode 0 was originally intended for a use case where the encoder would intend that the highest received layer is the one that is output; otherwise a different mode would be used. However, this had not been everyone’s understanding of what the mode meant (where another interpretation is to just have a signalling shortcut).

It was suggested to define mode 0 (and mode 1) behaviour normatively but allow discretion for mode 2.

It was commented that we should not specify a “normative error concealment”.

Decision (bug fix / cleanup): Adopt the non-normative approach.

[JVET-R0274](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9918) AHG8: On CVSS AU [V. Seregin, Y. He, M. Coban, M. Karczewicz (Qualcomm)]

The concept of the proposal is to allow layer “upswitching” within a CVS or at the start of a new CVS.

There is currently no provision in the standard considering conformance (e.g., HRD conformance) with layer switching. Although it is understood that this functionality is used and needed, it has been envisioned for this to be something outside the scope.

This contribution proposes to modify the CVSS AU constraint to require only independent layers PU to be present in each CVSS AU and require presence of at least VCL NALs of independent layers in a bitstream. The contribution also proposes to modify VCL NAL unit types constraint for all pictures of a CVSS AU.



JVET-R066 and JVET-R0067 are related.

The exact proposed phrasing was discussed.

It was noted that we need to be careful about what to specify if we want to allow “incomplete” random-acccess AUs (IRAP and GDR). In spirit, it was agreed that we would like to allow this if it is not too difficult to specify.

AfterA offline study, this was further discussed on 23 April at 0835 (GJS). An issue was whether to handle missing output layers with a normative specification or to leave this outside the scope of the standard. The side activity did not identify a bug in the proposed scheme, but concluded (taking into consideration the outcome for JVET-R0067) that leaving the behaviour outside the scope is preferred. No action was thus taken.

Secondly, it is reported that the currently contains a constraint that there should be present at least one VLC NAL (e.g. slice) of each layer included into output layer set:

* “There is at least one VCL NAL unit with nuh\_layer\_id equal to each of the nuh\_layer\_id values in LayerIdInOls[ opOlsIdx ] in BitstreamToDecode.”

This statement is suggested to be unnecessary/redundant because of the following constraint:

* “Each CVSS AU shall have a PU for each of the layers present in the CVS.”

The contribution suggests to either remove the allegedly redundant constraint or modify it to require at least one VCL NAL of each independent layer of an OLS to be present in a bitstream.

Decision (editorial redundancy): It is suggested for the editor to remove “There is at least one VCL NAL unit with nuh\_layer\_id equal to each of the nuh\_layer\_id values in LayerIdInOls[ opOlsIdx ] in BitstreamToDecode.”

There is also a third aspect in the contribution. It is proposed to modify the constraint on the value of nal\_unit\_type for all pictures in a CVSS AU as follows:

For any two PUs, puA and puB, in the current CVSS AU, the following constraints apply:

* puA is a PU of an independent layer, puA may be either an IRAP PU with NoOutputBeforeRecoveryFlag equal to 1 or a GDR PU with NoOutputBeforeRecoveryFlag equal to 1.
* puA is an IRAP PU with NoOutputBeforeRecoveryFlag equal to 1 of a layer layerA, puB is a CLVSS PU of a layer that depends on layerA, puB may be either an IRAP PU with NoOutputBeforeRecoveryFlag equal to 1 or a GDR PU with NoOutputBeforeRecoveryFlag equal to 1.
* puA is an GDR PU with NoOutputBeforeRecoveryFlag equal to 1 of a layer layerA, puB is a CLVSS PU of a layer that depends on layerA, puB shall be a GDR PU with NoOutputBeforeRecoveryFlag equal to 1, and the value of recovery\_poc\_cnt of puB shall be equal to or greater than the value of recovery\_poc\_cnt of puA.

The text currently prohibits NAL unit type mixing; even among IRAP types. The proposal is to slightly relax this constraint to account for having different random access types. It was asked whether there is an application use case that would use this flexibility.

One suggested use was having GDR in an enhancement layer for bit rate smoothing with an IRAP in the base layer.

Some participants commented that relaxing this constraint might cause unforeseen difficulties in properly drafting the text, and that a need for actual use of this flexibility was not adequately shown, so no action was taken on this aspect.

A sub-case was GDR in both layers, whether there should be a requirement for the recovery POC count in the BL to be less than or equal to the on in the EL. It was suggested that in some scenarios this might not be appropriate, and that it did not seem necessary to establish such a constraint.

[JVET-R0065](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9709) AHG8/AHG9: On IRAP and GDR AUs [Y.-K. Wang (Bytedance)]

Items 1 and 2 of this contribution belongs to this category.

TheThe first aspectaspect concerns the concept of “incomplete” random-access AUs and was initially deferred for offline study. It was further discussed on 23 April at 0840.

Decision (expression of existing intent): Specify that GDR AUs shall be complete – i.e., all of the layers in the CVS shall have a picture in the AU (as with IRAP AUs).

See section 6.1.3 for aspect #2.

[JVET-R0068](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9712) AHG8/AHG9/AHG12: Miscellaneous HLS topics [Y.-K. Wang, L. Zhang, Z. Deng, J. Xu, K. Zhang, K. Fan (Bytedance)]

Item 1 of this contribution belongs to this category.

Item 1 proposes to require that slice\_type shall be equal to 2 (intra slice) in the following cases (in addition to being required under some other conditions):

i) intra\_only\_constraint\_flag is equal to 1

ii) the NAL unit type is an IRAP NAL unit type and the current picture is the first picture in the current AU.

The first case would be redundant, and we generally don’t discuss implications of constraint flags outside of their semantics.

Decision (expression of existing intent): Specify that slice\_type shall be equal to 2 (intra slice) when the NAL unit type is an IRAP NAL unit type and the current picture is the first picture in the current AU.

[JVET-R0194](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9838) AHG8/AHG9: On parameter set sharing in multi-layered bitstream [Hendry (LGE)]

This contribution asserts that there are two problems related to parameter sharing in multi-layered bitstream as follows:

1. Currently it is allowed for a slice to refer to a parameter set even when the parameter set is in the layer that is not the direct / indirect reference layer of the layer where the slice belongs to, as long as there is at least one OLS that includes both layers. This would allow a slice in layerA refer to a parameter set in layerB even when layerA and layerB are not included in the current OLS being decoded as long as there is an OLS defined in VPS that contains both layerA and layerB.
2. When reference picture resampling (RPR) is not allowed, currently it is constrained that the picture size that is signalled in PPS shall be the same as the maximum picture size in the SPS. This constraint would prevent SPS sharing in spatial scalability bitstreams.

To resolve the above asserted problems, the following are proposed:

1. Change the constraint about parameter set sharing with either one of these options:
   * Option 1: a slice in layerA can refer to a parameter set in layerB only when either layerA is equal to layerB or layerB is a direct or indirect reference layer of layerA.
   * Option 2: a slice in layerA can refer to a parameter set in layerB only when layerB is less than or equal to layerA and the current OLS being decoded contains both layerA and layerB.

It was noted that the previous contribution Q0277 was also about this issue. It was commented that the recorded action for that may have been interpreted differently than intended.

Decision (sensibility constraint): Option 2, clarified as that a slice in layerA can refer to a parameter set in layerB only when layerB is less than or equal to layerA and all OLSs in the bitstream that contain layerA also contain layerB.

Discussion ended here for Track A on 17 April at 1715 (UTC).

Discussion started here on 23 April at 0925 (UTC) (GJS).

1. Change the current constraint regarding picture size in PPS and maximum picture size in SPS as follows? (paraphrased, additions in italics):
   * *When RPR is not allowed, the value of pic\_width\_in\_luma\_samples and pic\_width\_in\_luma\_samples in all PPS in the CLVS shall have the same values, respectively.*
   * When RPR is not allowed *and the sps\_video\_parameter\_set\_id is equal to 0*, the value of pic\_width\_in\_luma\_samples and pic\_height\_in\_luma\_samples in all PPS in the CLVS shall be the same as pic\_width\_max\_in\_luma\_samples and pic\_height\_max\_in\_luma\_samples, respectively.

In the first revision of this contribution, an option is added to the proposal item 1.

The notion is to allow pictures of different resolution to reference a lower-layer (non-base layer) SPS. It was noted that the base layer SPS cannot be shared anyway due to its inter-layer prediction flag.

There was discussion of the meaning of the res\_change\_in\_clvs\_allowed\_flag, whether it is allowed to have inter-layer upsampling when that flag is 0.

The relationship with the scaling window was discussed.

Since the low-level process is intended to be the same as RPR, it seemed that it should be possible to have inter-layer referencing with an explicit scaling window in the enhancement layer.

It was asked whether the flag means there is no resampling only when the current layer references pictures within the current layer, or does it mean there is no resampling at any point in the decoding process of the current layer. This contribution assumed the former.

It was noted that the explicit window parameter is only sent when the flag is 1, so inter-layer referencing would need to use the default (conformance cropping window) when the flag is 0.

Decision (expression of existing intent): Clarify that the res\_change…\_flag only governs when the decoding process of references pictures within the same layer.

It was noted that our current extraction process does not take advantage of some of the restrictions and was commented that it may be desirable to specify the extraction process in a “more intelligent” way, provided this does not entail unnecessary complications.

This was further discussed in the JVET closing plenary of 24 April at 1420 (GJS & JRO), after the discussion of JVET-R0058. The constraints that apply in R0058 were said to be a rather different topic, as this contribution is not focused on subpicture use. There seemed to be no strong need for this sharing usage, as the use case seems somewhat specialized, so no action was taken on this.

[JVET-R0123](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9767) AHG9: On derivation of picture output flag [B. Choi, S. Wenger, S. Liu (Tencent)] [late]

This is closely related to JVET-R0067; see the notes for that contribution.

#### Scalability information signalling and related (18)

[JVET-R0344](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9988) AHG9: A Summary of Proposals Related to Scalability Information Signalling [S. Deshpande (Sharp)]

Discussed in AHG Session 1.3 Monday 7 April at 2100 (GJS, YKW & JRO).

This contribution intends to provide a summary of proposals on scalability information signalling.

Seventeen proposals from the category “4.3.1.2 Scalability information signalling and related” listed in a revision of JVET-R0339-v4 are included in this summary. Thus in v3, summary is added for JVET-R0158, JVET-R0199, and JVET-R0222 aspect 1.

It is suggested that this summary be used for the reviewing of these proposals, such that the discussions may be done in a more structured and efficient manner.

**List of design questions**

**Related to PTL information signalling**

1. Omit signaling of index to the list of PTL structures for output layer sets when number of signalled PTL structures is equal to total number of output layer sets and instead infer its value? (JVET-R0161 PTL part of proposal 2, JVET-R0185 proposal 4, JVET-R0204, JVET-R0275 aspect 4)

Note: There may not be an OLS that contains all layers (regardless).

Something similar is in the draft for HRD.

Is the number of OLSs always less than or equal to the number of PTL structures? There is a constraint like that already (regardless of this proposal).

It was commented that this usage seems like it would be common. This is a syntax shortcut for that case.

AHG Recommendation (cleanup): Adopt. Text and software were provided by R0161 proponent (J. Chen).

**Related to DPB information signalling**

1. Modify the upper range of vps\_num\_dpb\_params to allow signalling of DPB parameters for all OLSs from current fixed upper value of 16:
   1. upper limit is equal to total number of OLSs minus the number of single-layer OLSs (JVET-R0099 Proposal 1, JVET-R0191 aspect 3). AHG Recommendation (expression of existing intent): Adopt. Text was provided by Hendry and he is also to supply software.
   2. upper limit is equal to total number of OLSs − 1 (JVET-R0196)
2. Update the range value for num\_ols\_hrd\_params\_minus1
   1. similarly as in (a) in previous item? (JVET-R0191 aspect 3) AHG Recommendation (expression of existing intent): Adopt. Text was provided by Hendry and he is also to supply software.
   2. to total number of OLSs − 2 (JVET-R0204)
3. Don't signal and instead infer the index of the dpb\_parameters( ) syntax structure that applies to the i-th OLS when a condition is met (JVET-R0099 Proposal 2, JVET-R0204, JVET-R0275 aspect 4)
   1. The condition is total number of output layer sets minus number of single layer output layer sets is equal to number of signalled dpb parameters (JVET-R0099 proposal 2). AHG Recommendation (expression of existing intent): Adopt, and also apply to HRD parameters. Text is provided in JVET-R0099-v2 by S. Deshpande and he is also to supply software.
   2. The condition is total number of output layer sets is equal to number of signalled dpb parameters (JVET-R0161 proposal 2, JVET-R0275 aspect4)
   3. The condition is total number of output layer sets is equal to number of signalled dpb parameters + 1 (JVET-R0204)
4. Start the for loop which signals ols\_dpb\_pic\_width[ i ], ols\_dpb\_pic\_height[ i ], and ols\_dpb\_params\_idx[ i ] to start at 1 instead of at 0, since 0-th OLS is single layer? (JVET-R0099 Proposal 3, JVET-R0196). AHG Recommendation (expression of existing intent): Adopt (unless affected by proposals to redefine the 0-th OLS).
5. Replace if( !vps\_all\_independent\_layers\_flag ) condition on vps\_num\_dpb\_params syntax element with if(!each\_layer\_is\_an\_ols\_flag) (JVET-R0185 proposal 1, JVET-R0196, JVET-R0275 aspect 3). AHG Recommendation (bug fix): Adopt.
   1. If above main item is agreed, additionally change vps\_num\_dpb\_params to vps\_num\_dpb\_params\_minus1? (JVET-R0185 proposal 2, JVET-R0196, JVET-R0275 aspect 3). It was commented the semantics of each\_layer\_is\_an\_ols\_flag is a “one-way” constraint. It was asked why we would want to allow the flag to be 0 and still have each layer be an OLS – all of this is in the VPS, so the encoder should know what it is doing when it writes the VPS. AHG Recommendation (bug fix): Adopt and change the semantics to a “two-way” constraint (so if the flag is zero, there must be at least one multilayer OLS specified by the VPS).
   2. Additionally signal DPB parameters for OLS in this case only if(!each\_layer\_is\_an\_ols\_flag) (JVET-R0185 proposal 3). AHG Recommendation (cleanup): Adopt.

Text was provided by Hendry (to be modified for the “two-way” constraint) and he is also to supply software.

**Related to HRD information signalling**

1. Allow control separately if HRD parameters are signalled for an OLSs or not on individual basis? (JVET-R0195).

The proponent indicated that this was motivated by the syntax allowing some HRD parameters to be present and some not for single-layer OLSs. This flexibility is not provided for other cases.

It was commented that the situation for single-layer OLSs was just a consequence of where the data is sent, and noted that each single-layer OLS could be extracted and become a single-layer stand-alone bitstream. So no action was recommended by the AHG on this.

* 1. If want separate control then signal a separate new flag for each OLS to specify if index to HRD parameters structure is signalled or not? OR
  2. Designate 0-th index to mean HRD parameters are not specified for an OLS?

1. Change condition for omitting signalling of ols\_hrd\_idx[ i ] from “num\_ols\_hrd\_params\_minus1 + 1 != TotalNumOlss” to “num\_ols\_hrd\_params\_minus1 + 2 != TotalNumOlss”? (JVET-R0204). This item no longer needed to be considered due to the action taken on item 4.a.
2. Add a constraint that vps\_general\_hrd\_params\_present\_flag shall be equal to 1 when more than one layer is included into any OLS? (JVET-R0275). It was commented that HRD parameters presence is optional in the single-layer case and has been optional in AVC and HEVC and their extensions and should be optional, so no action was taken on this.

