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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**  19th Meeting, by teleconference, 22 June – 1 July 2020 | Document: JVET-S\_Notes\_d4 |

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| *Title:* | **Meeting Report of the 19th Meeting of the Joint Video Experts Team (JVET), by teleconference, 22 June – 1 July 2020** | | |
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| *Purpose:* | Report | | |
| *Author(s) or Contact(s):* | **Gary Sullivan** Microsoft Corp. 1 Microsoft Way Redmond, WA 98052 USA  **Jens-Rainer Ohm** Institute of Communication Engineering RWTH Aachen Melatener Straße 23 D-52074 Aachen | Tel: Email:  Tel: Email: | +1 425 703 5308 [garysull@microsoft.com](mailto:garysull@microsoft.com)  +49 241 80 27671 [ohm@ient.rwth-aachen.de](mailto:ohm@ient.rwth-aachen.de) |
| *Source:* | Chairs of JVET | | |

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# Summary

The Joint Video Experts Team (JVET) of ITU-T WP3/16 and ISO/IEC JTC 1/ SC 29/ WG 11 held its nineteenth meeting during 22 June – 1 July 2020 as an online-only meeting. It had previously been planned to be held in Geneva, Switzerland, at the ITU premises. The conversion of the meeting to be conducted only online was necessitated due to issues associated with the 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 1300 hours UTC on Monday 22 June 2020. Meeting sessions were held on all days (including weekend days) until the meeting was closed at approximately XXXX hours UTC on Wednesday 1 July 2020. Approximately XXX people attended the JVET meeting, and approximately XXX input documents (not counting crosschecks), and 17 AHG reports were discussed. The meeting took place in a collocated fashion with a meeting of SG16 – one of the two parent bodies of the JVET. The subject matter of the JVET meeting activities consisted of developing video coding technology with a compression capability that significantly exceeds that of the current HEVC standard, or otherwise gives better support regarding the requirements of future application domains of video coding. As a primary goal, the JVET meeting reviewed the work that was performed in the interim period since the eighteenth JVET meeting in producing an ninth draft of the VVC standard and the ninth 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.

The JVET produced 8 output documents from the meeting (update):

* JVET-R2001 Versatile Video Coding specification text (Draft 9)
* JVET-R2002 Algorithm description for Versatile Video Coding and Test Model 9 (VTM 9)
* JVET-R2005 Methodology and reporting template for coding tool testing
* JVET-R2007 Supplemental enhancement information messages for coded video bitstreams (Draft 4)
* JVET-R2008 Conformance testing for versatile video coding (Draft 3)
* JVET-R2009 Draft plan for VVC verification testing (Draft 2)
* JVET-R2013 JVET common test conditions and software reference configurations for non-4:2:0 colour formats
* JVET-R2016 Summary information on BD-rate experiment evaluation practices.

For the organization and planning of its future work, the JVET established XX “ad hoc groups” (AHGs) to progress the work on particular subject areas. At this meeting, no Core Experiments (CE) were defined. The next four JVET meetings were planned for 7–16 October 2020 under WG 11 auspices in Rennes, FR (note this is likely to again be converted to a teleconference-based meeting in response to the COVID-19 pandemic), during 6–15 January 2021 under WG 11 auspices in Capetown, ZA, during 20–28 April 2021 under ITU-T SG16 auspices in Geneva, CH, and during XX–XX July 2021 under WG 11 auspices in Prague, CZ.

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 nineteenth meeting during 22 June – 1 July 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_06_S_Virtual/>.

## Primary goals

As a primary goal, the JVET meeting reviewed the work that was performed in the interim period since the eighteenth JVET meeting in producing a ninth draft of the VVC standard and the ninth 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, 10 June 2020. Any documents uploaded after 1159 hours Paris/Geneva time on Thursday 11 June 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.

In the interim period and prior to the regular JVET meeting, a series of AHG meetings were held during 27-28 May and during 19-21 June for HLS topics (AHG8/AHG9/AHG12). An earlier upload deadline of 22 May 2020 had been announced for documents to be discussed during the May 2020 AHG meeting days. Results of these meetings can be found in documents JVET-S0137 (27-28 May) and JVET-S0237 (19-21 June), which were later pasted into this main meeting report, being refined during further review, and AHG recommendations approved accordingly. AHG4 also conducted meetings for preparation of verification tests.

All contribution documents with registration numbers higher than JVET-S0238 were registered after the “officially late” deadline (and therefore were also uploaded late). Likewise, AHG 27-28 May meeting related proposal documents with registration numbers higher than JVET-S0136 were to be considered late, and due to lack of time, many of them could only be considered during the 19-21 June AHG meeting or durng 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-S0XXX (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-S0XXX (a document on …), uploaded XX-XX.
* …

Almost all cross-verification reports at this meeting were registered late, and even those registered before the deadline were all 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-S0XXX, ...

“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-S0XXX, … .

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

* JVET-S0XXX (…)
* …

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 and HLS topic 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-R2000, the Versatile Video Coding specification text (Draft 9) JVET-R2001, the Algorithm description for Versatile Video Coding and Test Model 9 (VTM 9) JVET-R2002, the Methodology and reporting template for coding tool testing JVET-R2005, the Supplemental enhancement information messages for coded video bitstreams (Draft 4) JVET-R2007, the Conformance testing for VVC (Draft 3) JVET-R2008, the Draft plan for VVC verification testing (Draft 2) JVET-R2009, the JVET common test conditions and software reference configurations for non-4:2:0 colour formats JVET-R2013, and the Summary information on BD-rate experiment evaluation practices JVET-R2016, had been completed and were approved. The software implementation of VTM (versions 9.0 and 9.1) 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

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

* 1300-1500 1st “afternoon” session [break after 2 hours]
* 1520-1720 2nd “afternoon” session
* [“dinner” break – nearly 2 hours]
* 1900-2100 1st “evening” session [break after 2 hours]
* 2120-2320 2nd “evening” 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 1251.

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.
* **CCALF**: Cross-component ALF.
* **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 Monday 22 June at 1300 UTC (chaired by GJS and JRO) were as follows.

* 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
  + Text with all agreements recorded: Wed July 1
  + DoCRs: Wed July 1
  + Consent in ITU-T & FDIS ballot requested: Friday July 3
  + Text submitted for ITU-T Last Call July 29
  + Text submitted for FDIS ballot Sept. 16
  + ITU-T prepublication expected Oct/Nov; publication Dec.
* 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.
* AHG pre-meetings
  + Notes of the AHG pre-meetings were available
  + JVET-S0152-v6 was available with edited results of the May interim meetings of AHGs 8, 9, 12.
  + Recommendations of the AHG interim and pre-meetings, as reflected in JVET-S0237, were considered JVET-approved decisions unless otherwise noted.
  + Moving forward based on these was agreed in the opening plenary.
* There was somewhat less of a problem of late non-cross-check documents and no “placeholders” – (see section 2.4.2).
* The primary goals of the meeting were to complete the preparation of the VVC and associated SEI message specification for Consent in ITU-T and FDIS in ISO/IEC at the current meeting.
* Due to the high number of input contributions, parallelization and/or breakout work may be used at the meeting.
* Verification test planning
* Scheduling was discussed
* 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; 7 hours ahead of the time in Los Angeles, etc.). No session should last longer than 2 hrs.

* 1300-1500 1st “afternoon” session [break after 2 hours]
* 1520-1720 2nd “afternoon” session
* [“dinner” break – nearly 2 hours]
* 1900-2100 1st “evening” session [break after 2 hours]
* 2120-2320 2nd “evening” 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:

* Mon. 22 June, 1st day
  + 1300–1330 Opening remarks, review of practices, agenda, IPR reminder
  + 1330–XXXX Reports of AHGs XX
  + …
* AHG report reviews were completed at end of second session (1720 Monday 22 June)

## 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 (0)
  + Text and software development (1)
  + Test conditions (2)
  + Verification test planning (8)
  + Coding studies and tools on specific use cases (0)
  + Test Material (1)
  + Conformance (0)
  + Implementation studies (1)
  + Profile/level specification (2)
* Low-level tool technology proposals (13) (section 5) (Track B)
* High-level syntax (HLS) proposals (section 6) with subtopics (Track A)
  + AHG9: General high-level syntax (105+74) (section 6.1)
  + AHG12: High-level parallelism and coded picture regions (7+5) (section 6.2)
  + AHG8: Layered coding and resolution adaptation (8+5) (section 6.3)
* Complexity analysis (0) (section 7) (Track B)
* Encoder optimization (0) (section 8) (Track B)
* Metrics and evaluation criteria (0) (section 9) (Track B)
* Withdrawn (1) (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 (XXX) was generally chaired by GJS and Track B (XXX) by JRO.

# AHG reports (17)

These reports were discussed Monday 22 June 2020 during 1330-1500 and … UTC (chaired by GJS & JRO), except as otherwise noted.

The general status of HLS AHGs (see S0137 and S0237) and AHG4 on verification test planning (see section 4.4) was also reviewed.

[JVET-S0001](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10368) 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 number of subscribers (by the beginning of the current meeting) was 1251.

The work of the JVET overall had proceeded well in the interim period with a moderate 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.int-evry.fr/jvet/>) or the ITU-based JVET site ([http://wftp3.itu.int/av-arch/jvet-site/2020\_04\_ R\_Alpbach/](http://wftp3.itu.int/av-arch/jvet-site/2020_04_%20R_Alpbach/)), particularly including the following:

The meeting report (JVET-R2000) [Posted 2020-06-22]

Versatile Video Coding (Draft 9) (JVET-R2001) [Posted 2020-04-26, last update 2020-06-20]

Algorithm description for Versatile Video Coding and Test Model 9 (VTM 9) (JVET-R2002) [Posted 2020-06-12, last update 2020-06-15]

Methodology and reporting template for coding tool testing (JVET-R2005) [Posted 2020-05-16]

Supplemental enhancement information messages for coded video bitstreams (Draft 4) (JVET-R2007) [Posted 2020-05-03, last update 2020-05-06]

Conformance testing for Versatile Video Coding (Draft 3) (JVET-R2008) [Posted 2020-06-09, last update 2020-06-12]

Draft plan for VVC verification testing (Draft 2) (JVET-R2009) [Posted 2020-05-02]

JVET common test conditions and software reference configurations for non-4:2:0 colour formats (JVET-R2013) [Posted 2020-05-16]

Summary information on BD-rate experiment evaluation practices (JVET-R2016) [Posted 2020-05-17]

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

Due to issues associated with the COVID-19 pandemic, a conversion of the meeting to be conducted only online was necessitated Prior to the regular JVET meeting, a series of AHG meetings were held during 27-28 May and during 19-21 June for HLS topics (AHG8/AHG9/AHG12). An earlier upload deadline of 22 May 2020 had been announced for documents to be discussed during the May 2020 AHG meeting days. Results of these meetings can be found in documents JVET-S0137 (27-28 May) and JVET-S0237 (19-21 June). Software integration of VTM was finalized approximately according to the plan. Significant activities were also conducted on preparation of verification tests, and on development of VVC conformance testing.

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 200 input contributions to the current meeting (not counting the AHG summary reports and crosschecks) had been registered for consideration at the meeting, or at the AHG meetings in the interim period. The bulk of these documents were submitted on aspects of high-level syntax, whereas only few submissions on low-level coding tools were made. No CEs had been conducted.

A preliminary basis for the document subject allocation and meeting notes for the 19th meeting had been made publicly available on the ITU-hosted ftp site <http://wftp3.itu.int/av-arch/jvet-site/2020_06_S_Virtual/>.

[JVET-S0002](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10369) JVET AHG report: Draft text and test model algorithm description editing (AHG2) [B. Bross, J. Chen, J. Boyce, S. Kim, S. Liu, Y.-K. Wang, Y. Ye]

This document reports the work of the JVET ad hoc group on draft text and test model algorithm description editing (AHG2) between the 18th meeting by teleconference, (15 – 24 April 2020) and the 19th meeting by teleconference, (22 June – 1 July 2020).

An ad hoc group meeting of the HLS AHG was held by teleconference in May 2020. Integrated specification text for the May 2020 HLS AHG meeting recommendations was produced and can be found in JVET-S0152.

At the 18th JVET meeting, it was decided to simplify, clean up and fix the existing features for intra picture-prediction, inter-picture prediction, transform, CABAC engine, in-loop filter, and high-level syntax functionalities in the ninth draft of Versatile Video Coding (VVC D9) and the VVC Test Model 9 (VTM9) encoding.

The normative decoding process for Versatile Video Coding is specified in the VVC draft 8 text specification document. The VVC Test Model 8 (VTM 8) Algorithm and Encoder Description document provides an algorithm description as well as an encoder-side description of the VVC Test Model 8, which serves as a tutorial for the algorithm and encoding model implemented in the VTM8.x software.

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

Fourteen versions of the VVC draft text JVET-R2001 were published by the Editing AHG between the 18th meeting by teleconference, (15 – 24 April 2020) and the 19th meeting by teleconference, (22 June – 1 July 2020).

Two versions of the VVC Test Model (VTM) JVET-R2002 were published by the Editing AHG between the 18th meeting by teleconference, (15 – 24 April 2020) and the 19th meeting by teleconference, (22 June – 1 July 2020).

JVET-R2002 has been established based on JVET-Q2002. It provides the algorithm description for majority of coding tools in VVC. In this editing period, the description of Profiles, Levels and Tiers was included.

Related contributions were noted as

* Y.-K. Wang, “AHG2: Editorial input of a text integration for the May 2020 HLS AHG meeting outcome,” document JVET-S0152, 19th JVET meeting: by teleconference, 22 June – 1 July 2020.
* M. Sarwer, Y. Ye, “AHG2: On residual coding syntax,” document JVET-S0215, 19th JVET meeting: by teleconference, 22 June – 1 July 2020.

The AHG recommends to:

* Approve the edited JVET-R2001 and JVET-R2002 documents as JVET outputs,
* Continue to edit the VVC draft and Test Model documents to ensure that all agreed elements of VVC are fully described,
* Compare the VVC documents with the VVC software and resolve any discrepancies that may exist, in collaboration with the software AHG,
* Encourage the use of the issue tracker to report issues with the text of both the VVC specification draft and the algorithm and encoder description,
* Continue to improve the editorial consistency of VVC draft text and Test Model documents,
* Ensure that, when considering changes to VVC, properly drafted text for addition to the VVC Test Model and/or the VVC draft text is made available in a timely manner,
* Review the recommendations and fixes in JVET-S0152 and approve it as a basis for D10 (which was already done during opening remarks).
* Review AHG2 related contributions and act on them if found to be necessary.

It was asked whether we have addressed the VUI length issue (see section 2.12 of the report of the previous meeting).

Decision (cleanup): Add a length field in the VVC specification prior to the VUI. YKW was asked to prepare text for revisit review.

[JVET-S0003](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10370) 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 18th and 19th JVET meetings.

The software development continued on the GitLab server. VTM version 8.2 was tagged on Apr. 27 (just removing macros of the previous meeting cycle), VTM 9.0 on May 26. VTM 9.1 was tagged on Jun. 15. VTM 9.2 is expected during the 19th JVET meeting.

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

The server is located at:

<https://vcgit.hhi.fraunhofer.de>

The registration and development workflow is documented at:

<https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/wikis/VVC-Software-Development-Workflow>

The VTM software can be found at

<https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/>

The following tables show **VTM 9.0** performance over **HM 16.20**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra Main10** |  |  |
|  |  |  | **Over HM 16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | −29.10% | −32.37% | −34.36% | 1630% | 190% |
| Class A2 | −29.29% | −23.97% | −21.08% | 2626% | 199% |
| Class B | −21.74% | −26.92% | −30.75% | 2946% | 198% |
| Class C | −22.54% | −18.92% | −22.71% | 4046% | 202% |
| Class E | −25.78% | −26.10% | −24.52% | 2381% | 187% |
| **Overall** | −25.08% | −25.42% | −26.91% | 2712% | 196% |
| Class D | −18.44% | −13.25% | −13.25% | 4528% | 204% |
| Class F | −39.39% | −39.90% | −42.49% | 5346% | 192% |
|  |  |  |  |  |  |
|  |  |  | **Random access Main10** |  |  |
|  |  |  | **Over HM 16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | −38.74% | −37.19% | −44.34% | 884% | 186% |
| Class A2 | −43.13% | −39.74% | −38.35% | 999% | 199% |
| Class B | −34.74% | −46.77% | −44.61% | 935% | 189% |
| Class C | −29.90% | −30.58% | −32.56% | 1212% | 199% |
| Class E |  |  |  |  |  |
| **Overall** | −35.93% | −39.13% | −40.09% | 1004% | 193% |
| Class D | −27.64% | −26.48% | −26.11% | 1326% | 194% |
| Class F | −41.55% | −44.78% | −46.09% | 689% | 163% |
|  |  |  |  |  |  |
|  |  |  | **Low delay B Main10** |  |  |
|  |  |  | **Over HM 16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | −30.78% | −37.52% | −35.44% | 836% | 171% |
| Class C | −29.11% | −22.39% | −22.49% | 1006% | 183% |
| Class E | −33.10% | −39.76% | −34.51% | 420% | 147% |
| **Overall** | −30.80% | −33.03% | −30.89% | 749% | 168% |
| Class D | −25.98% | −16.62% | −16.00% | 1024% | 182% |
| Class F | −42.77% | −44.36% | −44.85% | 558% | 145% |
|  |  |  |  |  |  |
|  |  |  | **Low delay P Main10** |  |  |
|  |  |  | **Over HM 16.20** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | −35.12% | −40.02% | −37.82% | 751% | 174% |
| Class C | −30.84% | −22.48% | −22.76% | 898% | 191% |
| Class E | −35.79% | −43.00% | −37.53% | 402% | 155% |
| **Overall** | −33.86% | −34.92% | −32.73% | 682% | 174% |
| Class D | −27.43% | −15.80% | −15.13% | 916% | 184% |
| Class F | −42.33% | −43.52% | −43.97% | 581% | 151% |