**Common or Combination aspects of PTL, DPB, HRD signalling:**

1. Constrain that each DPB, HRD, parameter structure signalled in VPS shall be associated with at least one OLS (in the VPS) that contains more than one layer and each PTL structure that is signalled is associated with at least one OLS? (JVET-R0191 Aspect 3). These are just “sensibility” constraints. AHG Recommendation (expression of existing intent): Adopt. Text was provided by Hendry and he is also to supply software.
2. Define and use a common gating flag vps\_dpb\_hrd\_params\_present\_flag and use this to condition presence of dpb\_parameters() and ols\_hrd\_parameters()? (JVET-R0275 aspect 2). The proposal is motivated by a desire for a consistent approach in the VPS and SPS. However, it was commented that the circumstances in the VPS and SPS are different. This item no longer needed to be considered due to the action taken on item 6.a.
3. Include PTL signalling in VPS under a common gating flag along with DPB and HRD signalling in VPS? (JVET-R0275 aspect 3). This is similar in spirit to item 11, so no action was taken on this.

**Related to max\_tid and number of sublayers:**

1. Signal the syntax elements max\_tid\_ref\_present\_flag[ i ], max\_tid\_il\_ref\_pics\_plus1[ i ] only when ols\_mode\_idc is not equal to 1 and each\_layer\_is\_an\_ols\_flag is not equal to 1? (JVET-R0107 Proposal 1). This is a “sensibility” issue – avoiding sending information that is not used. A participant questioned the aspect about ols\_mode\_idc, and it was discussed whether this information is intended to be metadata or only for sub-bitstream extraction. The proponent said that the syntax in the VPS is intended only to be non-metadata syntax. It was commented that the two syntax elements are already gated by a !vps\_independent\_layer\_flag[ i ] condition, and each\_layer\_is\_an\_ols\_flag can only be true if all layers are independent. No action seemed needed unless offline study indicates otherwise.

Discussion stopped here for AHG Session 1.3 on Monday 6 April at 2300 UTC, and resumed here in AHG Session 1.7 on Tuesday 7 April at 2100 UTC.]

1. Assertedly simplify the condition checking for signalling ptl\_max\_temporal\_id[ i ], dpb\_max\_temporal\_id[ i ], and hrd\_max\_tid[ i ] to only use the flag vps\_all\_layers\_same\_num\_sublayers\_flag instead of using the flag vps\_all\_layers\_same\_num\_sublayers\_flag and vps\_max\_sublayers\_minus1 syntax element. Also assertedly simplify the inference rules for ptl\_max\_temporal\_id[ i ], dpb\_max\_temporal\_id[ i ], and hrd\_max\_tid[ i ], when not present? (JVET-R0107 Proposal 2)

It was commented that this appears purely editorial – it is just removing checks that are unnecessary.

AHG Recommendation (editorial simplification): The editor is asked to confirm this and remove checks that are unnecessary.

1. Change the inferred value of max\_tid\_il\_ref\_pics\_plus1[] when not present from 7 to vps\_max\_sublayers\_minus1 + 1, to avoid an asserted wrong derivation case for the value of the variable NumSubLayersInLayerInOLS? (JVET-R0119 item 1)

AHG Recommendation (cleanup): Adopt this item. Text was provided by B. Choi, and he is also to supply the software.

1. Don't derive the NumSubLayersInLayerInOLS[] and layerIncludedInOlsFlag[][] values, when vps\_all\_independent\_layers\_flag is equal to 1? (JVET-R0119 item 2).

It was commented that this appears purely editorial – it is just removing an unnecessary derivation.

AHG Recommendation (editorial simplification): The editor is asked to confirm this and remove the derivation if confirmed editorially undesirable.

1. Fix an asserted bug in the iteration loop in eq. (40)? (JVET-R0119 item 3)

This was further discussed in the closing plenary of Friday 24 April (GJS & JRO). It was initially agreed to make this change to correct the error. However, this item is no longer needed after the action taken on R0193.

1. Signal max\_tid\_il\_ref\_pics\_plus1 value separately for each direct reference layer of a layer, i.e. max\_tid\_il\_ref\_pics\_plus1[ i ][ j ] for each direct reference layer j less than i, instead of single max\_tid\_il\_ref\_pics\_plus1[ i ] as currently? (JVET-R0193)

It was commented that HEVC has a two-dimensional array similar to what is proposed. With the one-dimensional approach, in some cases there may be unnecessary sublayers present after operation of the specified extraction process. The issue is whether the maximum number of sublayers used for interlayer prediction could be different for different layers.

It was commented that if some kind of hypothetical extra metadata is available (e.g. in a system environment or some SEI message), it could provide a more highly optimized extraction capability.

It was commented that the one-dimensional approach was chosen at the previous meeting (see the notes for Q0398), with an understanding that it involved some loss of generality, although there had not been much careful consideration of the question at the time. The amount of complication needed for supporting the greater generality did not seem substantial.

In HEVC, the generality is present in the syntax, and this functionality is used for reference picture list construction but it is not used in the extraction process.

It was commented that the HRD parameters in the bitstream are for the “thin” bitstream – i.e., the bitstream from which all pictures not needed for an OLS have been removed.

AHG Recommendation (cleanup): Adopt. Text was provided in the contribution, and the authors are to supply the software.

1. Signal a flag in VPS to indicate that all dependent layers share the same value of max\_tid\_il\_ref\_pics\_plus1. If the flag is set, signal a common vps\_max\_tid\_il\_ref\_pics\_plus1 for all layers. Otherwise conditionally signal separate values for max\_tid\_il\_ref\_pics\_plus1[ i ]? (JVET-R0261/ aspect 2)

This is a proposed signalling shortcut in the VPS. We have shortcuts for “vps\_all\_layers\_same\_num\_sublayers\_flag” and “vps\_all\_independent\_layers\_flag”. This proposes an additional shortcut “vps\_all\_layers\_same\_tid\_il\_flag” to save repetition of values of max\_tid\_ref\_present\_flag[ i ] and max\_tid\_il\_ref\_pics\_plus1[ i ]. With the adoption of JVET-R0193, this would save some more max\_tid\_il\_ref\_pics\_plus1 values, since that becomes two-dimensional.

It was commented that we should have conformance bitstreams to test the shortcuts.

The proponent said this does address a common case. Others thought this was unnecessary complication, and the most common case would not use this part of the syntax at all. No action was taken on this.

1. Fix an asserted bug for semantics of max\_tid\_il\_ref\_pics\_plus1[ i ] for special value 0? (JVET-R0107 proposal 3, JVET-R0296 aspect 1)? AHG Recommendation (editorial text bug): Adopt.

Additionally define the semantics for special value 0 to include GDR pictures with recovery\_poc\_cnt equal to 0 (JVET-R0107 Proposal 3)? It was said that such a GDR picture is functionally equivalent to an IRAP picture. Another participant commented that RPL constraints are different for such a GDR picture, and there was discussion of whether difference is appropriate or not. AHG Recommendation (editorial text bug): Adopt (assuming we don’t disallow GDR pictures with recovery\_poc\_cnt equal to 0).

1. Modify the sub-bitstream extraction process to account for GDR pictures with recovery\_poc\_cnt equal to 0? (JVET-R0107 Proposal 3) AHG Recommendation (editorial text bug): Adopt (assuming we don’t disallow GDR pictures with recovery\_poc\_cnt equal to 0).
2. Fix an asserted bug in the derivation of NumSubLayersInLayerInOLS by separating the cases for each\_layer\_is\_an\_ols\_flag is equal to 1 and ols\_mode\_idc is equal to 0? (JVET-R0296 aspect2). AHG Recommendation (bug fix): Adopt.

**Related to output layer sets and layer dependency:**

1. Re-define 0-th OLS to include all independent layers when present and every included layer is output? (JVET-R0261 aspect 3). Currently, the 0-th OLS is conceptually a base layer, and there did not seem to be a strong need to change that, so no action was recommended on this by the AHG.

Discussion stopped here in AHG Session 1.7 on Tuesday 7 April at 2300 UTC.

Discussion began here for JVET Track A on 19 April at 0715 (UTC) (GJS & YKW).

1. Keep the design that the 0-th OLS contains only the lowest layer when each\_layer\_is\_an\_ols\_flag is equal to 1, the output layer set mode is equal to 0 or the output layer set mode is equal to 1, but relax this when output layer set mode equal to 2 and if so modify the loop and derivation? (JVET-R0306)

The proponent discussed the case with all-independent layers (e.g., two layers). The contributor said that currently, it is required to have two OLSs. This was confirmed, but it was also remarked that the 0-th OLS is implicit in this case.

The proposal is to redefine the 0-th OLS when all layers are independent or the output layer set mode is 2.

V-PCC was mentioned as an example, where 3 independent layers are commonly used together (texture, depth and occupancy).

There is virtually no signalling for the 0-th OLS. The current scheme requires adding signalling for the all-encompassing OLS, whereas the proposal would make that be the 0-th OLS.

It was commented that the all\_independent\_layers\_flag already skips a lot of signalling.

There was discussion of whether the current scheme is really a burden.

It was commented that V-PCC is codec-agnostic, such that the different components can even be encoded with different video encoders.

Another mentioned use case was multi-party videoconferencing, where each independent layer is a separate camera view.

The proponent said that basically it seems strange to require having more than one OLS for such bitstreams that contain only independent layers and that the requirement to have multiple OLSs in the bitstream is not especially easy to notice and seems artificial in the use cases.

The current design was somewhat motivated by traditional scalability or multiview.

Some concern was expressed about whether there could be some bug in redefining the 0-th OLS.

It was commented that in such a traditional scalability case there would become a need for explicit signalling, so this proposal would be burdening that usage in order to facilitate the all-inclusive case.

It was commented that we have an inference of the VPS if it is not present, and nesting requirements and interpretations that might be changed by the proposal.

The contributor discussed the OLS modes, saying this would only affect OLS mode 2.

It was commented that making the definition of what is the 0-th OLS become different in different OLS modes seems confusing. One participant said that currently modes 0 and 1 are just shortcuts for signalling with mode 2 for traditional scalability and multiview operation.

No action was taken.

1. Change vps\_all\_independent\_layers\_flag to 2-bit vps\_layer\_dependency\_idc to indicate common layer dependency to align with VPS OLS mode signaling (0 means all layers independently coded, 1 means all non-base layers use ILP, with immediate lower layer as direct reference layer, 2 means general referencing, 3 is reserved)? (JVET-R0261 aspect 1)

This proposes shortcuts for particular layer dependency relationships that would be inferred by the value of this idc.

It was pointed out that the proposal was missing some necessary changes to the text. Another participant noticed a different problem.

The proposal did not seem mature or necessary, so no action was taken on it.

1. Add a constraint that for each independent layer (i.e., vps\_independent\_layer\_flag[ GeneralLayerIdx[ nuh\_layer\_id ] ] is equal to 1), there shall be an OLS that contains that layer only? (JVET-R0191 item 2).

The proponent said this did not need to be considered, especially considering the action taken on R0343 item 1.g.

It was also commented that this proposal would not be friendly to the V-PCC use case.

**Other VPS clean-ups:**

1. Change the coding of ols\_ptl\_idx[ i ] from u(8) and possibly vps\_num\_ptl\_minus1? (JVET-R0161 proposal 1)
   1. Option 1: Change to u(v) with length equal to Ceil(Log2(vps\_num\_ptls\_minus1+1))
   2. Option 2: Change to ue(v) and also change vps\_num\_ptl\_minus1 from u(8) to ue(v)

It was commented that there is a reason that FLC coding was used, which was to make those fields accessible to systems with fixed length. Variable-length codes are only used for syntax elements that are at later positions in the syntax structure, and PTL information can be carried separately by a system. Thus, no action was taken on this.

1. Change the coding of num\_output\_layer\_sets\_minus1 from u(8) to u(v) with length eqaul to min( 8, vps\_max\_layers\_minus1 + 1 ) (JVET-R0161 proposal 3)

This has the same issue as item 27 above, so no action was taken on it.

1. Infer vps\_layer\_id[ 0 ] to be equal to nuh\_layer\_id of the first VCL NAL unit in a bitstream when vps\_layer\_id[ 0 ] is not signalled? (JVET-R0158 aspect 1)

The proponent indicated that they were trying to address a case when the VPS is not present.

Decision (bug fix for existing intent): For the AUD, the value of nuh\_layer\_id should not be constrained (as with DCI, VPS and EOB).

1. When VPS is not present:
   1. Require sps\_max\_sublayers\_minus1 to be in the range of 0 to 6, inclusive, when sps\_video\_parameter\_set\_id is equal to 0? (JVET-R0158 aspect 2)

See the notes for item “b” below.

* 1. Infer vps\_max\_sublayers\_minus1 to be equal to 6 when sps\_video\_parameter\_set\_id is equal to 0 (i.e. VPS is not present). (JVET-R0222 aspect 1)

The difference between approaches “a” and “b” is purely editorial. A participant commented that this inference would fix another case in the spec as well.

It was commented that R0125 item 1 is also the same proposal.

Decision (bug fix for existing intent): Adopt this inference. (The exact editorial expression is at the discretion of the editor.)

* 1. If DCI is present, infer vps\_max\_sublayers\_minus1 to be dci\_max\_sublayers\_minus1 or 6 otherwise. (JVET-R0199 aspect 2)

Because of another action taken at the meeting that removed the syntax element dci\_max\_sublayers\_minus1, this item is no longer relevant.

1. Constrain the maximum value of vps\_max\_sublayers\_minus1 to be less than or equal to dci\_max\_sublayers\_minus1? (JVET-R0199 aspect 1)

Because of another action taken at the meeting that removed the syntax element dci\_max\_sublayers\_minus1, this item is no longer relevant.

Discussion stopped here for JVET Track A on 19 April at 0900 (UTC).

[JVET-R0099](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9743) AHG8/AHG9: On Output Layer Sets Signalling [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

[JVET-R0107](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9751) AHG8/AHG9: On Temporal Sublayers Information [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

[JVET-R0119](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9763) AHG8/AHG9: On derivation of sublayer number in output layer set [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-R0125](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9769) AHG8/AHG9: On signalling max number of sublayers [B. Choi, S. Wenger, S. Liu (Tencent)]

Item 1 of this contribution belongs in this category.

[JVET-R0158](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9802) AHG9: Semantic bug fixes for syntax elements in VPS and SPS [B. Wang, S. Esenlik, A. M. Kotra, H. Gao, E. Alshina (Huawei)]

[JVET-R0161](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9805) AHG8/AHG9: On VPS syntax signalling [J. Chen, J. Luo, Y. Ye, R.-L. Liao (Alibaba)]

[JVET-R0185](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9828) AHG9: On syntax elements signalling in VPS [S. Paluri, Hendry, S. Kim (LGE)]

[JVET-R019](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9835)1 AHG9: On miscellaneous updates for HLS signalling [Hendry, S. Paluri, S. Kim (LGE)]

Items 2, 3 of this contribution belong to this category.

[JVET-R019](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9837)3 AHG8/AHG9: On signalling of syntax element max\_tid\_il\_ref\_pics\_plus1 [Hendry, S. Paluri, S. Kim (LGE)]

[JVET-R019](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9839)5 AHG8/AHG9: On HRD structure and OLS mapping signalling in VPS [Hendry (LGE)]

[JVET-R019](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9840)6 AHG8: On signalling of DPB parameters in the VPS [T. Nishi, K. Abe, V. Drugeon (Panasonic)]

[JVET-R019](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9843)9 AHG9: On vps\_max\_sublayers\_minus1 [D. Kim, J. Jung, G. Ko, J. Son, J. Kwak(WILUS)]

[JVET-R0204](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9848) AHG8: On inference of index for PTL/DPB/HRD parameters in the VPS [T. Nishi, K. Abe, V. Drugeon (Panasonic)]

[JVET-R0261](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9905) AHG9: On VPS syntax [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-R027](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9919)5 AHG8: On PTL, HRD, and DPB structures signalling in VPS and SPS [V. Seregin, M. Coban, Y. He, M. Karczewicz (Qualcomm)]

[JVET-R0296](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9940) AHG9: On sublayer references [Y. Sanchez, R. Skupin, K. Suehring, T. Schierl (HHI)]

[JVET-R0306](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9950) AHG8/AHG9: On the 0-th OLS for multi-layer bitstream [E. Thomas (TNO)]

### Reference picture resampling (RPR) specific HLS (2)

[JVET-R0217](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9861) AHG8: On signalling PH RPR scaling window offsets [T. Lu, F. Pu, P. Yin, S. McCarthy, W. Husak, T. Chen (Dolby), J. Boyce (Intel), J. N. Shingala (Ittiam)]

This contribution was discussed in Track A on 18 April at 1625 (UTC) (GJS & YKW).

This contribution proposes that alternative RPR scaling window offsets be signalled in the picture header along with an indication of whether the alternative scaling window is to be applied to the reference or current picture. If present, the alternative scaling window is used instead of the scaling window signalled in the PPS. The alternative scaling window enables a sub-region within a picture – rather than the entire picture – to be resampled to create a reference picture. Similarly, the alternative scaling window enables a sub-region of the current picture to be predicted from a reference picture. No change in the current RPR design and constraints are required.

In v2, fix a bug in constraint as suggested and upload presentation slides.

The proposal was said to improve operation with continuous zooming, ROI and ROI scalability, global motion with zooming, some 360° uses, and other potential situations.

There have been several related prior proposals, including JVET-P0336, JVET-Q0199, and others. R0114 is also related and had been discussed in an AHG pre-meeting session.

At the previous meeting, the notes for Q0199 concluded with “Concern was expressed over whether introducing this at this stage could have side-effects and risk the ability to stabilize the design and complete the standard. Further study toward a v2 version of the standard was encouraged, but there was not a consensus to put this into the first version.” Software had been provided, and it had been commented that the proposed text had been well written.

It was commented that affine motion can also address zooming. The proponent said this was better than affine when the zoom factor is large.

For zooming, it was commented that the coding efficiency impact is not really known.

A proponent said the intent was not really primarily for coding efficiency; it was more for special use cases.

Another proponent said that in low latency operation it is especially important to try to avoid spikes in bit rate (or drops in quality).

It was commented that the proposal had been further simplified relative to what had previously been presented and that the current design where the signalled window is used both as the “source window” and “destination window” is unduly limiting. The current design also has an issue for low latency, as the window needs to be determined in advance. The memory bandwidth of the proposal did not appear to be different from that of the current scheme.

It was commented that the behaviour of the current scheme is more constrained. Concern was expressed about conformance, but the proponent responded that the conformance issue is really similar with the current scheme – this scheme would just provide more windows with the same conformance constraints required for these windows.

Similar concerns were expressed as had been expressed at the previous meeting. Concern was expressed about trying to expand the flexibility/functionality at this stage (and RPR itself was noted to be a late addition).

Given the continued concern, no action was taken on this.

[JVET-R0382](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10027) Crosscheck of JVET-R0217: AHG8: On signalling PH RPR scaling window offsets [J. Luo (Alibaba)] [late]

[JVET-R0114](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=9758) AHG9: On scaling window offsets [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

This was initially discussed in AHG Session 1.12 on 8 April at 2340 UTC in PPS syntax discussion (GJS & YKW).

The contribution proposed to allow signalling of negative scaling window offsets so that negative vertical and horizontal offsets can be derived even when the referenced picture did not include a scaling window (JVET-R0114).

It was asserted that this would improve support of zooming. An example use of this was illustrated in the contribution. The change to the text would be just changing ue(v) to se(v) and having a different value range.

It was asked whether this would increase the bit width needed for reference picture referencing. The proponent indicated that this should not be an issue.

It was commented that R0217 is related to the use cases for this.

This contribution was further discussed in Track A on 18 April at 1710 (UTC) (GJS & YKW).

It was commented that the constraint proposed in the contribution was acceptable.

This provides a more limited form of some of what is proposed in R0382. Software was not provided. The proponent said the software impact should be minimal – the relevant variables in the software are already signed variables and only the parsing would need to change.

One participant commented that in an actual implementation there could potentially be some low-level impact for some implementations, concerning the range of values (bit width) and usage of signed versus unsigned operations. Another said there should not really be a low-level impact, as this would change only the method of deriving a scaling relationship without affecting the operation of the scaling itself.

Further discussion was requested after offline study and having software provided (not necessarily including change of encoder estimation algorithms).

Discussion stopped here in in Track A on 18 April at 1715 (UTC).

This was further discussed on Friday 24 April at 0845 UTC (GJS) after software was provided.

After offline study, interested parties said there is no implementation problem caused by allowing the offets to be negative.

The contribution includes a value range constraint.was commented that perhaps the value range constraint was too restrictive for negative values. Others thought its was sufficient.

Decision (cleanup): Adopt.

# Complexity analysis (0)

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

# Encoder optimization (6)

Contributions in this category were discussed Monday 20 Apr. 1450–1510 and 1525-1625 in Track B (chaired by JRO).

[JVET-R0110](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9754) AHG14: Mixed lossy/lossless coding of VTM reference software [M. G. Sarwer, Y. Ye, J. Luo (Alibaba)]

One of the important use cases of VVC is mixed lossy/lossless coding where one part of the image is lossless coded and another part of the image is lossy coded. However, current VTM reference software does not support mixed lossy/lossless coding. In order to study the performance of VVC in mixed content, a reference software implementation is necessary. This contribution proposes encoder only implementation to support slice-level mixed lossy/lossless coding where a slice can be configured to be coded either in lossy or lossless mode.

In v2, this contribution proposes the common test conditions for mixed lossy/lossless coding support into VVC. It is asserted that establishing the mixed lossy/lossless coding CTC enables the JVET to evaluate the performance of VVC for mixed lossy/lossless coding use cases.

The encoder implementation of JVET-R0110 is supporting lossy/lossless switching at slice level, and the lossless area is static over the entire sequence. The granularity would be one CTU (with raster-scan slices). A more sophisticated encoder would be necessary to support dynamic selection, or even selection of lossless areas at sub-slice/sub-CTU level.

Decision (SW): Include the SW patch of JVET-R0110 (aligned with the changes made at this meeting), to enable studying lossy/lossless coding

CTC for lossy/lossless, as well as extending the encoder for flexibility should be further studied in AHG14

[JVET-R0428](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10090) Crosscheck of JVET-R0110 (AHG14: Mixed lossy/lossless coding of VTM reference software) [T.-C. Ma (Kwai Inc.)] [late]

[JVET-R0140](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9784) AHG14: Max BT/TT size restriction for lossless coding encoder configuration [T. Zhou, E. Sasaki, T. Ikai (Sharp)]

This contribution proposes a max BT/TT size restriction for lossless coding encoder configuration, which set MAX\_BT\_SIZE and MAX\_TT\_SIZE being equal to 8 Comparing to the current VTM-8.0 lossless anchor, the proposed modification provides average bitsaving difference of 0.32 %, 0.22 % and 0.24 % with 44 %, 22 % and 44 % encoding runtime on AI, RA and LB configuration respectively.

It is asked whether it was also considered to reduce the CTU size.

Generally, global lossless coding is not a very relevant application case of VVC, and not competitive in terms of runtime/compression benefit compared to HEVC.

The runtime advantage would mainly support easier executing of experimentation, but this does not appear a big problem currently.

In mixed lossy/lossless, which is a more relevant application case, such a restriction would not be done, and this should be kept consistent.

The information of how to design a faster lossless encoder is beneficial and very welcome.

No action.

[JVET-R0143](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9787) AHG14: Configuration parameter to enable TSRC for lossless coding [C. Hollmann, M. Damghanian, L. Litwic, M. von Strauss (Ericsson)]

In this contribution it is reported that Transform Skip Residual Coding was disabled for lossless compression in VTM-8.0. This contribution claims that this change reduces compression efficiency in non-CTC test cases. It is proposed to add a configuration parameter TSRCdisableLL to the VTM reference software, which allows to control the usage of Transform Skip Residual Coding in the lossless configuration.

The results presented in this contribution were generated using a non-CTC dataset. The CityScapes data set is known by the authors to be used in machine learning applications. The impact of allowing Transform Skip Residual Coding by setting the proposed parameter to false was measured using both 4:2:0 and 4:4:4 chroma sampling modes, and an increased compression efficiency is reported compared to VTM-8.0:

* 4:2:0: 2.6 percentage points in standard configuration, 2.3 percentage points in SCC,
* 4:4:4: 29.5 percentage points in standard configuration, 15.5 percentage points in SCC.

The content investigated is very similar to screen content.

It was asked how often palette is used in the SCC configuration?

The intent is not changing the CTC, but rather allowing more flexible experimentation. Currently, there is a comnfiguration parameter for lossless coding which inherently disables TSRC

It is commented by several experts that this flexibility is desirable. There could however be some interaction with R0110.

Decision (SW): Adopt in spirit, that invoking TSRC for lossless coding should be made separately configurable. Left to discretion of SW coordinator how to implement.

[JVET-R0470](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10132) Crosscheck of JVET-R0143 (AHG14: Configuration parameter to enable TSRC for lossless coding) [J. Gan (Canon)] [late]

[JVET-R0164](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9808) AHG10: Mean-scaled SATD for VTM encoder [J. Lainema, A. Hallapuro (Nokia)]

This contribution reports that a coding efficiency improvement is achieved by scaling down the DC coefficients in the SATD (Sum of Absolute Transformed Differences) calculations performed by the VTM encoder. It is proposed to apply a weight of one quarter for the absolute value of the DC coefficient resulting from the Hadamard transform of the SATD process, while keep applying a weight of one for the rest of the coefficients.

Coding efficiency impact is reportedly on average -0.12 %, -0.29 % and -0.37 % for AI, RA and LD-B configurations, respectively. It is further reported that the gains in coding efficiency tend to be larger for the higher resolution categories. For example, in the case of Class A1, the impact in RA configuration is reported as -0.57 %.

[v2 added LD-P results and a new section on output image analysis]

Reasonble gain which comes practically for free by a simple encoder change.

Decision (SW/CTC): Adopt JVET-R0164, modify SATD cost function both fo ME and initial intra mode preselection by giving less weight to DC coeff. This should be made configurable by macro.

It would be desirable to have the same change implemented in HM. It was reported that the proponents already checked that and got almost the same gain for intra, but lower gain for RA (might however not yet be fully correct implementation in HM)

[JVET-R0453](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10115) Crosscheck of R0164 (AHG10: Mean-scaled SATD for VTM encoder) [J. Enhorn, R. Sjöberg (Ericsson)] [late]

[JVET-R0327](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9971) AHG 10: One-pass CCALF [X.W. Meng (PKU), X. Zheng (DJI), S.S. Wang, S.W. Ma (PKU)]

In this contribution, a one-pass encoding algorithm is proposed for CCALF. The current CCALF encoding algorithm requires a lot of encoding passes (picture buffer accesses) which will increase external memory access, encoding latency, and power consumption significantly. Hence, we propose a method to estimate CCALF filtering distortion without conducting real filter operation. The number of encoding passes can be reduced from 152 to 1. The coding performance in VTM-8.0 is as follows,

AI: 0.00% 0.00% -0.01%

RA: 0.00% -0.10% -0.05%

LDB: -0.02% -0.06% -0.07%

Encoding/decoding are not changed according to cross-checkers and another independent company who ran the simulations.

It is confirmed that this change is a desirable simplification.

Decision (SW): Adopt JVET-R0327, encoder-only change of CCALF filter derivation

[JVET-R0464](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10126) Crosscheck of JVET-R0327 (AHG 10: One-pass CCALF) [G. Li (Tencent)] [late]

[JVET-R0328](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9972) AHG 10: ALF and CCALF encoder parallel design [X.W. Meng (PKU), X. Zheng (DJI), S.S. Wang, S.W. Ma (PKU)]

In this contribution, ALF and CCALF encoder parallel design is proposed. Chroma signal before ALF is used to replace the current reconstructed chroma signal after ALF in CCALF parameter training process. With the proposed method, CCALF parameter training and ALF process can be parallel. The coding performance in VTM-8.0 is as follows,

AI: 0.00% 0.16% 0.19%

RA: 0.00% 0.23% 0.20%

LDB: -0.04% 0.13% 0.04%

The benefit of parallel implementation would mainly be relevant for real-time encoding. For reference software, this option would not be so important, and there is also some (minor) loss in chroma.

No action.

[JVET-R0465](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10127) Crosscheck of JVET-R0328 (AHG 10: ALF and CCALF encoder parallel design) [G. Li (Tencent)] [late]

# Metrics and evaluation criteria (0)

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

# Withdrawn (8)

Section kept for future use.

JVET-R0075 Withdrawn

JVET-R0181 Withdrawn

JVET-R0346 Withdrawn

JVET-R0348 Withdrawn

JVET-R0377 Withdrawn

JVET-R0377 Withdrawn

JVET-R0409 Withdrawn

JVET-R0412 Withdrawn

JVET-R0488 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 19 April 1300-1500

Reports of the tracks were presented as follows:

The status of Tracks A and B was presented and discussed, which particularly included the following aspects:

Track A:

**Status of HLS review:**

By the end of April 18, 2020, the meetings had reviewed approximately ***172 (70%) of the 254 contributions***, which resulted in **65 recommendations/adoptions** for normative action, 26 recommendations/adoptions for editorial action, and ***25 revisits***.

1. 6.1.1 Combinations of subpictures and other features (3/3): 1 recommendation, 2 revisits
2. (done) 6.1.2.1 Chroma deblocking tc and β offsets signalling (13/13), 2 recommendations
3. 6.1.2.2 Deblocking control signalling - other aspects (4/5): 2 recommendations, 1 TBP
4. 6.1.2.3 Quantization control signalling (6/6): 1 adoption, 1 revisit
5. (assigned to 4/21 #3) 6.1.2.4 High-level control of features that use APSs: LMCS, scaling lists, and ALF (17/21): 12 recommendations/adoptions, 1 revisit, 4 TBP.
6. (assigned to 4/19 #3, 4/21 #3) 6.1.2.5 High level control of other tools (0/13): 13 TBP
7. 6.1.3 General and misc. HLS topics (6/9): 3 recommendations/adoptions, 3 revisits, 3 TBP
8. (assigned to 4/22 #1) 6.1.4 Profile, tier, level (PTL) (3/5): 1 recommendation, 1 revisit, 3 TBP
9. (assigned to 4/22 #1) 6.1.5 General constraints information (GCI) (0/9): 9 TBP
10. (assigned to 4/20 #3-4) 6.1.6 Parameter sets cleanups (14/22): 9 recommendations, 3 revisits, 8 TBP
11. (done) 6.1.7 Syntax for one slice per picture (14/14): 9 recommendations/adoptions
12. 6.1.8 Picture header and slice header (13/13): 7 adoptions, 1 revisit
13. (assigned to 4/20 #3-4) 6.1.9 Mixed NAL unit types within a coded picture (6/11): 5 adoptions, 1 revist, 5 TBP
14. (assigned to 4/20 #3-4) 6.1.10 RPL, WP, and collocated picture signalling (3/11): 2 adoptions, 1 revist, 8 TBP
15. (assigned to 4/21 #1-2) 6.1.11 Signalling of virtual boundaries (0/4): 4 TBP
16. 6.1.12 Hypothetical reference decoder (HRD) (9/9): 14 adoptions (of which 8 editorial bug fixes), 4 revists
17. 6.1.13 DCI, VUI, and SEI (0/8): 8 TBP
18. 6.1.14 HLS editorial inputs (0/1): 1 TBP
19. (assigned to 4/21 #1-2) 6.2.1 Subpictures (17/25): 5 adoptions, 1 revisit, 8 TBP
20. (done) 6.2.2.1 Tile signalling (6/6): 4 recommendations
21. (done) 6.2.2.2 Rectangular slice signalling (11/11), 1 adoption, 1 editor action item
22. (assigned to 4/21 #1-2) 6.2.2.3 Raster-scan slices (0/2): 2 TBP
23. (assigned to 4/21 #1-2) 6.2.3 Control of loop filtering across subpicture/tile/slice boundaries (0/6): 6 TBP
24. 6.3.1.1 General scalability HLS topics (6/8): 5 adoptions, 3 revists, 2 TBP
25. (done) 6.3.1.2 Scalability information signalling and related (17/17): 6 recommendations/adoptions
26. 6.3.2 Reference picture resampling (RPR) specific HLS (2/2): 1 revisit

Track B:

Documents to be reviewed in Track B included:

1. 5.1.5 Partitioning (3 docs)
2. 5.1.6 ACT (2 docs)
3. 5.1.7 Other (1 doc)
4. 4.3 Test conditions (2 docs)
5. 4.8 Implementation studies (4 docs)
6. 8 Encoder optimization (6 docs)

Both tracks had made only quite small changes – generally bug fix / cleanup. MIP for 4:4:4 single-tree (in Track B) was remarked to perhaps be the most substantial action.