The following tables show **VTM 9.0** performance compared to **VTM 8.1**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra Main10** |  |  |
|  |  |  | **Over VTM−8.1** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | −1.56% | 9.81% | 7.68% | 99% | 103% |
| Class A2 | −2.29% | 7.40% | 7.12% | 100% | 102% |
| Class B | −0.89% | 8.39% | 9.46% | 99% | 100% |
| Class C | −0.97% | 7.90% | 7.87% | 99% | 99% |
| Class E | −0.78% | 7.21% | 8.15% | 100% | 101% |
| **Overall** | −1.23% | 8.16% | 8.20% | 99% | 101% |
| Class D | −0.89% | 7.83% | 7.93% | 95% | 100% |
| Class F | −1.05% | 5.97% | 5.79% | 99% | 102% |
|  |  |  |  |  |  |
|  |  |  | **Random access Main10** |  |  |
|  |  |  | **Over VTM−8.1** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | −2.37% | 13.13% | 11.16% | 100% | 100% |
| Class A2 | −2.90% | 13.87% | 12.49% | 100% | 100% |
| Class B | −1.12% | 15.00% | 15.23% | 98% | 105% |
| Class C | −1.14% | 13.16% | 12.82% | 99% | 104% |
| Class E |  |  |  |  |  |
| **Overall** | −1.73% | 13.91% | 13.22% | 99% | 103% |
| Class D | −0.94% | 13.25% | 12.87% | 98% | 98% |
| Class F | −1.51% | 8.04% | 8.09% | 98% | 99% |
|  |  |  |  |  |  |
|  |  |  | **Low delay B Main10** |  |  |
|  |  |  | **Over VTM−8.1** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | −1.04% | 17.89% | 18.49% | 99% | 101% |
| Class C | −1.37% | 15.24% | 15.35% | 100% | 108% |
| Class E | −0.65% | 16.77% | 16.67% | 102% | 108% |
| **Overall** | −1.05% | 16.73% | 16.99% | 100% | 105% |
| Class D | −0.91% | 16.28% | 17.43% | 99% | 98% |
| Class F | −1.53% | 9.67% | 8.71% | 100% | 102% |
|  |  |  |  |  |  |
|  |  |  | **Low delay P Main10** |  |  |
|  |  |  | **Over VTM−8.1** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | −1.02% | 18.65% | 19.14% | 100% | 98% |
| Class C | −1.47% | 15.41% | 15.15% | 100% | 108% |
| Class E | −0.65% | 16.34% | 18.45% | 103% | 109% |
| **Overall** | −1.08% | 16.99% | 17.64% | 101% | 104% |
| Class D | −0.88% | 17.77% | 18.18% | 98% | 97% |
| Class F | −1.80% | 9.84% | 10.08% | 100% | 103% |

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

Several issues were encountered during software development:

* It was not always clear from the list of actions taken from the “R” meeting whether software changes are required for a given action. This made tracking of progress more difficult. It is suggested that, in the future, authors of documents listed for action inform software coordinators of cases where no software changes are required.
* Implementations should be tested on a wider range of configurations, e.g. the example configurations provided with the software. VTM 9.1 could not make significant progress with new implementations because multi-layer decoding was broken in 9.0, when bitstream constraint checks were only tested on single-layer bitstreams.

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

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

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

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

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

The AHG recommended to:

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

It was noted that software work needs to be completed ASAP to ensure there are no bugs in the design and make sure the work is followed up.

[JVET-S0004](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10371) JVET AHG report: Test material and visual assessment (AHG4) [V. Baroncini, T. Suzuki, M. Wien, A. Norkin, A. Segall, Y. Ye]

Dedicated AHG meeting were held on 2020-05-15 for SDR [JVET-S0041, JVET-S0043], on 2020-05-27 for 360° video [JVET-S0146, JVET-S0149], and on 2020-05-29 for HDR [JVET-S0151, JVET-S0153]. In the SDR category, a close-to-final definition of test sequences and selection of rate points for VTM and HM in the UHD Random Access test case are presented. For the HD Low Delay test case, the identification of test sequences is in progress. For the HDR category, a candidate set of five QP and five HLG sequences with corresponding QP settings are proposed for visual inspection. A tone mapping procedure has also been determined to enable the viewing of the PQ content on available UHD displays. In the 360° video category, viewpaths have been designed. The applicable projection formats for the sequences have to be determined in order to define VTM and HM QPs for the rate points to be assessed visually. A detailed update on the status of the verification test preparation status is provided in JVET-S0253.

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).

It is highlighted that the 12 new HDR-HLG sequences were received during the interim period. These sequences are further described in JVET-S0218.

Structure at test sequence repository

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

* ctc/ Contains the active test set of the common testing conditions
* ahg/ Contains subdirectories with sequences under consideration.
* ce/ Contains subdirectories for data exchange for specific CE
* jvet-cfe/ The sequences used for CfE
* jvet-cfp/ The sequences used for CfP
* old/ Contains the JEM bitstreams directory, used before the CfP
* upload Stays as before
* In the CTC directory, following subdirectories have been created:
* ctc/360/
* ctc/hdr/
* ctc/scc/
* ctc/sdr/

The following related contribution is submitted.

* JVET-S0041 “Status Report on SDR Verification Test Preparation” [M. Wien (RWTH), V. Baroncini (VABTECH ltd)]
* JVET-S0043 “Agenda and Report of the AHG4 Meeting on the SDR Verification Test on 2020-05-15” [M. Wien (RWTH), V. Baroncini (VABTECH), T. Suzuki (Sony)]
* JVET-S0146 “Status Report on 360º video Verification Test Preparation” [M. Wien (RWTH), V. Baroncini (VABTECH ltd), Y. Ye (Alibaba)]
* JVET-S0149 “Agenda and Report of the AHG4 Meeting on the 360 Verification Test on 2020-05-27” [M. Wien (RWTH), Y. Ye (Alibaba), V. Baroncini (VABTECH ltd), T. Suzuki (Sony)]
* JVET-S0151 “Status Report and Proposed Agenda for the AHG4 Meeting on HDR Verification Test Preparation” [A. Segall (Sharp)]
* JVET-S0153 “Agenda and Report of the AHG4 Meeting on the HDR Verification Test on 2020-05-29” [A. Segall, M. Wien, V. Baroncini, T. Suzuki]
* JVET-S0218 “4K HLG test sequences for HDR verification test” [S. Iwamura, S. Nemoto, A. Ichigaya (NHK)]
* JVET-S0246 “Results of dry run subjective assessment of SDR UHD verification test” [V. Baroncini, M. Wien]
* JVET-S0253 “Update on Verification Test Preparation” [M. Wien, V. Baroncini, A. Segall, Y. Ye]

The AHG recommended:

* To review the input contributions related to the verification test preparation at an early stage of the meeting.
* To continue to discuss and to update the verification test plan
* To create a BoG to progress the update of the verification test plan.
* To collect volunteers to conduct the verification test, including volunteers to encode.
* To review the set of available test sequences for the verification tests and potentially collect more test sequences with a variety of content.
* To continue to collect new test sequences available for JVET with appropriate licensing statements.

It was asked what studies could be conducted for determining scalable coding performance (e.g. relative to simulcast and relative to single-layer).

It was commented that verification testing effort has been planned for

* SDR
* HDR
* 360°

Verification testing should also be conducted for all three of the following areas:

* Screen content
* Scalability
* Camera-captured 4:4:4 content

[JVET-S0005](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10372) JVET AHG report: Conformance testing (AHG5) [J. Boyce, W. Wan, E. Alshina, I. Moccagatta, K. Kawamura, S. McCarthy, K. Sühring, X. Xu]

This document summarizes the activity of AHG5: “Conformance testing” between the 18th Meeting (teleconference, 15-24 April 2020) and the 19th Meeting (teleconference, 22 June – 1 July 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 shown in section 2.

Output document JVET-R2008 “Conformance testing for versatile video coding (Draft 3)” was published on 9 June 2020.

Bitstream submitters are requested to provide text descriptions of the bitstreams for inclusion in the conformance specification, in time for the output document for the current meeting, expected in July. A shared document has been made available at the Nextcloud link below, and bitstream submitters are requested to edit their section.

* <http://mpeg.expert/live/nextcloud/index.php/s/ZoTHgJeRDtXEBio>

Because CD is planned to be issued at the October meeting, all bitstream volunteers are requested to update their bitstreams using VTM 10.0 before the start of the October 2020 meeting.

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.

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

* 101 bitstream categories have been identified
* Volunteers have been identified to generate all but one category, 8-bit 4:2:2 in Main 4:4:4 10 profile
* 45 bitstreams in 21 bitstream categories have been provided for VTM 9.0
* 154 bitstreams in 48 bitstream categories have been provided for VTM 8.0
* 21 bitstreams in 8 bitstream categories have been provided for VTM incompatible
* 45 bitstream categories have no provided bitstreams (for any VTM version)

The procedure to exchange the bitstream (ftp site, bitstream files, etc.) is specified in Sec 2 “Procedure” of JVET-R2008. 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:



The AHG recommended:

* To review the input contributions related to the verification test preparation at an early stage of the meeting.
* To continue to discuss and to update the verification test plan
* To create a BoG to progress the update of the verification test plan.
* To collect volunteers to conduct the verification test, including volunteers to encode.
* To review the set of available test sequences for the verification tests and potentially collect more test sequences with a variety of content.
* To continue to collect new test sequences available for JVET with licensing statement.

Sending periodic email reminders to the volunteers was suggested to help ensure timely delivery of the bitstreams and associated descriptions.

There was discussion of whether we should provide extracted bitstreams as part of the conformance testing specification. In the past, our conformance testing specifications have (officially) required use of the reference software for performing the conformance tests. However, it was commented that we could use checksums of the cropped decoded pictures instead. This approach was agreed. Thus, distributing only a superset bitstream and extraction software would also not be the preferred approach, as this creates an undesirable software dependency. Instead, providing copies of extracted bitstreams as part of the conformance test is preferred.