Line buffering for CCALF for 4:2:2 and 4:4:4 was noted as an issue needing further attention.

Transform skip with regular residual coding for lossless and near-lossless coding with sign data hiding or dependent quantization was noted as another key issue under consideration.

Decisions recommended from Tracks A and B and the Category 1 and Category 2 AHG pre-meetings were agreed and approved, unless otherwise noted:

R0215, R0371 and R0373 were considered to be high-level control of coding tools (see section 6.1.2.5).

WG 11 NB comments

* No negative votes
* ISO CS comments on formatting and phrasing
* One NB commented on the SEI spec (US)
* Two NBs commented on the VVC spec (US and Finland)
  + US requested still picture profiles

Conformance testing was discussed (see section 4.7).

A plan for a joint meeting considering profile and tools-in-profiles was discussed (see section 4.9).

On verification testing, a contribution R0461 was noted.

Topics in section 6.1.2.5 were then discussed at 1415.

## Joint meeting Tuesday 21 April 0500-0600

Profiles and tools in profiles were discussed (see section 4.9).

NB ballot comments were also noted. [add detail]

## Plenary meeting Wednesday 22 April 0720-xxxx

Reports of the tracks were presented as follows:

The status of Tracks A and B was presented and discussed, which particularly included the following aspects:

**Status of HLS review:**

By the end of the first session on April 22, 2020, the meetings have reviewed approximately ***219 (84%) of the 262 contributions***, which resulted in **80 recommendations/adoptions** for normative action, 30 recommendations/adoptions for editorial action, and ***25 revisits***.

1. 6.1.1 Combinations of subpictures and other features (3/3): 1 recommendation, 2 revisits
2. (done) 6.1.2.1 Chroma deblocking tc and β offsets signalling (13/13), 2 recommendations
3. 6.1.2.2 Deblocking control signalling - other aspects (4/5): 2 recommendations, 1 TBP
4. 6.1.2.3 Quantization control signalling (6/6): 1 adoption, 1 revisit
5. 6.1.2.4 High-level control of features that use APSs: LMCS, scaling lists, and ALF (17/23): 12 recommendations/adoptions, 1 revisit, 6 TBP.
6. 6.1.2.5 High level control of other tools (11/17): 4 adoptions, 1 editor action item, 1 revisit, 6 TBP
7. 6.1.3General and misc. HLS topics (8/9): 5 recommendations/adoptions, 3 revisits, 1 TBP
8. 6.1.4 Profile, tier, level (PTL) (5/5): 3 recommendations/adoptions, 1 revisit
9. (assigned to 4/22 #1) 6.1.5 General constraints information (GCI) (0/9): 9 TBP
10. 6.1.6 Parameter sets cleanups (21/21): 9 recommendations, 3 revisits
11. (done) 6.1.7 Syntax for one slice per picture (14/14): 9 recommendations/adoptions
12. 6.1.8 Picture header and slice header (13/13): 7 adoptions, 1 revisit
13. 6.1.9 Mixed NAL unit types within a coded picture (11/11): 7 adoptions, 2 revisits
14. 6.1.10 RPL, WP, and collocated picture signalling (8/11): 5 adoptions, 4 revisits, 3 TBP
15. (done) 6.1.11 Signalling of virtual boundaries (4/4): 1 adoption
16. 6.1.12 Hypothetical reference decoder (HRD) (9/9): 14 adoptions (of which 8 editorial bug fixes), 4 revists
17. 6.1.13 DCI, VUI, and SEI (0/7): 7 TBP
18. 6.1.14 HLS editorial inputs (0/1): 1 TBP
19. 6.2.1 Subpictures (26/26): 10 adoptions, 1 revisit
20. (done) 6.2.2.1 Tile signalling (6/6): 4 recommendations
21. (done) 6.2.2.2 Rectangular slice signalling (11/11), 1 adoption, 1 editor action item
22. (assigned to 4/22 #3) 6.2.2.3 Raster-scan slices (0/2): 2 TBP
23. (assigned to 4/22 #3) 6.2.3 Control of loop filtering across subpicture/tile/slice boundaries (0/6): 6 TBP
24. 6.3.1.1General scalability HLS topics (7/8): 6 adoptions, 3 revists, 1 TBP
25. (done) 6.3.1.2 Scalability information signalling and related (18/18): 6 recommendations/adoptions
26. 6.3.2 Reference picture resampling (RPR) specific HLS (2/2): 1 revisit

Side activity to integrate the decisions – see document R0481.

The change of coding of level numbers was noted – see R04xx

Track B had reviewed all documents, and basically had just one open topic remaining.

* VT – to be further discussed in Track B.
* CTC –single-tree should be used for I slices (so ACT can be used for I slices for RGB content). See notes in section 4.3; luma/chroma balance issue to be further discussed.

An action relating to quantization scaling matrices for ACT was noted.

Joint meeting with parent bodies upcoming noted.

Additional topics to be discussed

* Review of editors’ notes
* Conformance to be discussed.

## Joint meeting Thursday 23 April 0500-0600

Profiles and tools in profiles were discussed (see section 4.9).

NB ballot comments were also noted.

## Plenary Thursday morning 0630

The current status of review at the meeting was discussed.

Decisions recommended from Tracks A and B and the Category 1 and Category 2 AHG pre-meetings were agreed and approved, unless otherwise noted.

Conformance status was checked and discussed (see section 4.7).

AHGs and outputs were planned.

[Additional sessions split mode]

## Closing plenary meeting Thursday 23 April xxxx-xxxx

Reports of the tracks were presented as follows:

The status of Tracks A and B was presented and discussed, which particularly included the following aspects:

## Closing plenary meeting Friday 24 April 1300-

The status of work was discussed

* CTC on chroma QP offsets 4.x – further study was requested
  + Selection of chroma QP offsets (possibly QP-dependent and class-dependent) to improve the luma/chroma balance are delegated to the CTC editors
  + There was discussion of terminology – “sensor-generated” and “computer-generated” were suggested as appropriate terms.
* Open input reviews and revisits
  + Open R0058 with R0194 and R0342 item 17 – these were closed by 1450.
  + The record for JVET-R0119 item 3 was changed due to an interaction with R0193.
  + JVET-R0481, a roll-up of prior actions of the meeting, was reviewed.
  + The notes were scanned for TBPs and revisits.
* Project development discussion (section 4.1)
  + VVC extensions for high fidelity video
  + MC-IF survey and sub-profiling
* Output docs & dates
* AHG plans
* Mtg plans
* Discussion of the verification test plan and procedure (future planning for scalability was noted)
* List of actions taken
* Doc deadline

## BoGs (X)

## 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.

[Add actions of Friday 24 April.]

[This is just a reflection of what has already been recorded.]