Revisit for further planning.

[JVET-S0006](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10373) 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 18th (15–24 Apr. 2020) and the 19th (22 June – 1 July 2020) JVET meetings.

There was no update for 360Lib software (latest version 360Lib-10.1).

Based on discussions regarding preparation of 360 video content for the verification test, a request was made to enable the GCMP and ERP SEI message information within bitstreams to be used for creating configuration files for 360 format conversion and viewport extraction using 360Lib. Bytedance is planning to provide the patch for the VTM.

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>

There is one input contributions related to 360° video, as listed below.

* JVET-S0172 AHG9: On generalized cubemap projection SEI message [Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek)]

The AHG recommended:

* To review input contributions
* To continue software development of the 360Lib software package for the verification test.

Software work for the SEI messages was reported to be happening in the background. It was requested for information about this effort to be provided in a late contribution.

[JVET-S0007](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10374) 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 18th meeting by teleconference (14–24 April 2020)and the 19th meeting by teleconference (22 June – 1 July 2020).

The primary activity of the AhG was related to the mandates of (i) study and evaluate available HDR/WCG test content, (ii) comparing the performance of the VTM for HDR/WCG content, (iii) preparing for expert viewing of HDR content at the next JVET meeting, and (iv) coordinating with AHG4 in preparation for verification testing for HDR video content. This work is described in the following subsection.

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

**VTM 9.0 versus VTM 8.0**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | | | | | |
|  | **Over VTM-7.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -0.12% | -0.13% | -0.09% | -0.04% | -0.09% | -0.09% | 0.01% | -0.14% | 99% | 87% |
| Class H2 |  |  |  |  |  | -0.09% | -0.09% | -0.17% | 99% | 85% |
| **Overall** | -0.12% | -0.13% | -0.09% | -0.04% | -0.09% | -0.09% | -0.02% | -0.15% | 99% | 87% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access** | | | | | | | | | |
|  | **Over VTM-7.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -0.22% | -0.04% | -0.06% | -0.04% | -0.74% | -0.06% | -0.04% | -0.60% | 96% | 99% |
| Class H2 |  |  |  |  |  | -0.10% | -0.04% | -0.20% | 97% | 94% |
| **Overall** | -0.22% | -0.04% | -0.06% | -0.04% | -0.74% | -0.07% | -0.04% | -0.45% | 96% | 97% |

**VTM 9.0 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 | -41.23% | -26.73% | -26.20% | -56.66% | -52.00% | -23.52% | -52.55% | -45.17% |  |  |
| Class H2 |  |  |  |  |  | -21.23% | -47.48% | -49.00% |  |  |
| **Overall** | -41.23% | -26.73% | -26.20% | -56.66% | -52.00% | -22.69% | -50.70% | -46.56% |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access** | | | | | | | | | |
|  | **Over HM-16.18** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -31.57% | -31.46% | -31.17% | -46.14% | -38.90% | -28.14% | -41.07% | -31.22% |  |  |
| Class H2 |  |  |  |  |  | -28.61% | -56.29% | -58.70% |  |  |
| **Overall** | -31.57% | -31.46% | -31.17% | -46.14% | -38.90% | -28.31% | -46.60% | -41.21% |  |  |

***Tool-On / Tool-Off Comparisons***

In addition to evaluating the performance of VTM 9.0, the AhG also studied the performance of individual coding tools in the context of HDR content. This was accomplished by conducting a Tool-On/Tool-Off test according to the methodology established in AhG13.

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

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

**Class H1 (PQ)**

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

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **AI** |  |  |  |  |
| **Abbreviation** | **DE100** | **PSNR-L** | **BDR-wY** | **BDR-wU** | **BDR-wV** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| **CST** | **15.99%** | **0.98%** | **0.88%** | **14.34%** | **18.76%** | **151%** | **99%** | **149%** | **102%** |
| **DQ** | **0.11%** | **1.35%** | **1.45%** | **0.17%** | **0.25%** | **94%** | **108%** | **97%** | **104%** |
| **CCLM** | **18.99%** | **2.33%** | **2.15%** | **46.64%** | **52.53%** | **101%** | **99%** | **101%** | **100%** |
| **MTS** | **1.16%** | **1.31%** | **1.30%** | **0.72%** | **0.96%** | **86%** | **109%** | **85%** | **100%** |
| **ALF** | **10.13%** | **2.75%** | **2.18%** | **18.37%** | **37.13%** | **96%** | **88%** | **96%** | **89%** |
| **MRLP** | **0.33%** | **0.34%** | **0.30%** | **0.12%** | **0.06%** | **98%** | **99%** | **98%** | **100%** |
| **IBC** | **-0.27%** | **-0.32%** | **-0.32%** | **-0.15%** | **-0.03%** | **145%** | **96%** | **183%** | **101%** |
| **ISP** | **0.13%** | **0.60%** | **0.70%** | **-0.39%** | **-0.19%** | **90%** | **100%** | **85%** | **99%** |
| **LMCS** | **1.07%** | **0.85%** | **4.27%** | **1.63%** | **4.54%** | **100%** | **101%** | **101%** | **110%** |
| **BDPCM** | **0.00%** | **0.01%** | **0.00%** | **-0.13%** | **-0.05%** | **101%** | **100%** | **108%** | **101%** |
| **MIP** | **0.52%** | **0.73%** | **0.58%** | **0.21%** | **0.09%** | **94%** | **98%** | **89%** | **101%** |
| **LFNST** | **0.95%** | **0.91%** | **0.81%** | **1.27%** | **2.23%** | **107%** | **96%** | **105%** | **100%** |
| **JCCR** | **0.19%** | **0.54%** | **0.55%** | **0.30%** | **-1.87%** | **99%** | **98%** | **97%** | **101%** |
| **SAO** | **0.94%** | **0.07%** | **0.00%** | **1.12%** | **2.35%** | **100%** | **95%** | **99%** | **103%** |
| **CCALF** | **7.38%** | **-0.16%** | **-0.17%** | **13.26%** | **33.77%** | **98%** | **99%** | **100%** | **98%** |

**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** | **13.74%** | **0.54%** | **0.45%** | **10.53%** | **15.03%** | **103%** | **99%** | **106%** | **101%** |
| **DQ** | **-0.34%** | **1.51%** | **1.44%** | **-1.07%** | **-0.48%** | **100%** | **103%** | **102%** | **102%** |
| **CCLM** | **15.43%** | **1.10%** | **0.99%** | **36.08%** | **39.94%** | **100%** | **98%** | **102%** | **101%** |
| **MTS** | **0.93%** | **1.07%** | **1.02%** | **0.86%** | **1.52%** | **96%** | **105%** | **97%** | **101%** |
| **ALF** | **11.66%** | **1.98%** | **1.66%** | **17.73%** | **46.72%** | **95%** | **86%** | **96%** | **91%** |
| **AFF** | **0.93%** | **1.12%** | **1.11%** | **0.63%** | **0.58%** | **81%** | **96%** | **83%** | **100%** |
| **SbTMVP** | **0.31%** | **0.34%** | **0.37%** | **0.23%** | **0.37%** | **102%** | **98%** | **102%** | **99%** |
| **AMVR** | **0.97%** | **0.72%** | **0.74%** | **1.38%** | **1.70%** | **89%** | **101%** | **88%** | **101%** |
| **GPM** | **0.55%** | **0.39%** | **0.44%** | **1.00%** | **1.04%** | **97%** | **99%** | **99%** | **101%** |
| **BDOF** | **0.77%** | **0.93%** | **1.00%** | **0.45%** | **0.25%** | **99%** | **95%** | **100%** | **100%** |
| **CIIP** | **0.05%** | **0.12%** | **0.15%** | **-0.10%** | **-0.02%** | **99%** | **97%** | **99%** | **101%** |
| **MMVD** | **0.31%** | **0.28%** | **0.30%** | **0.26%** | **0.31%** | **92%** | **101%** | **93%** | **102%** |
| **BCW** | **0.70%** | **0.26%** | **0.22%** | **0.42%** | **0.65%** | **97%** | **100%** | **96%** | **103%** |
| **MRLP** | **0.17%** | **0.20%** | **0.14%** | **-0.25%** | **0.56%** | **99%** | **98%** | **102%** | **101%** |
| **IBC** | **0.29%** | **-0.09%** | **-0.01%** | **0.16%** | **0.90%** | **103%** | **99%** | **111%** | **101%** |
| **ISP** | **0.32%** | **0.43%** | **0.45%** | **-0.02%** | **0.71%** | **97%** | **102%** | **99%** | **100%** |
| **DMVR** | **1.26%** | **1.11%** | **0.96%** | **1.32%** | **1.42%** | **102%** | **97%** | **103%** | **99%** |
| **SBT** | **0.15%** | **0.15%** | **0.37%** | **0.06%** | **0.08%** | **96%** | **98%** | **98%** | **100%** |
| **LMCS** | **-0.85%** | **0.12%** | **4.41%** | **0.86%** | **4.29%** | **100%** | **96%** | **101%** | **100%** |
| **SMVD** | **0.16%** | **0.13%** | **0.15%** | **0.14%** | **0.24%** | **98%** | **99%** | **99%** | **101%** |
| **BDPCM** | **0.15%** | **0.01%** | **0.00%** | **0.07%** | **0.65%** | **102%** | **100%** | **104%** | **102%** |
| **MIP** | **0.58%** | **0.51%** | **0.34%** | **0.12%** | **0.96%** | **98%** | **101%** | **99%** | **101%** |
| **LFNST** | **0.68%** | **0.57%** | **0.44%** | **0.85%** | **2.40%** | **96%** | **102%** | **99%** | **100%** |
| **JCCR** | **-0.14%** | **0.36%** | **0.35%** | **-0.60%** | **-0.97%** | **99%** | **100%** | **101%** | **100%** |
| **SAO** | **1.00%** | **-0.04%** | **-0.11%** | **1.23%** | **2.32%** | **100%** | **97%** | **101%** | **101%** |
| **PROF** | **0.07%** | **0.08%** | **0.10%** | **0.03%** | **-0.15%** | **95%** | **102%** | **101%** | **100%** |
| **CCALF** | **9.23%** | **-0.54%** | **-0.55%** | **14.75%** | **42.44%** | **99%** | **99%** | **103%** | **100%** |