| **Category** | **Rationale** | **Description** | **Document(s)** |
| --- | --- | --- | --- |
| **Inloop Filter** |  |  |  |
| DF | Bug fix | Cleanup DF tC value derivation | JVET-R0130 |
| DF | Bug fix | Fix DF boundary strength derivation | JVET-R0437 |
| ALF | Cleanup | Rounding correction for ALF VB | JVET-R0208 |
| CC-ALF | Complexity reduction | Reduce CC-ALF line buffer for 4:2:2, 4:4:4 | JVET-R0233 |
| LMCS | Cleanup | Remove average luma value clipping | JVET-R0330 |
| **Intra** |  |  |  |
| MIP | Coding efficiency | Chroma MIP for 4:4:4 single tree | JVET-R0350 |
| Palette | Cleanup | Disable chroma palette for local dual tree | JVET-R0334 |
| **Quantization** |  |  |  |
| QM signalling | Cleanup | Disabling scaling matrices for RGB or YCC | JVET-R0380 |
| QM signalling | Bug fix | Define chroma lists for 4:0:0 for prediction | JVET-R0055 |
| TS | Cleanup | Minimum QP of transform skip signalling | JVET-R0045 |
| **Partitioning** |  |  |  |
| QT | Bug fix | Chroma QT split in 4:2:2 | JVET-R0131 |
| QTBTTT | Cleanup | Upper limits for min QT, max BT/TT size | JVET-R0347 |
| **Text only** |  |  |  |
| Inter | Bug fix | Define colPic and NoBackwardPredFlag | JVET-R0137 |
| DMVR | Cleanup | Cleanup of DMVR (not used with RPR) | JVET-R0223 |
| IBC | Bug fix | Fix cu\_skip\_flag signaling for IBC | JVET-R0311 |
| CCLM | Bug fix | Align CCLM text with SW | JVET-R0452 JVET-R0471 |
| DF | Bug fix | Align deblocking of subblock motion edges | JVET-R0134 |
| LFNST | Bug fix | Interaction between LFNST and BDPCM | JVET-R0319 |
| ACT | Bug fix | Fix clipping input residuals to IACT | JVET-R0329 |
| Palette | Bug fix | Fix palette prediction mismatch | JVET-R0333 |
| **Software only** |  |  |  |
| CTC | Coding efficiency | Disable dual tree for 4:4:4 RGB | JVET-R0468 |
| Trafo | Exploration | High bit depth coding | JVET-R0351 |
| CC-ALF | Bug fix | Fix CC-ALF VB for 4:4:4, 4:2:2 | JVET-R0322 |
| QM signalling | Bug fix | Size 32 matrices for chroma size 64 for 4:4:4 | JVET-R0166 |
| Lossless | Functionality | Mixed lossy/lossless configuration | JVET-R0110 |
| Lossless | Functionality | TSRC configuration parameter | JVET-R0143 |
| Intra | Coding efficiency | Mean-scaled SATD in intra search | JVET-R0164 |
| CC-ALF | Simplification | One-pass CCALF | JVET-R0327 |
| Coeff. coding | Cleanup | Remove disabling DQ scaling for TS+RRC | JVET-R0083 |
| **New profiles** |  |  |  |
|  | New profiles | Add main 10 Still Picture and Main 4:4:4 10 Still Picture profiles. | JVET-R0370 |
| **Review of editors' notes in texts** |  |  |  |
| Chroma sample location | Cleanup | Allow the value 6 for chroma sample location type indicators when present. | n/a |
| Decoded picture hash SEI | Cleanup | Add a byte to the decoded picture hash SEI message with a single\_component\_flag followed by 7 reserved zero bits. The width and height of each component are defined externally. |  |
| Decoded picture hash SEI |  | For the decoded picture hash, the two’s complement issue is also found in HEVC. This should be further studied. | n/a |
| RWP SEI | Cleanup | When used with a RWP SEI message, the generalized cubemap message shall have the same functionality as the “traditional” cubemap message (define by syntax element constraints) | n/a |
| Display period | Cleanup | (pt\_)display\_elemental\_periods\_minus1: specify as u(4). | n/a |
| **Combinations of subpictures and other features** |  |  |  |
| Subpictrures, RPR, and scalability | Functionality cleanup | Change the constraint on the combination of subpictures and scalability (in the semantics of subpic\_treated\_as\_pic\_flag[ i ]), the RPR aspects related to the combination of RPR, subpictures, and scalability, and the decoding processes involving the clipping operations for treating subpicture boundaries in motion compensation and motion prediction as picture boundaries. | JVET-R0058 |
| Subpictures and wraparound | Cleanup | Allow wraparound MC for subpictures with subpic\_treated\_as\_pic\_flag[ i ] equal to 1 and subpicture width same as the picture width. | JVET-R0184 |
| **Deblocking control signalling** |  |  |  |
| Deblocking signalling | Cleanup | Skip the signalling of the chroma tc and β deblocking offset syntax elements (SEs) in the PPS when the chroma format is ( 4:0:0 or (4:4:4 and the separate color plane coding mode is in use) ) and/or when the parameter values for chroma are the same as for luma, and condition the SEs on the existing pps\_chroma\_tool\_offsets\_present\_flag currently for controlling the presence of the QP offsets in the PPS. (The editor may also consider renaming the flag.) If the flag is zero, the chroma offsets (if needed) are inferred from the luma offsets. | JVET-R0078, R0095, R0106, R0152, R0172, R0206, R0218, R0232 |
| Deblocking signalling | Cleanup | Skip the signalling of the chroma tc and β deblocking offset syntax elements (SEs) in the PH and the SH when the chroma format is (4:0:0 or (4:4:4 and the separate color plane coding mode is in use) ) and/or when the parameter values for chroma are the same for luma, and condition the SEs on the existing pps\_chroma\_tool\_offsets\_present\_flag currently for controlling the presence of the QP offsets in the PPS. (The editor may also consider renaming the luma beta and tc offset control syntax elements.) If the flag is zero, the chroma offsets (if needed) are inferred from the luma offsets. | JVET-R0078, R0152, R0232 |
| Deblocking signalling | editorial BF | Fixing basically editorial bugs of the semantics of DBF control related syntax elements. (with editor discretion on exact form of expression) | JVET-R0159 |
| Deblocking signalling | Cleanup | Move the signalling location of syntax element dbf\_info\_in\_ph\_flag to locate it near the other deblocking control parameters signalling. | JVET-R0106 |
| Deblocking signalling | sensibility cleanup | 1) Change the semantics of the deblocking signalling control syntax elements as editorial improvement. 2) Infer slice\_deblocking\_filter\_override\_flag to be equal to 0 (instead of to be equal to ph\_deblocking\_filter\_override\_flag) when not present. 3) Skip the signalling of ph\_/slice\_deblocking\_filter\_disabled\_flag when pps\_deblocking\_filter\_disabled\_flag and ph/slice\_deblocking\_filter\_override\_flag are both equal to 1 and infer the value of ph/slice\_deblocking\_filter\_disabled\_flag to be equal to 0 under this condition. For item 1, it was commented that it would be better to say “in the picture header or slice header” than “at the picture level or slice level”. Another participant said that the version from R0159 is more clear in terms of exactly how specific syntax element interact. This is an editorial matter that can be resolved by the editor. It was commented and agreed that, as written, we cannot remove “in which slice\_deblocking\_filter\_disabled\_flag is not present” in the semantics of ph\_deblocking\_filter\_disabled\_flag. | JVET-R0388 |
| **Quantization control signalling** |  |  |  |
| Quantization control signalling | expression of existing intent | Regarding the CU-level luma QP delta control, resolve an asserted error in the semantics of pps\_cu\_qp\_delta\_enabled\_flag by using it to specify the presence of cu\_qp\_delta\_abs and cu\_qp\_delta\_sign\_flag in both the transform unit syntax and the palette coding syntax. The editor should also consider the suggestion in “b” (Rename the PPS-level on/off control flag to be pps\_cu\_qp\_delta\_enabled\_flag for clearer wordings.). | JVET-R0073 |
| **High-level control of features that use APSs: LMCS, scaling lists, and ALF** |  |  |  |
| LMCS signalling | cleanup | Skip the signalling of the SH LMCS enabled flag for the case when the PH is in the SH. | JVET-R0089, JVET-R0098, JVET-R0210, JVET-R0200, JVET-R0202 |
| LMCS signalling | cleanup | Move the SH flag slice\_lmcs\_enabled\_flag to be just after the ALF parameters so that the header information for LMCS is grouped in a similar way as in the picture header. | JVET-R0200 |
| LMCS signalling | ed. | Add a NOTE to caution the reader that enabling chroma residual scaling could cause a GDR problem if there is a virtual boundary that is not aligned with a CTU boundary. It is suggested to add such a NOTE. The editor is requested to consider this. (No normative effect.) | JVET-R0393 |
| LMCS signalling | Ed. BF / expression of existing intent | Revise the semantics of slice\_lmcs\_enabled\_flag, ph\_lmcs\_enabled\_flag, and ph\_chroma\_residual\_scale\_flag. (editor has discretion over exact expression) | JVET-R0051, JVET-R0063, JVET-R0160, JVET-R0210 |
| General semantics cleanup | Ed. | It is suggested to remove “one, more, or all” phrases in the text. | n/a |
| Explicit scaling list signalling | cleanup | Skip the signalling of the SH explicit scaling list enabled flag for when the PH is in the SH.  Adopt. Text is in R0098 and software will be provided by that proponent. | JVET-R0089, JVET-R0098, JVET-R0202 |
| Explicit scaling list signalling | cleanup | Move the SH flag slice\_explicit\_scaling\_list\_used\_flag to be just after the ALF parameters (but after slice\_lmcs\_enabled\_flag) so that the header information for explicit scaling lists is grouped in a similar way as in the picture header. | JVET-R0200 |
| ALF signalling | cleanup | Use two separate flags (one for Cb, one for Cr) to replace ph\_alf\_chroma\_idc in PH and slice\_alf\_chroma\_idc in SH. Adopt (as a non-editorial matter, this is just a swap of the bit order) | JVET-R0225 |
| ALF signalling | cleanup | In PH/SH, add a constraint such that if CCALF is disabled in SPS, an ALF\_APS cannot contain any CCALF filters. | JVET-R0232 section 3.2 |
| ALF/SAO signalling | Ed. BF / expression of existing intent | Revise the semantics of ph\_alf\_enabled\_flag and sps\_sao\_enabled\_flag (editor has discretion over exact expression). | JVET-R0068, JVET-R0160, JVET-R0251 |
| Explicit scaling list signalling | cleanup | Move scaling\_matrix\_for\_lfnst\_disabled\_flag from the scaling\_list\_data( ) syntax to the SPS. | JVET-R0064 |
| APS cleanups | cleanup | Add the following constraints: 1. To constrain suffix APS NAL units to be located after the last VCL NAL unit of the PU. 2. To allow prefix and suffix APS NAL units with particular APS identifier and type to have different content. 3. To constrain prefix APS NAL unit to be located before the first VCL NAL unit of the PU. | JVET-R0201 |
| **High-level control of other tools** |  |  |  |
|  | cleanup (text/SW) | The picture header flags ph\_dep\_quant\_enabled\_flag and pic\_sign\_data\_hiding\_enabled\_flag are moved to slice header before slice\_ts\_residual\_coding\_disabled\_flag and the signalling of slice\_ts\_residual\_coding\_disabled\_flag are conditioned on these flags. In this case, if slice\_ts\_residual\_coding\_disabled\_flag=0 then DQ and SDH are automatically turned off at the slice level. | JVET-R0271 variant #3 |
|  | cleanup | Condition slice\_ts\_residual\_coding\_disabled\_flag on "if(sps\_transform\_skip\_enabled\_flag && !slice\_dep\_quant\_enabled\_flag && ! slice\_sign\_data\_hiding\_enabled\_flag )". | JVET-R0483 Combination 4 |
| Affine and AMVR signalling | editorial bug fix | Change the semantics of sps\_affine\_amvr\_enabled\_flag equal to 1 to use the wording of "may be used" instead of "is used". Adopt (clarify that this has “one way” semantics). | JVET-R0068 |
| General editing issues | Editor action item | There should be a general review of the word “may”, for wording consistency and clarity – e.g., whether it expresses permission. | n/a |
| Subblock merge signalling | cleanup to avoid strange encoder behaviour | The range of five\_minus\_max\_num\_subblock\_merge\_cand is set to 0 to 5 − sps\_sbtmvp\_enabled\_flag, inclusive. Adopt R0371 (without the inference rule). | JVET-R0371, R0373 |
| MMVD signalling | cleanup. Adopt (all aspects) with change of flag rather than additional flag as above. | 1. Move the location of sps\_fpel\_mmvd\_enabled\_flag to directly follow sps\_mmvd\_enabled\_flag. It is claimed that this modification makes the specification text cleaner as it groups together the MMVD related syntax elements in the SPS. Cleanup to group related things together. 2. Infer the value of sps\_fpel\_mmvd\_enabled\_flag to be equal to 0 when the flag is not present. It is reported that the current specification text does not specify the value of sps\_fpel\_mmvd\_enabled\_flag when the flag is not present. It is asserted that the current specification text is broken since an unspecified value of sps\_fpel\_mmvd\_enabled\_flag would make the presence of ph\_fpel\_mmvd\_enabled\_flag in the picture header undetermined. Editorial spec bug fix. 3. Add a no\_mmvd\_constraint\_flag in general\_constraint\_info(). When this flag is equal to 1, sps\_mmvd\_enabled\_flag shall be equal to 0. It is claimed that MMVD is a relative substantial inter coding feature. A constraint flag that allows indicating that such a feature is not used in the bitstream is claimed to be desirable to have. Extra constraint flag. Instead it was suggested to replace/rename the current flag no\_fpel\_mmvd\_constraint\_flag to no\_mmvd\_constraint\_flag and change the semantics accordingly. | JVET-R0214 |
| Transform signalling | cleanup | If the luma CTB size is not larger than 32, sps\_max\_luma\_transform\_size\_64\_flag is not signalled and inferred to be 0. | JVET-R0097 aspect 1 |
|  | ed. BF/text | JVET-R0252 semantics cleanup aspect. | JVET-R0252 |
| **General and misc. HLS topics** |  |  |  |
| Picture types and related constraints |  | Changes on the definitions of "associated IRAP picture", "associated GDR picture", and "trailing picture" and the constraints regarding different types of pictures and their relationships in terms of decoding order, output order, and prediction relationship. | JVET-R0041-v2, JVET-R0226 |
| Picture types and related constraints | editorial bug fix in expression of existing intent | Add the following constraint: When the current picture is an IDR picture and sps\_idr\_rpl\_present\_flag is equal to 1, there shall be no picture referred to by an entry in RefPicList[ 0 ] or RefPicList[ 1 ] that precedes, in output order or decoding order, any preceding IRAP picture in decoding order (when present). Adopt this constraint (rephrased to account for multilayer context) | JVET-R0267 |
| IRAP and GDR AU | cleanup | Add a flag named irap\_or\_gdr\_au\_flag to the AUD to specify whether the AU is an IRAP or GDR AU, and mandate the presence of an AUD NAL unit in each IRAP or GDR AU when vps\_max\_layers\_minus1 is greater than 0. | JVET-R0065 |
| APS cleanups | expression of existing intent | The same types of APSs share the same value space for the APS ID, regardless of whether the APSs are prefix or suffix APS NAL units. | JVET-R0070 |
| Byte alignment modifications | editorial bug fix | Editorial bug fixes, including to use the syntax element alignment\_bit\_equal\_to\_one to indicate the last bit in the arithmetic decode terminate process | JVET-R0082 |
| Unnecessary pictures | sensibility cleanup | pic\_output\_flag is not signalled in picture header and inferred to be equal to 1, when the value of non\_reference\_picture\_flag is equal to 1. Adopt. The NOTE needs to be rephased (delegated to the editor). | JVET-R0122 |
| **Profile, tier, level (PTL)** |  |  |  |
|  | cleanup | Remove the dci\_max\_sublayers\_minus1 SE, but to use 4 reserved bits (at the begin of the DCI syntax) instead of having 8 bits for the number of PTL structures (as proposed), and reserve the value 15 of dci\_num\_ptls\_minus1. | JVET-R0108 |
|  | cleanup | MaxCPB = 80 000 for level 6, 120 000 for level 6.1, 180 000 for level 6.2, and change MinCrScaleFactor for the 4:4:4 profile to 0.75, and change MinCrBase to 8 for level 6.2. This could be an errata report for AVC and HEVC, to change the MinCr limit to be derived from the CPB size limit or add a note for cases where the CPB size imposes a tighter limit than the MinCr does. | JVET-R0244 |
|  | cleanup | Adopt the level value scheme of major \* 16 + minor \* 3 (with the top number retaining its special meaning). The basic idea is to leave the same amount of gap between sublevels but reduce the gap for major levels to enable hypothetical future higher level numbers. | JVET-R0245 |
|  |  | Editor action item: It is suggested to put the number correspondence table in the text, along with an informative note that describes the formula and states that future-specified levels could have values selected in a different manner that respects the specified hierarchy. | n/a |
| **General constraints information (GCI)** |  |  |  |
|  | sensibility constraint | Require that when no\_aps\_constraint\_flag is equal to 1, sps\_lmcs\_enabled\_flag and sps\_scaling\_list\_enabled\_flag shall be equal to 0. | JVET-R0178 |
|  | cleanup | Add a no\_tsrc\_constraint\_flag constraining slice\_ts\_residual\_coding\_disabled\_flag to be equal to 1. | JVET-R0179 |
|  | sensibility constraints and editorial | 1. Mandate the value of no\_ccalf\_constraint\_flag to be equal to 1 when no\_alf\_constraint\_flag is equal to 1. It is reported that when no\_alf\_constraint\_flag is equal to 1, sps\_alf\_enabled\_flag is equal to 0 which disables the adaptive loop filter (ALF) tool, including cross-component ALF. Decision (sensibility constraint): Adopt. 2. Mandate the value of no\_sbtmvp\_constraint\_flag to be equal to 1 when no\_temporal\_mvp\_constraint\_flag is equal to 1. It is reported that when no\_temporal\_mvp\_constraint\_flag is equal to 1, sps\_temporal\_mvp\_enabled\_flag is equal to 0 which disables temporal motion vector prediction, including SbTMVP. Decision (sensibility constraint): Adopt. 3. Rename no\_qp\_delta\_constraint\_flag to no\_cu\_qp\_delta\_constraint\_flag. It is reported that the current name is misleading since no\_qp\_delta\_constraint\_flag is only constraining cu\_qp\_delta\_enabled\_flag and not ph\_qp\_delta or slice\_qp\_delta. Editor action item: The editor is suggested to consider the names of these syntax elements. | JVET-R0227 |
|  | sensibility constraints and general constraints on tools | 1. Sensibility constraints on values without introducing such syntax conditions 2. Various constraint flags on tools: no\_mrl\_constraint\_flag, no\_isp\_constraint\_flag, no\_mip\_constraint\_flag, no\_lfnst\_constraint\_flag, no\_mmvd\_constraint\_flag, no\_smvd\_constraint\_flag, no\_prof\_constraint\_flag, no\_palette\_constraint\_flag, no\_act\_constraint\_flag, no\_lmcs\_constraint\_flag 3. Add single\_layer\_constraint\_flag and no\_inter\_layer\_pred\_constraint\_flag (perhaps renamed to all\_layers\_independent\_constraint\_flag). | JVET-R0286 |
|  | general constraints cleanup | Add a no\_chroma\_qp\_offset\_constraint\_flag. | JVET-R0341 |
| **Parameter sets cleanups** |  |  |  |
|  | cleanup | Condition the presence of sps\_sublayer\_dpb\_params\_flag on the value of sps\_ptl\_dpb\_hrd\_params\_present\_flag, in addition to sps\_max\_sublayer\_minus1 | JVET-R0156 proposal 3, JVET-R0170, JVET-R0222 proposal 2 |
|  | sensibility constraint | Change the constraint on when the value of sps\_ptl\_dpb\_hrd\_params\_present\_flag shall be equal to 1 | R0275, JVET-R0108, R0156, R0191 |
|  | expression of existing intent | Infer the value of sps\_ccalf\_enabled\_flag to be equal to 0 when not present. | JVET-R0105 |
|  | ed. | Editors are asked to review the semantics of poc\_msb\_val such that it is clear that all “missing” MSBs are inferred to be 0. | JVET-R0266 proposal 2 |
|  | editorial expression of existing intent | Specify that no\_gdr\_constraint\_flag equal to 1 specifies that sps\_gdr\_enabled\_flag shall be equal to 0. no\_gdr\_constraint\_flag equal to 0 does not impose such a constraint. | JVET-R0266 proposal 5, JVET-R0178 |
|  | cleanup | Grouping syntax elements in SPS based on slice type | JVET-R0332 |
|  | cleanup | Require the value of pps\_conformance\_window\_flag to be equal to 0 when the picture width and height are the maximum picture width and height, and infer the values of the PPS conformance window syntax elements to be the same as those signalled in the SPS if the picture width and height are the maximum picture width and height and to be equal to 0 otherwise. | JVET-R0068 proposal 6, JVET-R0262 proposal 1 and 2 |
|  | cleanup | Change the signalling for wraparound offset. Signal “picture width minus wraparound offset” instead of “wraparound offset” | JVET-R0162 proposal 1 |
|  | cleanup | Change the signalling of the PPS ID from ue(v) to u(6). | JVET-R0266 proposal 4 |
|  | cleanup | Repurpose the chroma scaling list presence flag in the APS (i.e., aps\_chroma\_present\_flag) and use this flag to condition the presence of chroma presence flags in the APS, and move some APS constraints to the PH and SH semantics. | JVET-R0433 |
| **Syntax for one slice per picture (PH in SH)** |  |  |  |
|  | cleanup | Add a general constraint flag pic\_header\_in\_slice\_header\_constraint\_flag. | JVET-R0118 |
|  | cleanup | When pps\_no\_pic\_partition\_flag is equal to 1, skip the 6 PPS flags rpl\_info\_in\_ph\_flag, dbf\_info\_in\_ph\_flag, sao\_info\_in\_ph\_flag, alf\_info\_in\_ph\_flag, wp\_info\_in\_ph\_flag, qp\_delta\_info\_in\_ph\_flag and infer them to be equal to 0. | JVET-R0113 |
|  | cleanup | When sh\_picture\_header\_in\_slice\_header\_flag is equal to 1, require rpl\_info\_in\_ph\_flag, dbf\_info\_in\_ph\_flag, sao\_info\_in\_ph\_flag, wp\_info\_in\_ph\_flag, qp\_delta\_info\_in\_ph\_flag to be equal to 0. | JVET-R0202 |
|  | cleanup | Only allow sh\_picture\_header\_in\_slice\_header\_flag to be equal to 1 when pps\_rect\_slice\_flag is 1. | n/a |
|  | cleanup | Skip the SH SE num\_tiles\_in\_slice\_minus1 when NumTilesInPic − slice\_address is not greater than 1. | JVET-R0210, R0248 |
|  | cleanup | Add a constraint such that when sps\_subpic\_info\_present\_flag is equal to 1, the value of sh\_picture\_header\_in\_slice\_header\_flag shall be equal to 0. | JVET-R0189, R0202 |
|  | basically editorial cleanup | Add a constraint such that when separate\_colour\_plane\_flag is equal to 1, the value of picture\_header\_in\_slice\_header\_flag shall be equal to 0. | JVET-R0202 |
|  | BF / expression of existing intent | Fix the text for determination of the first VCL NAL unit of an AU. | JVET- R0124, R0163 |
|  | Ed. BF/expression of existing intent | Fix the semantics of the 6 PPS flags rpl\_info\_in\_ph\_flag, dbf\_info\_in\_ph\_flag, sao\_info\_in\_ph\_flag, alf\_info\_in\_ph\_flag, wp\_info\_in\_ph\_flag, qp\_delta\_info\_in\_ph\_flag. | JVET-R0251 |
| **Picture header and slice header** |  |  |  |
|  | cleanup | When ( rpl\_info\_in\_ph\_flag && num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] > 0 ) is false, skip the PH SEs ph\_collocated\_from\_l0\_flag, mvd\_l1\_zero\_flag, ph\_disable\_bdof\_flag, and ph\_disable\_dmvr\_flag and infer the values. | JVET-R0324 |
|  | cleanup | When ( rpl\_info\_in\_ph\_flag && num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] > 0 ) is false, skip the WP table SE num\_l1\_weights and infer the value. | JVET-R0324 |
|  | cleanup | Require ph\_inter\_slice\_allowed\_flag to be equal to 0 when the PH flag gdr\_or\_irap\_pic\_flag is equal to 1 and the PH flag gdr\_pic\_flag is equal to 0 (i.e., the picture is an IRAP picture), and vps\_independent\_layer\_flag[ GeneralLayerIdx[ nuh\_layer\_id ] ] is equal to 1. | JVET-R0278 |