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)

**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** | **0.61%** | **13.02%** | **19.42%** | **163%** | **107%** | **159%** | **104%** |
| **DQ** | **1.69%** | **0.67%** | **0.82%** | **99%** | **104%** | **99%** | **106%** |
| **CCLM** | **1.80%** | **26.99%** | **17.03%** | **103%** | **101%** | **101%** | **100%** |
| **MTS** | **1.87%** | **2.62%** | **2.22%** | **87%** | **98%** | **86%** | **99%** |
| **ALF** | **2.70%** | **18.55%** | **20.85%** | **97%** | **89%** | **95%** | **89%** |
| **MRLP** | **0.04%** | **-0.04%** | **0.12%** | **99%** | **101%** | **98%** | **101%** |
| **IBC** | **-0.11%** | **-0.03%** | **-0.01%** | **208%** | **101%** | **184%** | **101%** |
| **ISP** | **0.31%** | **-0.65%** | **-0.09%** | **85%** | **99%** | **85%** | **100%** |
| **LMCS** | **0.06%** | **-0.99%** | **-0.73%** | **100%** | **101%** | **100%** | **101%** |
| **MIP** | **0.72%** | **0.75%** | **0.54%** | **90%** | **101%** | **90%** | **100%** |
| **LFNST** | **0.53%** | **1.38%** | **1.63%** | **110%** | **100%** | **109%** | **101%** |
| **JCCR** | **0.28%** | **0.84%** | **5.83%** | **99%** | **100%** | **98%** | **102%** |
| **SAO** | **0.05%** | **0.27%** | **0.65%** | **101%** | **97%** | **100%** | **98%** |
| **CCALF** | **-0.12%** | **16.13%** | **16.74%** | **103%** | **100%** | **100%** | **99%** |

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **VTM RA** |  |  |  |  |
| **Abbreviation** | **BDR-wY** | **BDR-wU** | **BDR-wV** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| **CST** | **0.24%** | **7.24%** | **13.57%** | **104%** | **103%** | **105%** | **104%** |
| **DQ** | **1.73%** | **0.97%** | **0.85%** | **103%** | **104%** | **105%** | **104%** |
| **CCLM** | **0.85%** | **24.19%** | **18.37%** | **101%** | **102%** | **104%** | **105%** |
| **MTS** | **1.15%** | **1.43%** | **1.18%** | **96%** | **101%** | **97%** | **99%** |
| **ALF** | **3.37%** | **26.70%** | **28.86%** | **97%** | **91%** | **97%** | **95%** |
| **AFF** | **0.76%** | **0.50%** | **0.60%** | **80%** | **99%** | **83%** | **101%** |
| **SbTMVP** | **0.37%** | **0.20%** | **0.14%** | **102%** | **102%** | **103%** | **101%** |
| **AMVR** | **0.72%** | **0.91%** | **1.25%** | **85%** | **100%** | **88%** | **104%** |
| **GPM** | **0.64%** | **0.76%** | **0.93%** | **97%** | **100%** | **101%** | **104%** |
| **BDOF** | **0.60%** | **0.24%** | **0.22%** | **96%** | **98%** | **100%** | **101%** |
| **CIIP** | **0.19%** | **-0.31%** | **-0.34%** | **97%** | **99%** | **102%** | **104%** |
| **MMVD** | **0.23%** | **0.22%** | **0.24%** | **92%** | **103%** | **90%** | **100%** |
| **BCW** | **0.20%** | **0.16%** | **0.24%** | **95%** | **103%** | **93%** | **101%** |
| **MRLP** | **0.05%** | **-0.08%** | **0.18%** | **101%** | **102%** | **102%** | **101%** |
| **IBC** | **0.10%** | **-0.01%** | **-0.07%** | **111%** | **102%** | **109%** | **102%** |
| **ISP** | **0.23%** | **0.18%** | **0.29%** | **97%** | **101%** | **99%** | **102%** |
| **DMVR** | **0.87%** | **1.07%** | **1.10%** | **101%** | **99%** | **100%** | **98%** |
| **SBT** | **0.31%** | **-0.17%** | **-0.21%** | **97%** | **101%** | **96%** | **99%** |
| **LMCS** | **0.98%** | **0.60%** | **0.66%** | **99%** | **97%** | **103%** | **102%** |
| **SMVD** | **0.20%** | **0.06%** | **0.13%** | **98%** | **102%** | **96%** | **99%** |
| **BDPCM** | **0.03%** | **-0.13%** | **0.01%** | **103%** | **101%** | **101%** | **100%** |
| **MIP** | **0.48%** | **0.49%** | **0.06%** | **98%** | **102%** | **96%** | **99%** |
| **LFNST** | **0.48%** | **0.85%** | **1.34%** | **96%** | **99%** | **99%** | **101%** |
| **JCCR** | **0.21%** | **0.35%** | **6.84%** | **99%** | **99%** | **101%** | **101%** |
| **SAO** | **0.07%** | **0.34%** | **1.67%** | **101%** | **101%** | **100%** | **97%** |
| **PROF** | **0.13%** | **0.02%** | **-0.08%** | **100%** | **100%** | **102%** | **100%** |
| **CCALF** | **-0.13%** | **22.73%** | **24.55%** | **100%** | **96%** | **106%** | **104%** |



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)

***Evaluating Additional HDR/WCG Content***

During the AhG period, 12 new HDR-HLG sequences were provided for study. These sequences are further described in JVET-S0218. Compression results were generated for the sequences, and visual evaluation was performed. As a result, three of the sequences were identified as potential candidates for HDR verification testing.



Coding performance of the new “Amsterdam” sequences when using HEVC.

***Preparing for Expert Viewing***

In advance of the 19th meeting, a set of procedures were developed to allow for remote, expert viewing during the 19th meeting. These procedures are defined below and consist of two major areas of work. The first is defining what tone mapping should be used for viewing. And, the second is defining how viewing should be performed when using consumer equipment.

**Tone Mapping**

The HDR-PQ content that is available to JVET has largely been master for a 4,000 nit display. This is representative of a portion of content that is available in the eco-system today, but it has historically created issues for performing expert viewing in JVET as (i) there are no consumer displays available with a brightness of 4,000 nits, and (ii) the only non-consumer display available to JVET that supports 4,000 nits is limited in resolution to HD. During the Call for Evidence and Call for Proposals, this was addressed by using the available non-consumer display and down-sampling the HDR-PQ sequences to HD resolution. Additionally, for less critical viewing, a 1,000 nit display has been used. And, the content was scaled (approximately in linear light) to map the entire dynamic range into the capability of the 1,000 nit display.

During the interim period, the tone mapping process was re-studying in the context of candidate sequences for the verification tests. In these sequences, it was determined applying the scaling described above was less than ideal, and that applying tone mapping in only the brighter regions of the sequences would be more suitable for the content. As a result of this work, it was decided to not use the previous tone mapping methods for verification testing, but instead to allow the brighter regions of the image to clip. It is noted that this process may be further refined to include some form of roll-off, but this is only mentioned as future work – and not expected to impact the verification testing.

**Consumer Playback**

To facilitate remote expert viewing, a number of procedures were developed to assist in experts being able to reproduce evaluation environments. This procedures are listed below, and the result was that two participants were able to re-create a similar viewing environment remote from each other successfully.

**Compressed Playback**

To simplify the management of meta-data and allow experts to participate in viewing remotely, it was recommened that compressed versions of test content could be created with the following commands:

PQ content:

ffmpeg -pix\_fmt yuv420p10le -r 60 -s 3840x2160 -i <filename.yuv> -c:v libx265 -crf <crf\_value> -x265-params colorprim=bt2020:transfer=smpte2084:colormatrix=bt2020nc <filename.mkv>

 HLG content:

ffmpeg -pix\_fmt yuv420p10le -r 60 -s 3840x2160 -i <filename.yuv> -c:v libx265 -crf <crf\_value> -x265-params colorprim=bt2020:transfer=arib-std-b67:colormatrix=bt2020nc <filename.mkv>

Here, the crf\_value is used to control the bit-rate. For those using the internal decoder of a monitor (e.g., via USB playback), a crf\_value of 15 is typically required. For those using a PC based playback system, the crf\_value will be determined by the playback capabilities of the PC hardware. Typically, a crf\_value of less than 10 will result in visually transparent playback.

**PC Platform**

During the interim period, it was recommended to use a a consumer LG OLED display when possible to evaluate the HDR content. To drive the LG display in HDR mode, a set of procedures was developed to facilitate reproduceable results. They are:

1. Enable the 4:2:2 12-bit mode in the Nvidia driver
2. Enable HDR support in Windows 10 (For example, using the steps at: <https://support.microsoft.com/en-us/help/4040263/windows-10-hdr-advanced-color-settings>)
3. Download a recent version of Video LAN (3.x)
4. Select the “HDR Standard” mode (or similar) on the LG display and disable automatic tone mapping

After performing Step 1 and 2, the monitor should provide visual feedback that it is operating in HDR mode.

***Coordinating with AHG4***

The AHG had significant coordination with AHG4, including sharing results on the new HDR content and expert viewing procedures.

1. **Contributions**

There were three contribution related to HDR video coding that were noted in the AHG report.

JVET-S0151 Status Report and Proposed Agenda for the AHG4 Meeting on HDR Verification Test Preparation A. Segall (Sharp)

JVET-S0153 Agenda and Report of the AHG4 Meeting on HDR Verification Test on 2020-05-29 A. Segall, M. Wien, V. Baroncini, T. Suzuki

JVET-S0218 4K HLG test sequences for HDR verification test S. Iwamura, S. Nemoto, A. Ichigaya (NHK)

1. **Recommendations**

The AHG recommended the following:

* Review all input contributions
* Establish a BoG during the 19th meeting to progress the work on HDR verification test preparations

It was commented that chroma imbalance is still evident in the HDR sequences (more imbalance in the case of HLG than for PQ).

[JVET-S0008](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10375) 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 document summarizes the activity of AHG08: Layered coding and resolution adaptivity, between the 18th JVET meeting by teleconference (15–24 April 2020), and the 19th meeting June 22 through July 1st, 2020).

Joint ad hoc group meetings of AHGs 8, 9 and 12 were held by teleconference in the timeframe between May 27 and May 29 (involving 8 sessions of two hours each), and June 19 through June 21 (involving 12 sessions of two hours each). The report from the joint AHG meeting sessions can be found in [JVET-S137](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10259) and [JVET-S0237](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10359), respectively

No email traffic on the JVET reflector was observed that was labelled as belonging to AHG8. However, intense AHG activity was performed during two virtual, multiday joint AHG8/AHG9/AHG12 ad hoc meetings in the timeframe between May 27 and May 29 (involving 8 sessions of two hours each), and June 19 through June 21 (involving 12 sessions of two hours each). The report from the joint AHG meeting sessions can be found in JVET-S137 and JVET-S0237, respectively.

There were 20 technical contributions that were noted to be related to the AHG provided as input to the current meeting, most of which were reviewed during the joint ad hoc meeting.

* JVET-S0008 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
* JVET-S0048 AHG9/AHG8: On reference picture resampling Y.-K. Wang, Z. Deng, K. Zhang, L. Zhang (Bytedance)
* JVET-S0049 AHG9/AHG8/AHG12: On parameter sets and picture header Y.-K. Wang, L. Zhang, Z. Deng, K. Zhang (Bytedance)
* JVET-S0057 AHG8/AHG9: On signaling reference picture resampling B. Choi, S. Wenger, S. Liu (Tencent)
* JVET-S0082 AHG8/AHG9: On signaling of inter-layer reference picture layer index H. Jang, Hendry, S. Paluri, J. Nam, S. Kim, J. Lim (LGE)
* JVET-S0083 AHG8/AHG9: On signaling of ILRP layer index using delta value Hendry, H. Jang, J. Nam, S. Kim, J. Lim (LGE)
* JVET-S0089 AHG8: On TMVP derivation using inter-layer reference picture N. Park, J. Nam, H. Jang, J. Lim, S. Kim(LGE)
* JVET-S0090 AHG8/AHG9: On single\_layer\_constraint\_flag K. Abe, T. Nishi, T. Toma, V. Drugeon (Panasonic)
* JVET-S0091 AHG8/AHG9: On constraints of still picture K. Abe, T. Nishi, T. Toma, V. Drugeon (Panasonic)
* JVET-S0097 AHG8/AHG9: Clarifications to HRD specification for single-layer and multi-layers bitstreams V. Drugeon, T. Nishi, K. Abe, T. Toma (Panasonic)
* JVET-S0108 AHG8/AHG9: Refinement of proposed positioning information SEI message of output independent layers E. Thomas (TNO)
* JVET-S0126 AHG8: On scaling window constraint Y.-J. Chang, V. Seregin, Y. He, A. K. Ramasubramonian, M. Coban, M. Karczewicz (Qualcomm)
* JVET-S0147 AHG8: A summary of proposals on scalability and RPR Y.-K. Wang (Bytedance)
* JVET-S0154 AHG9/AHG8/AHG12: On the subpicture sub-bitstream extraction process Y.-K. Wang, Z. Deng, K. Zhang, L. Zhang (Bytedance)
* JVET-S0158 AHG9/AHG8: On the general sub-bitstream extraction process Y.-K. Wang, Z. Deng (Bytedance)
* JVET-S0160 AHG9/AHG12/AHG8: Miscellaneous HLS cleanups Y.-K. Wang, Z. Deng, L. Zhang, K. Zhang (Bytedance)
* JVET-S0189 AHG9/AHG8/AHG12: On subpicture bitstream extraction process B. Choi, S. Wenger, S. Liu (Tencent)
* JVET-S0190 AHG8/AHG9/AHG12: On reference picture resampling with scalability B. Choi, S. Wenger, S. Liu (Tencent)
* JVET-S0213 AHG8/AHG9: Refinement of proposed positioning information SEI message of output independent layers with example bitstreams E. Thomas (TNO)
* JVET-S0214 AHG8/AHG9: Updates on the implementation of multi-layer decoding and output independent layer arrangement in VTM E. Thomas (TNO)
* JVET-S0219 AHG8/AHG9: On APS NAL unit clean-up H. Jang, J. Nam, J. Lim, S. Paluri, Hendry, S. Kim (LGE)

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

[JVET-S0009](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10376) 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 summarizes the activities of the AHG on High-level syntax (HLS) between the 18th JVET meeting held by teleconference (15–24 April 2020) and the 19th JVET meeting held by teleconference (22 June – 1 July 2020).

It is reported that the estimated number of input contributions related to high-level syntax has decreased from 253 at the 18th JVET meeting to 204 at this 19th meeting.

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

The e-mail reflector ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de)) activities related to AHG9 includes the following:

* Announcements of summary documents for the HLS AHG meetings
* Announcements of HLS AHG meeting reports and text integration from the 27–28 May meeting
* A number of JVET VVC bug tracker discussions related to HLS
* General constraint indicators (GCI) side activity announcement and suggestion of GCI principles

Five days of HLS AHG teleconference meetings were held on May 27–28 and June 19–21. The AHG meetings are reported in [JVET-S0137](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10259) and [JVET-S0237](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10359). In JVET-S0237-v8, the high-level syntax input documents have been categorized into subsections of section 3. The number of inputs in each category is shown in the figure below.

Most sections have completed a first scan of the input documents. Most remaining work seems to be in 3.1.8 HRD where 55 of the 72 identified proposed changes from the 27 input contributions remains to be addressed.



*AHG9 input document breakdown*

The accumulated review progress and the accumulated number of AHG recommendations over time is illustrated in the figure below. The straight line represents the total number HLS contributions submitted to the JVET meeting.

**

*HLS document review progress over time*

There were 10 more JVET meeting days and approximately 47 remaining HLS documents. Although there are also 23 revisits, there seemed to be sufficient time to adequately handle all HLS input contributions in time.

[JVET-S0010](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10377) 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 18th meeting conducted by teleconference 15-24 April 2020 and the 19th meeting conducted by teleconference (22 June – 1 July 2020).

No e-mail related to AHG10 activity was sent to the JVET reflector during the AHG period.

One contribution related to the AHG was noted to have been presented.

JVET-S0180: Addition of a GOP hierarchy of 32 for random access configuration for VTM

This contribution is proposing to include a GOP hierarchy of 32 for random access configuration to VTM and it is also suggested to use it for CTC. This will increase the number of pictures in the DPB by one compared to a GOP hierarchy of 16 such that the DPB requirements are 8, e.g. at the maxDpbPicBuf, instead of 7. It will also increase the end-to-end latency by additional 2x16/60 seconds for 60 Hz video which is expected to be acceptable for a wide range of random access applications. Enabling a GOP hierarchy of 32 also for sequences which not have an intra period which is a multiple of 32 requires adjustment of the intra period for those sequences such that the intra period becomes a multiple of 32, e.g. frame rate 50/60Hz will have an intra period of 64 and frame rate 30Hz or below will have an intra period of 32.

The BD rate effect of this change is as follows:

* CTC SDR RA -3.0%, -6.3%, -6.4% (luma,Cb/Cr)
* CTC HDR RA -7.8%, -5.2, -4.4%, -4.2% (deltaE, psnrL, wpsnrY, psnrY)

It is also asserted that the visual quality is improved.

In JVET-B0039 the benefits of a GOP hierarchy of 32 compared to GOP hierarchy of 16 was shown. An informal viewing was also held at the meeting and reported in JVET-B0075. The results indicated visual benefits of using a GOP hierarchy of 32 compared to a GOP hierarchy of 8. The doubling of the memory for the encoder compared to a GOP hierarchy of 16 was at the time (year 2016) regarded as an issue and a GOP hierarchy of 16 was instead selected for CTC. However, the contribution argues that these memory constraints are more relaxed now, more than four years later. At a recent meeting the maxDpbPicBuf was also increased for VVC to 8 pictures which gives additional capability that can be used by a larger GOP hierarchy for random access.