|  | expression of existing intent | Change the semantics of gdr\_or\_irap\_pic\_flag such that the GDR part is "two-way" while keeping the IRAP part to be "one-way" | JVET-R0112 |
|  | ed. | Rename the syntax elements pic\_sign\_data\_hiding\_enabled\_flag, sps\_bdof\_pic\_present\_flag, sps\_dmvr\_pic\_present\_flag and sps\_prof\_pic\_present\_flag to ph\_sign\_data\_hiding\_enabled\_flag, sps\_bdof\_control\_present\_in\_ph\_flag, sps\_dmvr\_control\_present\_in\_ph\_flag and sps\_prof\_control\_present\_in\_ph\_flag, respectively. | JVET-R0251 |
|  | encoder complexity and coding efficiency | Revert to making the entry point signalling optional. | JVET-R0165 |
|  | cleanup | Move the entry point syntax to the end of the slice header, i.e., behind the slice header extension. | JVET-R0298 |
| **Mixed NAL unit types within a coded picture** |  |  |  |
|  | expression of existing intent, cleanup | Changes for clarifying the meaning of a subpicture in a picture with mixed subpicture types, in terms of relative decoding order, output order, and prediction relationship among the subpicture and the same-layer subpictures with the same subpicture index in preceding and succeeding AUs. | JVET-R0042 |
|  | cleanup | Replace the existing constarint requiring that a subpicture with a different subpicture ID compared to the collocated subpicture in the previous picture in the CLVS needing to have IRAP NUTs with the following: For each value of i in the range of 0 to sps\_num\_subpics\_minus1, inclusive, if the value of SubpicIdVal[ i ] is not equal to the value of SubpicIdVal[ i ] of a reference picture, the active entries of the RPL of the coded slices in the i-th subpicture of the current picture shall not include that reference picture. | JVET-R0276 |
|  | an overlooked sensibility constraint | Disallow the mix of an IRAP NUT and a leading picture NUT. | JVET-R0203 |
|  | cleanup | Allow mixing of more than two NUTs within a coded picture. | JVET-R0203 |
|  | expression of existing intent | On treating a picture with mixed RASL\_NUT and RADL\_NUT in the output of the decoding process and bitstream conformance tests (R0270) 1) A picture with mixed RASL\_NUT and RADL\_NUT is treated as a RASL picture during the decoding process, i.e., regardless of whether a RASL picture has slices with nal\_unit\_type equal to RADL\_NUT, the RASL picture is not output when the associated IRAP picture has NoOutputBeforeRecoveryFlag equal to 1. 2) A picture with mixed RASL\_NUT and RADL\_NUT is treated as a RADL picture in bitstream conformance tests, i.e., only those RASL pictures for which all slices have nal\_unit\_type equal to RASL\_NUT associated with the first IRAP picture are removed from the bitstream to be decoded when the alternative HRD timing is used in the particular bitstream conformance test. These pictures can still serve as references for other pictures that are to be output, so they need to be kept in the bitstream. | JVET-R0270 |
| **RPL, WP, and collocated picture signalling** |  |  |  |
|  | expression of existing intent | Remove only “rpl\_info\_in\_ph\_flag | | ( ( nal\_unit\_type != IDR\_W\_RADL && nal\_unit\_type !=IDR\_N\_LP ) | | sps\_idr\_rpl\_present\_flag ) ) &&” conditioning in the slice header to not signal the override flag for I-slices. | JVET-R0277 item 1 |
|  | sensibility | Skip the signalling of the ltrp\_in\_header\_flag[ listIdx ][ rplsIdx ] syntax element when the ref\_pic\_list\_struct( listIdx, rplsIdx ) syntax strucure is directly included in the PH or SH instead of in the SPS. | JVET-R0059 |
|  | cleanup | Conditionally signal (sps\_)inter\_layer\_ref\_pics\_present\_flag, based on sps\_video\_parameter\_set\_id is greater than 0, and infer it to be equal to 0 when not signalled. | JVET-R0205 |
|  | obvious editorial bug fix | Change the reference picture list structure semantics by replacing the parameters ph\_rpl\_idx[ listIdx ] and slice\_rpl\_idx [ listIdx ] with rpl\_idx[ listIdx ]. | JVET-R0255 item 1 |
|  | expression of existing intent | Modify the inference of rpl\_idx [ i ] when not present: if rpl\_sps\_flag[ i ] is equal to 1 and rpl1\_idx\_present\_flag is equal to 0, the value of rpl\_idx[ 1 ] is inferred to be equal to rpl\_idx[ 0 ], otherwise the value of rpl\_idx[ i ] is inferred to be equal to 0. | JVET-R0255 item 3 |
|  | bug fix | When not present, infer slice\_collocated\_from\_l0\_flag to be equal to 1 for P-slices. | JVET-R0277 item 2 |
|  | Editor action item | Modify the existing constraint in the slice header semantics on the collocated picture by only keeping the 0-valued-RprConstraintsActive[ ][ ]. | JVET-R0059 |
|  | Editor action item | Replace the existing constraint on the value of ph\_temporal\_mvp\_enabled\_flag with a NOTE, with the addition of the scaling window offsets to be also the same, and taking in account that when there is no common reference picture existing among all the slices associated with the PH, the value of ph\_temporal\_mvp\_enabled\_flag has be equal to 0. | JVET-R0059, JVET-R0323 |
| **Signalling of virtual boundaries** |  |  |  |
|  | cleanup | Code virtual boundary positions using ue(v). | JVET-R0266 |
| **Hypothetical reference decoder (HRD)** |  |  |  |
|  | sensibility cleanup | Not signal and infer dui\_sublayer\_delays\_present\_flag[ bp\_max\_sublayers\_minus1 ] to be 1, to make sure du\_spt\_cpb\_removal\_delay\_increment[ bp\_max\_sublayers\_minus1 ] which is used for inference of other syntax is always signalled in DUI SEI message. | JVET-R0100 Proposal 1 |
|  | expression of existing intent | Add missing inference rules for the alternative timing information related syntax elements cpb\_alt\_initial\_cpb\_removal\_delay\_delta[ i ][ j ], cpb\_alt\_initial\_cpb\_removal\_offset\_delta[ i ][ j ] which are used for HRD operation. | JVET-R0101 Proposal 1 |
|  | editorial bug fix | Fix asserted bugs related to unspecified or missing length of u(v) coded syntax elements by referring to correct length syntax elements. | JVET-R0101 Proposal 2 |
|  | sensibility cleanup | Not signal du\_common\_cpb\_removal\_delay\_flag, du\_common\_cpb\_removal\_delay\_increment\_minus1[ i ], num\_nalus\_in\_du\_minus1[ i ] and du\_cpb\_removal\_delay\_increment\_minus1[ i ][ j ] in picture timing SEI message when there is only one DU in an AU and condition the duCpbRemovalDelayInc variable derivation. | JVET-R0103 Proposal 1 |
|  | editorial bug fixes | Perform the editorial fixes for the CPB operation section to define and use AU and DU related variable names correctly. | JVET-R0103 Proposal 2 |
|  | editorial bug fixes, expression of existing intent | Apply an asserted editorial clarification of what n0…n5 mean for the number of conformance tests in Annex C. Fix an asserted bug for the inference rule for syntax elements in the syntax structure sublayer\_hrd\_parameters( ) to use syntax from SPS or VPS as appropriate instead of always using sps\_max\_sublayers\_minus1. Fix an asserted bug for n3 specifying number of conformance test for IRAPs that are not CRAs with associated RASL pictures and alternative timing. Fix an asserted bug in the derivation of InitialCpbRemovalDelay in C.2.3 (Timing of DU removal and decoding of DU) aligning it with derivation in C.2.2 (Timing of DU arrival) to account for alternative timing. Fix an asserted bug by adding missing text to update values of CpbDelayOffset and DpbDelayOffset in C.2.3 -Timing of DU removal and decoding of DU. Fix an asserted bug in equation C.11 for derivation of NominalRemovalTime[ n ], to account for CpbDelayOffset. | JVET-R0297 |
|  | bug fix | Signal a separate set of alternative buffering delay parameters for VCL HRD and for NAL HRD and use them for HRD operation. | JVET-R0413 |
|  | bug fix | Add a constraint that when max\_tid\_il\_ref\_pic\_plus1 is equal to 0 (which means that only the IRAP pictures in the reference layer would be allowed to be used for reference) it would be prohibited to have mixtures of IRAP and non-IRAP NAL units in the picture. | JVET-R0264 |
|  | (editorial) bug fix, expression of existing intent | Use the bit rate indicated in general\_hrd\_parameters( ) and ols\_hrd\_parameters( ) of the OLS for derivation of the subpicture bit rate variables SubpicBitRateVcl and SubpicBitRateNal in the subpicture level information SEI message in Section D.7.2.  Fix an asserted bug which rewrites the cbr\_flag[ tIdTarget ][ j ] to 1 for all CPBs when sli\_cbr\_constraint\_flag is equal to 1 in subpicture extraction process.  The editor is asked to consider rephrasing the subpicture extraction process to use subpicture IDs or indexes in order to simplify the description. If the editorial expression is simpler after accounting for the R0058 aspect, it is suggested to use this expression.  Also perform several assertedly minor fixes (e.g. #903) and editorial improvements in Annex C.6 (Sub-bitstream extraction process) and C.7 (subpicture sub-bitstream extraction process). | JVET-R0295 |
|  | bug fix | Signal a fixed DPB output time offset for each temporal sublayer, controlled by a presence flag, within the buffering period SEI message and use these offsets to calculate picDpbOutputDelta[ i ] | JVET-R0094 |
| **DCI, VUI, and SEI** |  |  |  |
|  | bug fix | Move the two flags about GeneralProgressiveSourceFlag and GeneralInterlacedSourceFlag into the VUI specification as proposed in JVET-R0090. | JVET-R0090 |
| **HLS editorial inputs** |  |  |  |
|  | Editorial action item | Replace ‘slice\_’ prefix for slice header syntax elements by ‘sh\_’, except for slice\_address and slice\_type which are proposed to be renamed to sh\_slice\_address and sh\_slice\_type, respectively. Rename syntax elements in VPS, SPS, PPS, PH, SH to ensure that the names of all syntax elements in these places start with ‘vps\_’, ‘sps\_’, ‘pps\_’, ‘ph\_’ and ‘sh\_’, respectively. The editor is asked to consider renaming ph\_disabled\_xxx\_flag to ph\_xxx\_disabled\_flag. | JVET-R0249 |
| **Subpictures signalling** |  |  |  |
|  | cleanup | Condition sps\_independent\_subpics\_flag on "sps\_num\_subpics\_minus1 > 0". | JVET-R0071, R0156, R0284 |
|  | ed. | It is suggested for the editor to specify inference of the value 1 for sps\_independent\_subpics\_flag and the value 1 for subpic\_treated\_as\_pic\_flag[ i ] and the value 0 for loop\_filter\_across\_subpic\_enabled\_pic\_flag[ i ] when not present. | JVET-R0071 |
|  | ed. | It is suggested for the editor to specify inference of the value 1 for single\_slice\_per\_subpic\_flag when not present. | JVET-R0071 |
|  | cleanup | Introduce constraints to ensure that the slice signalling order in the PPS and the slice coding order within the bitstream are the same. Adopt the constraint approach of JVET-R0091 option 1. (The editor has discretion over the manner of expression in the text.) | JVET-R0091 |
|  | cleanup | Move the signalling of no\_pic\_partition\_flag to be earlier than the signalling of pps\_num\_subpics\_minus1. When the value of no\_pic\_partition\_flag is equal to 1, pps\_num\_subpics\_minus1 is not present and inferred to be equal to 0 | JVET-R0186, R0088 |
|  | cleanup | Use the subpicture index instead of the subpicture ID in the subpicture sub-bitstream extraction process. | JVET-R0068 |
|  | spec bug fix / expression of existing intent | Fix the bug in the current spec for rewriting of picture size during sub-bitstream extraction process. The root of the problem is when the subpicture is located at the bottom and/or right border of a picture that has a size that is not a multiple of the CTU size because subpicture size (i.e., width and height) is expressed in CtbSize, instead of luma samples. Adopt as proposed. The editorial difference can be worked out by the editor. No impact on the software. | JVET-R0092, R0294 |
|  | sensibility cleanup | Add a constraint such that no subpicture can be located completely outside of the conformance cropping window. | JVET-R0093, R0294 |
|  | expression of existing intent | Define rewriting process for conformance cropping window for sub-bitstream extranction process. The editor was requested to figure out the exact wording based on the proposed changes. | JVET-R0093, R0294 |
|  | cleanup | Change the extraction process to utilize the existing scalable nesting SEI message and the existing decoded picture hash SEI message in the extraction process. | JVET-R0294 |
|  |  |  |  |
| **Tiles and slices signalling** |  |  |  |
|  | cleanup | Adopt conditioning presence of loop\_filter\_across\_tiles\_enabled\_flag per JVET-R0113 aspect 1 (avoiding redundant signalling without change of functionality). | JVET-R0113 aspect 1 |
|  | cleanup | 1) In the equation (Eqn. 23) for derivation of tile columns parameters, replace the loop count "i < num\_exp\_tile\_columns\_minus1" with "i <= num\_exp\_tile\_columns\_minus1", such that the value of the last explicitly signalled tile\_column\_width\_minus1[ i ] specifies the width of at least one tile column. The semantics of tile\_column\_width\_minus1[ i ] is updated accordingly. 2) In the equation (Eqn. 24) for derivation of tile rows parameters, replace the loop count "j < num\_exp\_tile\_rows\_minus1" with "j <= num\_exp\_tile\_rows\_minus1", such that the value of the last explicitly signalled tile\_row\_height\_minus1[ i ] specifies the height of at least one tile row. The semantics of tile\_row\_height\_minus1[ i ] is updated accordingly. 3) In the equation (Eqn. 30) for derivation of in-tile rectangular slices parameters, replace the loop count "j < num\_exp\_slices\_in\_tile[ i ] − 1" with "j < num\_exp\_slices\_in\_tile[ i ]", such that for each value of i, the value of the last explicitly signalled exp\_slice\_height\_in\_ctus\_minus1[ i ][ j ] specifies the height of at least one rectangular slice in the tile containing the i-th rectangular slice. | JVET-R0062 |
|  | cleanup | Change the condition for signalling the syntax element of tile\_idx\_delta\_present\_flag. When the value of num\_slices\_in\_pic\_minus1 is greater than 1 instead of 0, the syntax element of tile\_idx\_delta\_present flag is signalled. | JVET-R0080, R0211 |
|  | expression of existing intent | The editor is asked to ensure that the text adequately expresses the necessary constraints, such that tiles, slices, and subpictures are a proper partitioning of the picture (no overlaps, no gaps, no CTUs that are outside the picture). | JVET-R0221 |
|  | Editor action item | The editor was asked to check and make sure that the constraints related to item 1 of JVET-R0157 (which we believe are already expressed in some form) are sufficiently clear to the reader. | JVET-R0157 item 1 |
|  | sensibility cleanup | 1. When the first tile of a rectangular slice is one of the tile(s) at the last tile column of the picture, the syntax element slice\_width\_in\_tiles\_minus1[ i ] is not present and inferred to be equal to 0. 2. When the first tile (i.e., the tile at the top-left corner) of a rectangular slice is one of the tile(s) at the last tile row of the picture, the syntax element slice\_height\_in\_tiles\_minus1[ i ] is not present and inferred to be equal to 0. | JVET-R0188,R0211 item 3, and R0209 |
|  | cleanup | Condition the presence of (pps\_)loop\_filter\_across\_slices\_enabled\_flag on the number of slices in a coded picture or subpicture when known, as follows: if( !rect\_slice\_flag | | single\_slice\_per\_subpic\_flag | | num\_slices\_in\_pic\_minus1 > 0 ) | JVET-R0247 |
|  |  | c |  |
| **General scalability HLS** |  |  |  |
|  | expression of existing intent | Change the description of the bitstream extraction process per the value of max\_tid\_il\_ref\_pics\_plus1[ ][ ] (aspect 1.2 per JVET-R0046-v4). Add a requirement of bitstream conformance that the picture referred to by each ILRP entry in RefPicList[ 0 ] or RefPicList[ 1 ] of a slice of the current picture shall be an IRAP picture or shall have TemporalId less than or equal to Max(0, max\_tid\_il\_ref\_pics\_plus1[ refPicVpsLayerId ] − 1), with refPicVpsLayerId equal to the value of the nuh\_layer\_id of the referenced picture. | JVET-R0046 |
|  | cleanup | Adopt he following changes related to DPB memory allocation and the derivation of the variable NoOutputOfPriorPicsFlag: 1) The maximum values of chroma\_format\_idc and bit\_depth\_minus8 for all pictures of all layers are signalled in the VPS. 2) The setting of the value of the variable NoOutputOfPriorPicsFlag is updated as follows: a. To use the maximum picture width and height values for all pictures of all layers signalled in the VPS instead of the values for a single layer. b. To use the maximum values of chroma\_format\_idc and bit\_depth\_minus8 for all pictures of all layers signalled in the VPS instead of the values for a single layer. c. To not use the value of the separate\_colour\_plane\_flag. 3) Both the semantics of no\_output\_of\_prior\_pics\_flag and the use of this flag in the setting of NoOutputOfPriorPicsFlag are specified in an AU-specific manner (instead of in a PU-specific manner), and the value of no\_output\_of\_prior\_pics\_flag, when present, is required to be the same for all pictures in an AU. | JVET-R0066 |
|  | bug fix / cleanup | Bug fixes for the derivation of PictureOutputFlag and not to specify a specific picture output behavior for an AU when the picture of the only output layer is not present (due to e.g. loss or layer down-switching) in a normative manner, but rather describe that in a NOTE. | JVET-R0067 |
|  | editorial redundancy | It is suggested for the editor to remove “There is at least one VCL NAL unit with nuh\_layer\_id equal to each of the nuh\_layer\_id values in LayerIdInOls[ opOlsIdx ] in BitstreamToDecode.” | JVET-R0274 |
|  | expression of existing intent | Specify that GDR AUs shall be complete – i.e., all of the layers in the CVS shall have a picture in the AU (as with IRAP AUs). | JVET-R0065 |
|  | expression of existing intent | Specify that slice\_type shall be equal to 2 (intra slice) when the NAL unit type is an IRAP NAL unit type and the current picture is the first picture in the current AU. | JVET-R0068 |
|  | sensibility constraint | Change the constraint about parameter set sharing to be as follows: A slice in layerA can refer to a parameter set in layerB only when layerB is less than or equal to layerA and all OLSs in the bitstream that contain layerA also contain layerB. | JVET-R0194 |
| **Scalability information signalling and related** |  |  |  |
|  | cleanup | Omit signaling of index to the list of PTL structures for output layer sets when number of signalled PTL structures is equal to total number of output layer sets and instead infer its value. | JVET-R0161, R0185, R0204, R0275 |
|  | expression of existing intent | Modify the upper range of vps\_num\_dpb\_params to allow signalling of DPB parameters for all OLSs from current fixed upper value of 16, upper limit is equal to total number of OLSs minus the number of single-layer OLSs. | JVET-R0099, R0191 |
|  | expression of existing intent | Update the range value for num\_ols\_hrd\_params\_minus1. | JVET-R0191 |
|  | expression of existing intent | Don't signal and instead infer the index of the dpb\_parameters( ) syntax structure that applies to the i-th OLS when the total number of output layer sets minus number of single layer output layer sets is equal to number of signalled dpb parameters. | JVET-R0099 |
|  | expression of existing intent | Start the for loop which signals ols\_dpb\_pic\_width[ i ], ols\_dpb\_pic\_height[ i ], and ols\_dpb\_params\_idx[ i ] to start at 1 instead of at 0, since 0-th OLS is single layer. Adopt (unless affected by proposals to redefine the 0-th OLS). | JVET-R0099, R0196 |
|  | bug fix | Replace if( !vps\_all\_independent\_layers\_flag ) condition on vps\_num\_dpb\_params syntax element with if(!each\_layer\_is\_an\_ols\_flag). | JVET-R0185 proposal 1, JVET-R0196, JVET-R0275 aspect 3 |
|  | bug fix | Change vps\_num\_dpb\_params to vps\_num\_dpb\_params\_minus1. Adopt and change the semantics to a “two-way” constraint (so if the flag is zero, there must be at least one multilayer OLS specified by the VPS). | JVET-R0185 proposal 2, JVET-R0196, JVET-R0275 aspect 3 |
|  | cleanup | Additionally signal DPB parameters for OLS in this case only if(!each\_layer\_is\_an\_ols\_flag). | JVET-R0185 proposal 3 |
|  | expression of existing intent | Constrain that each DPB, HRD, parameter structure signalled in VPS shall be associated with at least one OLS (in the VPS) that contains more than one layer and each PTL structure that is signalled is associated with at least one OLS. | JVET-R0191 Aspect 3 |
|  | editorial simplification | Assertedly simplify the condition checking for signalling ptl\_max\_temporal\_id[ i ], dpb\_max\_temporal\_id[ i ], and hrd\_max\_tid[ i ] to only use the flag vps\_all\_layers\_same\_num\_sublayers\_flag instead of using the flag vps\_all\_layers\_same\_num\_sublayers\_flag and vps\_max\_sublayers\_minus1 syntax element. Also assertedly simplify the inference rules for ptl\_max\_temporal\_id[ i ], dpb\_max\_temporal\_id[ i ], and hrd\_max\_tid[ i ], when not present. The editor is asked to confirm this and remove checks that are unnecessary. | JVET-R0107 Proposal 2 |
|  | cleanup, editorial simplification, editorial bug fix | Change the inferred value of max\_tid\_il\_ref\_pics\_plus1[] when not present from 7 to vps\_max\_sublayers\_minus1 + 1, to avoid an asserted wrong derivation case for the value of the variable NumSubLayersInLayerInOLS. Don't derive the NumSubLayersInLayerInOLS[] and layerIncludedInOlsFlag[][] values, when vps\_all\_independent\_layers\_flag is equal to 1. The editor is asked to confirm this and remove the derivation if confirmed editorially undesirable. | JVET-R0119 |
|  | cleanup | Signal max\_tid\_il\_ref\_pics\_plus1 value separately for each direct reference layer of a layer, i.e. max\_tid\_il\_ref\_pics\_plus1[ i ][ j ] for each direct reference layer j less than i, instead of single max\_tid\_il\_ref\_pics\_plus1[ i ] as currently. | JVET-R0193 |
|  | editorial text bug | Fix an asserted bug for semantics of max\_tid\_il\_ref\_pics\_plus1[ i ] for special value 0. Additionally define the semantics for special value 0 to include GDR pictures with recovery\_poc\_cnt equal to 0. | JVET-R0107 proposal 3, JVET-R0296 aspect 1 |
|  | editorial text bug | Modify the sub-bitstream extraction process to account for GDR pictures with recovery\_poc\_cnt equal to 0. | JVET-R0107 Proposal 3 |
|  | bug fix | Fix an asserted bug in the derivation of NumSubLayersInLayerInOLS by separating the cases for each\_layer\_is\_an\_ols\_flag is equal to 1 and ols\_mode\_idc is equal to 0. | JVET-R0296 aspect2 |
|  | bug fix for existing intent | For the AUD, the value of nuh\_layer\_id should not be constrained (as with DCI, VPS and EOB). | JVET-R0158 |
|  | bug fix for existing intent | Infer vps\_max\_sublayers\_minus1 to be equal to 6 when sps\_video\_parameter\_set\_id is equal to 0 (i.e. VPS is not present). The exact editorial expression is at the discretion of the editor. | JVET-R0222 aspect 1 |
| **Reference picture resampling** |  |  |  |
|  | cleanup | Allow signalling of negative scaling window offsets. | JVET-R0114 |



# Project planning

## Core experiment planning

No CEs planned at this meeting.

## 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:

* VTM8.0 will be released by 2020-02-17 including all adoptions necessary for CTC. VTM8.1 with non-CTC adoptions will be released 2020-03-16. 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.
* 360lib software is to be revised for the modified generalized cubemap, which was requested by 2019-02-28
* No change of HDRTools software 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)).

+Meeting plans for ad hocs

|  |  |  |
| --- | --- | --- |
| **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 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-R2001 VVC text specification draft 9 and JVET-R2007 SEI text draft 4. * Produce and finalize JVET-R2002 VVC Test Model 9 (VTM 9) 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))   * Produce the draft verification test plan JVET-R2009 and develop proposed improvements for verification testing of VVC capability. * 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. * Coordinate with AHG11 on test material for screen content coding. | V. Baroncini, T. Suzuki, M. Wien (co-chairs), A. Norkin, A. Segall, Y. Ye (vice-chairs) | Tel.  2020-05-14/15 on SDR  2020-05-27 on 360°  TBD on HDR  2 weeks notice |
| **Conformance testing (AHG5)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Produce the JVET-R2008 draft conformance testing specification and develop proposed improvements. * 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, X. Xu (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-Q1012. * Generate CTC anchors and PERP results for the VTM according to JVET-Q1012 within two weeks of availability of SDR CTC anchors. * Coordinate with AHG4 in preparation for verification testing for 360° video content. * 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. * Coordinate with AHG4 in preparation for verification testing for HDR video content. * 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. * Coordinate with AHG2 and AHG3 for text drafting and software development for the layered coding and resolution adaptivity aspects of the VVC design. * Study and develop improvements of the JVET-Q2015 functionality testing condition description. * 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) | Tel. (Cat.1) 3 weeks notice |
| **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 P. Wu (vice-chairs) | Tel. (Cat.1) 3 weeks notice |
| **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 (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. * Coordinate with AHG2 and AHG3 for text drafting and software development for the high-level parallelism and coded picture regions aspects of the VVC design. * 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, B. Wang, Y.-K. Wang (vice-chairs) | Tel. (Cat.1) 3 weeks notice |
| **Tool reporting procedure and testing (AHG13)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Prepare output document JVET-R2005, 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. * Produce, study and develop improvements of the JVET-R2013 testing condition description for non-4:2:0 colour format coding. * Provide configurations files, bitstreams, and results of tool-on/tool-off testing. * Develop and collect test results for additional testing of VVC capabilities. * 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), 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))   * Produce, study and develop improvements of the JVET-Q2014 testing condition description. * 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. * 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-adaptive 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 |
| **SEI message studies (AHG17)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study the SEI messages in current draft texts. * Collect software and SEI showcase information for SEI messages, including encoder and decoder implementations and bitstreams for demonstration and testing. * Identify potential needs for addition SEI message. * Study SEI messages defined in HEVC and AVC for potential use in the VVC context. | S. McCarthy (chair), J. Boyce, P. de Lagrange, A. Luthra, A. Tourapis, Y.-K. Wang, S. Wenger (vice-chairs) | N |

# Output documents

The following documents were agreed to be produced or endorsed as outputs of the meeting. Names recorded below indicate the editors responsible for the document production. Where applicable, dates of planned finalization and corresponding parent-body document numbers are also noted.

It was reminded that in cases where the JVET document is also made available as MPEG output document, a separate version under the MPEG document header should be generated. This version should be sent to GJS and JRO for upload.

[Replace 12 June with 5 June]

[JVET-R2000](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9674) Meeting Report of the 18th JVET Meeting [G. J. Sullivan, J.-R. Ohm] (2020-06-12, near next meeting)

Initial versions of the meeting notes (d0 … dB) were made available on a daily basis during the meeting.

[JVET-R2001](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9675) Versatile Video Coding (Draft 9) [B. Bross, J. Chen, S. Liu, Y.-K. Wang] [WG 11 N 19194] (2020-06-12)

(Initial version planned to be made available by 2020-05-01.)

Draft DoCR N 19203.

See the list of elements under section 11.7, [revisit to check].

[JVET-R2002](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9676) Algorithm description for Versatile Video Coding and Test Model 9 (VTM 9) [J. Chen, Y. Ye, S. Kim] [WG 11 N 19195] (2019-06-12)

(Initial version planned to be made available by 2020-05-22.)

Request for ISO/IEC 23090-16 reference software specification in WG 11 N 19202.

Software release of the 9.0 version was expected by 2020-05-15.

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-Q2004](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9677) Algorithm descriptions of projection format conversion and video quality metrics in 360Lib (Version 10) [Y. Ye, J. Boyce] (2020-02-28)

[JVET-R2005](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9678) Methodology and reporting template for coding tool testing [W.-J. Chien and J. Boyce] (2020-05-15)

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-R2007](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9679) Supplemental enhancement information messages for coded video bitstreams (Draft 4) [J. Boyce, V. Drugeon, G. J. Sullivan, Y.-K. Wang] [WG 11 N 19196] (2020-05-29)

DoCR WG 11 N 19204.

See the list of elements under section 11.8 [revisit to check].

[JVET-R2008](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9680) Conformance testing for versatile video coding (Draft 3) [J. Boyce, E. Alshina, F. Bossen, K. Kawamura, I. Moccagatta, W. Wan] [WG 11 N 19199] (2020-05-29)

Request for ISO/IEC 23090-15 in WG 11 N 19201.

Bitstream were requested to be provided by two weeks after the release of the VTM 9.0 software.

[JVET-R2009](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9681) Draft plan for VVC verification testing (Draft 2) [M. Wien, V. Baroncini, A. Segall, Y. Ye] [WG 11 N 19200] (2020-05-01)

See notes in section 4.4.

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)

Remains valid – not updated: [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)

Remains valid – not updated: [JVET-L1012](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=4840) JVET common test conditions and evaluation procedures for 360° video [P. Hanhart, J. Boyce, K. Choi, J.-L. Lin] (2018-10-26)

[JVET-R2013](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9682) JVET common test conditions and software reference configurations for non-4:2:0 colour formats [Y.-H. Chao, Y.-C. Sun, J. Xu, X. Xu] (2020-05-15)

Issuing an update was confirmed to be needed to reflect the disabling of dual tree for RGB content. (See the notes for R0468: “Change the conf setting for RGB coding of camera-captured content, single tree in I slices as suggested in JVET-R0468.” – single tree has already been used for computer-generated content) It was also agreed to avoid including the config files in the document.