The impact of extending the length of the GOP hierarchy from 16 to 32 are:

* The number of temporal layers increases from 5 to 6.
* The DPB size increases from 7 to 8
* An increase of the maximum reorder latency from 16 to 32 pictures which corresponds to an end-to-end (encoder + decoder) latency of 2x32/60 instead of 2x16/60 for a frame rate of 60 Hz.

Since most current and future content is expected to be at least 60 Hz, the added latency may be found acceptable for several broadcast, streaming and offline video delivery applications.

**VTM-9.0**

BDR for a GOP hierarchy of 32 for SDR CTC VTM-9.0 random access configuration

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Over VTM-9.0 (Intra period 64 for 50Hz and 32 for 20Hz)** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -1,94% | -4,83% | -5,05% | 101% | 90% |
| Class A2 | -3,10% | -6,87% | -6,07% | 100% | 92% |
| Class B | -3,32% | -7,23% | -7,58% | 100% | 94% |
| Class C | -3,39% | -5,95% | -6,13% | 100% | 93% |
| Class E |  |  |  |  |  |
| **Overall** | -3,02% | -6,33% | -6,38% | 100% | 92% |
| Class D | -3,28% | -5,93% | -6,23% | 101% | 96% |
| Class F | -6,46% | -7,36% | -7,23% | 96% | 90% |

**HM-16.20**

BDR for a GOP hierarchy of 32 for SDR HM-16.20 CTC random access configuration

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Over VTM-9.0 (Intra period 64 for 50Hz and 32 for 20Hz)** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -1,12% | -4,57% | -4,65% | 95% | 99% |
| Class A2 | -1,67% | -4,63% | -4,83% | 94% | 96% |
| Class B | -2,59% | -7,87% | -7,38% | 93% | 95% |
| Class C | -3,33% | -5,65% | -5,53% | 94% | 96% |
| Class E |  |  |  |  |  |
| **Overall** | -2,31% | -5,97% | -5,83% | 94% | 96% |
| Class D | -3,21% | -5,80% | -5,64% | 96% | 92% |
| Class F | -6,07% | -6,86% | -6,69% | 92% | 97% |

1. **Recommendation**

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

Should the CTC adopt this? Revisit as part of the VT discussion. Discuss the points below:

* Does it have visual artefacts? The proponents seemed to think it is OK – the gap between the lowest and highest QP is similar – it may be visually better. Visual cross-checking was encouraged.
* In HM comparison we seem to have been using a non-valid configuration (when operating at the largest picture size).
* There also had been some change in the LB GOP structure.
* Encoding time analysis

[JVET-S0011](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10378) JVET AHG report: Screen content coding (AHG11) [S. Liu, J. Boyce, A. Filippov, Y.-C. Sun, X. Xu]

This document summarizes the activity of AHG11: Screen Content Coding between the 18th Meeting (16–24 April 2020) and the 19th meeting (22 June – 1 July 2020), both held by teleconference.

The AHG used the main JVET reflector, jvet@lists.rwth-aachen.de, with [AHG11] in message headers. There were few email activities through the main reflector. Some private email exchanges were made regarding the preparation of JVET-Q2013 (non-420 CTC document).

In total there were SCC related technical contributions identified in the opening plenary, among which all are ACT related technical contributions for this meeting. They are listed in the next section.

Input documents related to AHG11 are summarized as follows. Note that some of these contributions maybe discussed in the context of other AHGs.

* JVET-S0072 [Add title something about PDPC and ref sample smoothing]
* JVET-S0170, Use of ACT with IBC, S. Keating, K. Kondo (Sony)
* JVET-S0197, AHG9: On ACT and LFNST, M. G. Sarwer, Y. Ye (Alibaba)
* JVET-S0217, On deblocking filter for ACT, S. Iwamura, S. Nemoto, A. Ichigaya (NHK)
* JVET-S0231, On Signalling of TU Luma Coded Flag for CU with ACT, L.-F. Chen, X. Li, S. Liu (Tencent)
* JVET-S0233, Suggested bug fixes for ACT text in VVC draft 9, X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, C.-W. Kuo, X. Wang (Kwai)
* JVET-S0234, Mismatch between text specification and reference software on chroma residual scaling when ACT is enabled, X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, C.-W. Kuo, X. Wang (Kwai)
* JVET-S0244 [Add title LMCS for RGB]

The AHG recommended:

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

[JVET-S0012](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10379) 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]

The document summarizes activities of AHG on High-level parallelism and coded picture regions between the 18th and the 19th JVET meetings.

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

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

There were JVET HLS AHG meetings for AHG8, AHG9, AHG12 on 27-28 May 2020 and 19-21 June 2020. Report of those meetings are available in JVET-S0137 and JVET-S0237 respectively.

Input documents (total 18) related to AHG12 are listed below. Majority of these documents were discussed in the two JVET HLS AHG meetings. Report of those meetings (JVET-S0137, JVET-S0237) contain additional details.

|  |  |  |
| --- | --- | --- |
| **JVET-S0049** | AHG9/AHG8/AHG12: On parameter sets and picture header | Y.-K. Wang, L. Zhang, Z. Deng, K. Zhang (Bytedance) |
| **JVET-S0071** | AHG12: Cleanup of subpicture layout signalling | M.  Katsumata, M.  Hirabayashi, T.  Suzuki (Sony) |
| **JVET-S0095** | AHG12: On tile and slice partitioning related syntax and semantics | J. Chen, Y. Ye, R.-L. Liao (Alibaba) |
| **JVET-S0099** | AHG12: SEI message handling in subpicture extraction | R. Skupin, Y. Sanchez, K. Suehring (HHI), V. Drugeon (Panasonic) |
| **JVET-S0107** | AHG9/AHG12: Recommended multi-layer composite picture SEI messages | J. Boyce (Intel) |
| **JVET-S0117** | AHG12: On Subpicture sub-bitstream exaction | Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm) |
| **JVET-S0128** | AHG12: On entry point signalling | M. Coban, V. Seregin, Y. He, Y.-J. Chang, M. Karczewicz (Qualcomm) |
| **JVET-S0134** | AHG9/AHG12: Relaxing an ALF APS constraint | A. Aminlou, M. M. Hannuksela (Nokia) |
| **JVET-S0145** | AHG12: A summary of proposals on tile, slices, and subpictures | Y.-K. Wang (Bytedance) |
| **JVET-S0154** | AHG9/AHG8/AHG12: On the subpicture sub-bitstream extraction process | Y.-K. Wang, Z. Deng, K. Zhang, L. Zhang (Bytedance) |
| **JVET-S0160** | AHG9/AHG12/AHG8: Miscellaneous HLS cleanups | Y.-K. Wang, Z. Deng, L. Zhang, K. Zhang (Bytedance) |
| **JVET-S0162** | AHG3/AHG12: Subpicture merging software | A. Hallapuro, M. M. Hannuksela (Nokia) |
| **JVET-S0173** | AHG9/AHG12: Subpicture related cleanups | R. Skupin, Y. Sanchez, K. Suehring, T. Schierl (HHI) |
| **JVET-S0189** | AHG9/AHG8/AHG12: On subpicture bitstream extraction process | B. Choi, S. Wenger, S. Liu (Tencent) |
| **JVET-S0190** | AHG8/AHG9/AHG12: On reference picture resampling with scalability | B. Choi, S. Wenger, S. Liu (Tencent) |
| **JVET-S0206** | AHG12: Raster scan order subpictures | M. Damghanian, D. Liu, R. Sjöberg, M. Pettersson, J. Enhorn, J. Ström, R. Yu (Ericsson) |
| **JVET-S0236** | AHG9/AHG12: High-level syntax cleanups on subpictures | S.-T. Hsiang, L. Chen, O. Chubach, Y.-W. Huang, S.-M. Lei (MediaTek) |
| **JVET-S0247** | Crosscheck of JVET-S0071 (AHG12: Cleanup of subpicture layout signalling) | R. Sjöberg, D. Liu, M. Damghanian (Ericsson) |

The AHG recommends:

To review all related contributions and AHG meeting recommendations

[JVET-S0013](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10380) 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 18th meeting by teleconference (15–24 April 2020) and the 19th Meeting by teleconference (22 June – 1 July 2020). Tool on/off experimental results vs. VTM anchor are provided for the tools specified in JVET-R2005.

The initial version of JVET-R2005 “Methodology and reporting template for tool testing” was provided on May 16th.

All tests described in JVET-R2005 were conducted. VTM tool tests were conducted on VTM-9.0 software with VTM configuration by switching off or on specific tool either in configuration files or macros.