Remains valid – not updated: [JVET-Q2014](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9683) JVET common test conditions and software reference configurations for lossless, near lossless, and mixed lossy/lossless coding [T.-C. Ma, A. Nalci, T. Nguyen] (2020-03-02)

Remains valid – not updated: [JVET-Q2015](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9684) JVET functionality confirmation test conditions for reference picture resampling [J. Luo, V. Seregin] (2020-03-02)

[JVET-R2016](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9673) Summary information on BD-rate experiment evaluation practices [K. Andersson, F. Bossen, J.-R. Ohm, A. Segall, R. Sjöberg, J. Ström, G. J. Sullivan, A. Tourapis] (2020-05-15)

Minor refinements of the description.

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

Future meeting plans were established according to the following guidelines:

* Meeting under ITU-T SG 16 auspices when it meets (ordinarily starting meetings on the Tuesday of the first week and closing it on the Wednesday of the second week of the SG 16 meeting – a total of 9 meeting days), and
* Otherwise meeting under ISO/IEC JTC 1/SC 29/WG 11 auspices when it meets (ordinarily starting meetings on the Wednesday prior to such meetings and closing it at lunchtime on the last day of the WG 11 meeting – a total of 9.5 meeting days).

In cases where an exceptionally high workload is expected for a meeting, an earlier starting date may be defined.

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

* Mon. 22 June – Wed. 1 July 2020, 19th meeting under ITU-T auspices conducted by teleconference.
* 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.
* Tue. 20 – Wed. 28 April 2021, 22nd meeting under ITU-T auspices in Geneva, CH.

The agreed document deadline for the 19th JVET meeting was planned to be Wednesday 10 June 2020 [early].

Vittorio Baroncini, Andrew Segall, Mathias Wien, and Yan Ye were thanked for their efforts in further developing the VVC verification test plan and procedure, and the experts who encoded bitstreams for this purpose were also thanked.

Kenzler Conference Management was thanked for its advance arrangements and management of the unfortunate interruption of these arrangements under the exceptional circumstances of the current meeting.

The 18h JVET meeting was closed at approximately 1730 hours UTC on Friday 24 April 2020.

# Annex A to JVET report: List of documents

# Annex B to JVET report: List of meeting participants

The participants of the eighteenth meeting of the JVET, according to an attendance sheet circulated during the meeting sessions (approximately 298 people in total), were as follows:

1. Kiyofumi Abe (Panasonic)
2. Yongjo Ahn (Digital Insights)
3. Elena Alshina (Huawei)
4. Alireza Aminlou (Nokia-FI)
5. Hadi Amirpour (ITEC)
6. Kenneth Andersson (Ericsson)
7. Ichiro Ando (Nikon)
8. Jeeva Raj Arumugam (Ittiam)
9. Hamid Azadegan (IRIB)
10. Tae Meon Bae (Ofinno)
11. Gun Bang (ETRI)
12. Vittorio Baroncini (VABTECH)
13. Philippe Bordes (InterDigital)
14. Frank Bossen (Sharp)
15. Jill Boyce (Intel)
16. Benjamin Bross (Fraunhofer HHI)
17. Adrian Browne (Sony)
18. Angelo Bruccoleri (RAI)
19. Hung CaoVan (Renesas)
20. Chi Chai (Ubilinx )
21. Eric Chai (Ubilinx)
22. Yao-Jen Chang (Qualcomm)
23. Yung-Hsuan (Jessie) Chao (Qualcomm)
24. Ching-Yeh Chen (MediaTek)
25. Chun-Chi Chen (Qualcomm)
26. Huanbang Chen (Huawei)
27. Jianle Chen (Qualcomm)
28. Jie Chen (Alibaba)
29. Lien-Fei Chen (Tencent)
30. Lulin Chen (MediaTek)
31. Peisong Chen (Broadcom)
32. Wei Chen (Kwai)
33. Ya Chen (InterDigital)
34. Yi-Wen Chen (Kwai)
35. Roman Chernyak (Huawei)
36. Man-Shu Chiang (MediaTek)
37. Wei-Jung Chien (Qualcomm)
38. Chih Yao Chiu (MediaTek)
39. Colin Chiu (MediaTek)
40. Yi-Jen Chiu (Intel)
41. Byeongdoo Choi (Tencent)
42. Jangwon Choi (LGE)
43. Jungah Choi (LGE)
44. Kiho Choi (Samsung)
45. Tzu-Der (Peter) Chuang (MediaTek)
46. Olena Chubach (MediaTek Inc.)
47. Takeshi Chujoh (Sharp)
48. Muhammed Coban (Qualcomm)
49. Wei Dai (Agora)
50. Mitra Damghanian (Ericsson)
51. Philippe de Lagrange (InterDigital)
52. Santiago De Luxán Hernández (Fraunhofer HHI)
53. Zhipin Deng (Bytedance)
54. Franck Denoual (Canon)
55. Sachin Deshpande (Sharp)
56. Jihoon Do (ETRI)
57. Virginie Drugeon (Panasonic)
58. Yixin Du (Tencent)
59. Fanyi Duanmu (Apple)
60. Xavier Ducloux (Harmonic)
61. Alberto Duenas (Facebook)
62. Hilmi E. Egilmez (Qualcomm)
63. Jack Enhorn (Ericsson)
64. Semih Esenlik (Huawei)
65. Alexey Filippov (Huawei)
66. Chad Fogg (MovieLabs)
67. Remy Foray (Allegro DVT)
68. Edouard Francois (InterDigital)
69. Per Fröjdh (Ericsson)
70. Franck Galpin (InterDigital)
71. Jonathan Gan (Canon)
72. Han Gao (Huawei)
73. Patrick Garus (Orange)
74. Diego Gibellino (Telecom Italia)
75. Dan Grois (Comcast)
76. Srinivas Gudumasu (InterDigital)
77. Thomas Guionnet (ATEME)
78. Wassim Hamidouche (IETR/INSA)
79. Miska Hannuksela (Nokia)
80. Mahmoud Hashemi (University of Tehran)
81. Ryoji Hashimoto (Renesas)
82. Yong He (Qualcomm)
83. Christian Helmrich (Fraunhofer HHI)
84. Hendry (LGE)
85. Jin Heo (LGE)
86. Sebastien Herbreteau (Ateme)
87. Christian Herglotz (FAU Erlangen-Nürnberg)
88. Mitsuhiro Hirabayashi (Sony)
89. Christopher Hollmann (Ericsson)
90. Seungwook Hong (Nokia)
91. Shih-Ta Hsiang (MediaTek)
92. Ted Hsieh (Qualcomm)
93. Chih-Wei Hsu (MediaTek)
94. Nan Hu (Qualcomm)
95. Cheng Huang (ZTE)
96. Han Huang (Qualcomm)
97. Yu-Wen Huang (MediaTek)
98. Junyan Huo (Xidian Univ.)
99. Walt Husak (Dolby)
100. Roberto Iacoviello (RAI)
101. Atsuro Ichigaya (NHK)
102. Tomohiro Ikai (Sharp)
103. Masaru Ikeda (Sony)
104. Sergey Ikonin (Huawei)
105. Shunsuke Iwamura (NHK)
106. Hyeongmun Jang (LGE)
107. Byeungwoo Jeon (SKKU)
108. Hong-Jheng Jhu (Kwai)
109. Jaehong Jung (WILUS)
110. Zhang Kai (Bytedance)
111. Je-Won Kang (Ewha W. University)
112. Jungwon Kang (ETRI)
113. Alexander Karabutov (Huawei)
114. Marta Karczewicz (Qualcomm)
115. Mitsuru Katsumata (Sony)
116. Kei Kawamura (KDDI)
117. Steve Keating (Sony)
118. Michel Kerdranvat (InterDigital)
119. Louie Kerofsky (Qualcomm)
120. DaeYeon Kim (Chips&Media)
121. Dong-Cheol Kim (WILUS)
122. Hyun-Gyu Kim (Chips&Media)
123. Jaeil Kim (SK Telecom)
124. Seung-Hwan Kim (LGE)
125. Heiner Kirchhoffer (Fraunhofer HHI)
126. Kenji Kondo (Sony)
127. Konstantinos Konstantinides (Dolby)
128. Moonmo Koo (LGE)
129. Anand Meher Kotra (Huawei)
130. Matthias Kränzler (FAU Erlangen)
131. Gosala Kulupana (BBC)
132. Ankit Kumar (Chosun Uni.)
133. Daniel Kuo (Foxconn)
134. Joohyeng Kwangwoon (University)
135. Chen-Yen Lai (MediaTek)
136. Jani Lainema (Nokia)
137. Guillaume Laroche (Canon)
138. Fabrice Le Léannec (InterDigital)
139. Bae-Keun Lee (Xris)
140. Brian Lee (Dolby)
141. Jongseok Lee (Digital Insights)
142. Ju Ock Lee (Chips&Media)
143. Ya-Hsuan Lee (MediaTek)
144. Ryan Lei (Intel)
145. Shawmin Lei (MediaTek)
146. Claire Li (Tencent)
147. Guichun Li (Tencent)
148. Jingya Li (Panasonic)
149. Ling Li (Tencent)
150. Ming Li (OPPO)
151. Tsung-Hua Li (Foxconn)
152. Xiang Li (Tencent)
153. Ru-Ling Liao (Alibaba)
154. Chong Soon Lim (Panasonic)
155. Jaehyun Lim (LGE)
156. Sungwon Lim (KT)
157. Woong Lim (ETRI)
158. Ching-Chieh Lin (ITRI)
159. Lukasz Litwic (Ericsson)
160. Du Liu (Ericsson)
161. Shan Liu (Tencent)
162. Jiancong Luo (Alibaba)
163. Ajay Luthra (Picsel Labs)
164. Tsung-chuan Ma (Kwai)
165. Xiang Ma (Huawei)
166. Yanzhuo Ma (Xidian Univ.)
167. Frédéric Mazé (Canon)
168. Sean McCarthy (Dolby)
169. Dominik Mehlem (RWTH)
170. Xuewei Meng (Peking University)
171. Marta Milovanovic (Orange)
172. Akira Minezawa (Mitsubishi Electric)
173. Koohyar Minoo (N/A)
174. Kiran Misra (Sharp)
175. Iole Moccagatta (Intel)
176. Kaito Mori (Renesas)
177. Alican Nalci (Qualcomm)
178. Junghak Nam (LGE)
179. Karam Naser (InterDigital)
180. Shimpei Nemoto (NHK)
181. Tung Nguyen (Fraunhofer Fraunhofer HHI)
182. Didier Nicholson (EKTACOM)
183. Yu-Chieh Nien (Foxconn)
184. Andrey Norkin (Netflix)
185. Jens-Rainer Ohm (RWTH)
186. Patrice Onno (Canon)
187. Nael Ouedraogo (Canon)
188. Seethal Paluri (LGE)
189. Krit Panusopone (Nokia)
190. Min Woo Park (Samsung)
191. Minsoo Park (Samsung)
192. Naeri Park (LGE)
193. Martin Pettersson (Ericsson)
194. Jonathan Pfaff (Fraunhofer HHI)
195. Luong Pham Van (Qualcomm)
196. Yinji Piao (Samsung)
197. Tangi Poirier (InterDigital)
198. Shailesh Ramamurthy (Ittiam)
199. Adarsh Krishnan Ramasubramonian (Qualcomm)
200. Krishna Rapaka (Apple)
201. Bappaditya Ray (Qualcomm)
202. Kevin Reuzé (Qualcomm)
203. Justin Ridge (Nokia)
204. Antoine Robert (InterDigital)
205. Christian Rohlfing (RWTH)
206. Hoda Roodaki (KNTU)
207. Chris Rosewarne (Canon)
208. Vasily Rufitskiy (Huawei)
209. Dmytro Rusanovskyy (Qualcomm)
210. Mehdi Salehifar (LGE)
211. Jonatan Samuelsson (Sharp)
212. Yago Sanchez (Fraunhofer HHI)
213. Mohammed Sarwer (Alibaba)
214. Eiichi Sasaki (Sharp)
215. Johannes Sauer (RWTH)
216. Thomas Schierl (Fraunhofer HHI)
217. Heiko Schwarz (Fraunhofer HHI)
218. Andrew Segall (Sharp)
219. Vadim Seregin (Qualcomm)
220. Zafar Shahid (Facebook)
221. Masato Shima (Canon)
222. Jay Shingala (Ittiam)
223. Rickard Sjöberg (Ericsson)
224. Robert Skupin (Fraunhofer HHI)
225. Timofey Solovyev (Huawei)
226. Ju-Hyung Son (WILUS)
227. Kashyap Kammachi Sreedhar (Nokia)
228. Alan Stein (InterDigital)
229. Jacob Ström (Ericsson)
230. Karsten Suehring (Fraunhofer HHI)
231. Shiori Sugimoto (NTT)
232. Gary Sullivan (Microsoft)
233. Teruhiko Suzuki (Sony)
234. Yasser Syed (Comcast)
235. Chih-Yu Teng (Foxconn)
236. Han Boon Teo (Panasonic)
237. Andy Tescher (Microsoft)
238. Herbert Thoma (Fraunhofer IIS)
239. Emmanuel Thomas (TNO)
240. Dong Tianyu (Hanyang Univ.)
241. Tadamasa Toma (Panasonic)
242. Alexandros Tourapis (Apple)
243. Chia-Ming Tsai (MediaTek)
244. Chia-Yang Tsai (Facebook)
245. Yiting Tsai (ITRI)
246. Takeshi Tsukuba (Sony)
247. Kyohei Unno (KDDI)
248. Geert Van der Auwera (Qualcomm)
249. Mikael von Strauss (Ericsson)
250. Shuai Wan (NPU)
251. Wade Wan (Broadcom)
252. Biao Wang (Huawei)
253. Dong Wang (OPPO)
254. Fan Wang (OPPO)
255. Hongtao Wang (Qualcomm)
256. Limin Wang (Nokia)
257. Mingze Wang (NPU Univ.)
258. Sheng-Po Wang (ITRI)
259. Xianglin Wang (Kwai)
260. Yang Wang (Bytedance)
261. Ye-Kui Wang (Bytedance)
262. Yijun Wang (Unknown)
263. Stephan Wenger (Tencent)
264. Adam Wieckowski (Fraunhofer HHI)
265. Mathias Wien (RWTH)
266. Samuel Wong (Intel)
267. Ping Wu (ZTE)
268. Zhao Wu (ZTE)
269. Zhihuang Xie (OPPO)
270. Xiaoyu Xiu (Kwai)
271. Jizheng Xu (Bytedance)
272. Lidong Xu (Intel)
273. Xiaozhong Xu (Tencent)
274. Yoichi Yagasaki (Sony)
275. Yong Yan (Polycom)
276. Haitao Yang (Huawei)
277. Yu-Chiao Yang (Foxconn)
278. Yan Ye (Alibaba)
279. Peng Yin (Dolby)
280. Sunmi Yoo (LGE)
281. Yong-Uk Yoon (KAU)
282. Haoping Yu (PengCheng Lab)
283. Ruoyang Yu (Ericsson)
284. Alireza Zare (Nokia)
285. Bruno Zatt (UFPEL)
286. Weimin Zeng (Ubilinx)
287. Hongbin Zhang (Tencent)
288. Kai Zhang (Bytedance)
289. Li Zhang (Bytedance)
290. Qian Zhang (BOE Technology Group)
291. Wenhao Zhang (Hulu)
292. Zhi Zhang (Ericsson)
293. Jane Zhao (LGE)
294. Liang Zhao (Tencent)
295. Xin Zhao (Tencent)
296. Xiaozhen Zheng (DJI)
297. Minhua Zhou (Broadcom)
298. Tianyang Zhou (Sharp)