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

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Tool Name** | **Acronym** | **Document reference(s)** | **AI** | **RA** | **LD** | **Tester** | **Crosscheck** |
| Chroma separate tree | CST | JVET-P0063, JVET-P0406 | X | X | X | Tzu-Der Chuang (peter.chuang@mediatek.com) | Wei-Jung Chien (wchien@qti.qualcomm.com) |
| Dependent quantization\* | DQ | JVET-P0170, JVET-Q0433, | X | X | X | Tzu-Der Chuang (peter.chuang@mediatek.com) | Shan Liu (shanl; xinzzhao@ tencent.com) |
| Cross-component linear model | CCLM | JVET-O1124, JVET-Q0500, JVET-Q0194, | X | X | X | Roman Chernyak (chernyak.roman@huawei.com) | Shan Liu (shanl; leolzhao@ tencent.com) |
| multiple transform set | MTS | JVET-O0294, JVET-O0474, JVET-O0541, JVET-Q0055, JVET-Q0516, | X | X | X | Kiho Choi (kiho14.choi@samsung.com) | Shan Liu (shanl; xinzzhao@ tencent.com) |
| Adaptive loop filter | ALF | JVET-P0162, JVET-P0164, JVET-P0505, JVET-P0554, JVET-P0665, JVET-P1038, JVET-Q0249, JVET-Q0150, JVET-Q0495, JVET-Q0795, | X | X | X | Wei-Jung Chien (wchien@qti.qualcomm.com) | Tzu-Der Chuang (peter.chuang@mediatek.com) |
| Affine motion model | AFFINE | JVET-O0070 |  | X | X | Roman Chernyak (chernyak.roman@huawei.com) | Shan Liu (shanl; guichunli@ tencent.com) |
| subblock-based temporal merging candidates | SbTMC | JVET-P0385 |  | X | X | Shan Liu  (shanl; guichunli@ tencent.com) | Wei-Jung Chien (wchien@qti.qualcomm.com) |
| Adaptive motion vector resolution | AMVR | JVET-O0057 |  | X | X | Shan Liu (shanl; guichunli@ tencent.com) | Wei-Jung Chien (wchien@qti.qualcomm.com) |
| Geometric partition mode | GPM | JVET-Q0806 |  | X | X | Kiho Choi (kiho14.choi@samsung.com) | Shan Liu (shanl; leolzhao@ tencent.com) |
| Bi-directional optical flow | BDOF | JVET-P0091, JVET-P0519, JVET-P1023, JVET-Q0128, |  | X |  | Kiho Choi (kiho14.choi@samsung.com) | Tzu-Der Chuang (peter.chuang@mediatek.com) |
| Combined intra/inter prediction | CIIP | JVET-O0108, JVET-O0681 |  | X | X | Kiho Choi (kiho14.choi@samsung.com) | Tzu-Der Chuang (peter.chuang@mediatek.com) |
| Merge with MVD | MMVD | JVET-P1023 |  | X | X | Kiho Choi (kiho14.choi@samsung.com) | Hyeongmun Jang ([hm.jang@lge.com](mailto:hm.jang@lge.com)) |
| Bi-predictive with CU weights | BCW | JVET-P0280 |  | X | X | Wei-Jung Chien (wchien@qti.qualcomm.com) | Tzu-Der Chuang (peter.chuang@mediatek.com) |
| Multi-reference line prediction | MRLP | JVET-P0418 | X | X | X | Shan Liu (shanl; leolzhao@ tencent.com) | Hyeongmun Jang (hm.jang@lge.com) |
| Intra block copy mode | IBC | JVET-P0400, JVET-P0457, JVET-P1018 | X | X | X | Shan Liu (shanl; xiaozhongxu@ tencent.com) | Wei-Jung Chien (wchien@qti.qualcomm.com) |
| Intra sub-partitioning | ISP | JVET-O0106, JVET-O0341, JVET-O0502 | X | X | X | Roman Chernyak (chernyak.roman@huawei.com) | Hyeongmun Jang (hm.jang@lge.com) |
| Decoder motion vector refinement | DMVR | JVET-O0297, JVET-O0590, JVET-O0634 |  | X |  | Hyeongmun Jang (hm.jang@lge.com) | Roman Chernyak  ([chernyak.roman@huawei.com](mailto:chernyak.roman@huawei.com)) |
| Sub-block transform | SBT | JVET-P1026 |  | X | X | Roman Chernyak (chernyak.roman@huawei.com) | Shan Liu (shanl; xinzzhao@ tencent.com) |
| Luma mapping with chroma scaling | LMCS | JVET-P0254, JVET-P0371 | X | X | X | Taoran Lu (tlu@dolby.com) | Hyeongmun Jang (hm.jang@lge.com) |
| Symmetric motion vector difference | SMVD | JVET-O0284, JVET-O0414, JVET-O0567, JVET-O0572 |  | X |  | Yi-Wen Chen(yiwenchen@kwai.com) | Hyeongmun Jang (hm.jang@lge.com) |
| Quantized residual DPCM | BDPCM | JVET-P0059, JVET-Q0089, JVET-Q0110, JVET-Q0785, | X | X | X | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) | Yi-Wen Chen(yiwenchen@kwai.com) |
| Matrix based intra prediction | MIP | JVET-P0054, JVET-P0199, JVET-P0803, JVET-Q0446 | X | X | X | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) | Yi-Wen Chen(yiwenchen@kwai.com) |
| Low frequency non-separable transform | LFNST | JVET-P1026, JVET-P0350, JVET-Q0784, | X | X | X | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) | Yi-Wen Chen(yiwenchen@kwai.com) |
| Joint coding of chrominance residuals | JCCR | JVET-N0054 | X | X | X | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) | Yi-Wen Chen(yiwenchen@kwai.com) |
| Sampled-adaptive offset | SAO | JVET-Q0441, | X | X | X | Tzu-Der Chuang (peter.chuang@mediatek.com) | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) |
| Prediction refinement using optical flow | PROF | JVET-P0409, JVET-P0057, JVET-P0154, JVET-P0491, JVET-P0653 |  | X | X | Yi-Wen Chen(yiwenchen@kwai.com) | Ru-Ling Liao (ruling.lrl@alibaba-inc.com) |
| Cross component adaptive loop filter | CCALF | JVET-Q0795 | X | X | X | Shan Liu (shanl; xinzzhao@ tencent.com) | Hyeongmun Jang (hm.jang@lge.com) |
| Palette coding mode\*\* | PALLETE | JVET-P0077, JVET-Q0291, JVET-Q0491, JVET-Q0501, JVET-Q0504, JVET-Q0629, JVET-Q0447, JVET-Q0493, JVET-Q0503, JVET-Q0712, | X | X | X | Yung-Hsuan Chao (yunghsua@qti.qualcomm.com) | Yi-Wen Chen(yiwenchen@kwai.com) |
| Adaptive colour transform\*\* | ACT | JVET-P0517, JVET-Q0820, JVET-Q0353, JVET-Q0512, | X | X | X | Xiaoyu Xiu (xiaoyuxiu@kwai.com) | Shan Liu (shanl; xinzzhao@ tencent.com) |

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

\*\* Test was conducted with test sequences and test condition defined in JVET-R2013[1].

1. **Results**

The results of the tests are summarized in the tables below. The attached spreadsheet provides additional data. Tool test results are also tabulated 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-9.0/>

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

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

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **AI** |  |  |  |
| **Acronym** | **BDR-Y** | **BDR-U** | **BDR-V** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| CST | 0.41% | 9.86% | 9.52% | 147% | 101% | 154% | 102% |
| DQ | 1.71% | 1.42% | 1.23% | 96% | 103% | 94% | 104% |
| CCLM | 1.54% | 13.92% | 14.77% | 100% | 99% | 99% | 98% |
| MTS | 1.32% | 0.99% | 1.06% | 85% | 98% | 85% | 99% |
| ALF | 2.20% | 12.81% | 12.44% | 97% | 90% | 95% | 86% |
| MRLP | 0.33% | 0.15% | 0.14% | 99% | 101% | 100% | 103% |
| ISP | 0.48% | 0.30% | 0.23% | 85% | 98% | 86% | 100% |
| LMCS | 0.97% | 0.42% | 0.72% | 99% | 98% | 99% | 99% |
| MIP | 0.63% | 0.20% | 0.20% | 90% | 102% | 89% | 100% |
| LFNST | 0.97% | 2.04% | 2.28% | 111% | 101% | 107% | 98% |
| JCCR | 0.57% | 0.58% | 0.66% | 98% | 101% | 99% | 102% |
| SAO | 0.01% | 0.14% | 0.20% | 100% | 99% | 100% | 97% |
| CCALF | -0.14% | 9.69% | 8.55% | 100% | 98% | 101% | 100% |

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% | 4.12% | 4.57% | 102% | 100% | 102% | 100% |
| DQ | 1.60% | 0.95% | 0.66% | 99% | 103% | 100% | 102% |
| CCLM | 1.02% | 11.52% | 12.58% | 99% | 99% | 99% | 100% |
| MTS | 0.75% | 0.66% | 0.64% | 94% | 99% | 93% | 100% |
| ALF | 4.34% | 19.31% | 19.06% | 98% | 89% | 95% | 84% |
| AFFINE | 3.11% | 2.36% | 2.16% | 81% | 97% | 81% | 97% |
| SbTMC | 0.43% | 0.29% | 0.38% | 101% | 100% | 101% | 101% |
| AMVR | 1.42% | 2.15% | 2.35% | 85% | 101% | 86% | 101% |
| GPM | 0.67% | 1.14% | 1.16% | 97% | 101% | 97% | 101% |
| BDOF | 0.76% | 0.33% | 0.26% | 98% | 97% | 96% | 95% |
| CIIP | 0.26% | 0.00% | -0.02% | 98% | 100% | 97% | 95% |
| MMVD | 0.52% | 0.44% | 0.49% | 94% | 100% | 93% | 101% |
| BCW | 0.40% | 0.46% | 0.46% | 92% | 98% | 95% | 101% |
| MRLP | 0.17% | 0.08% | 0.10% | 100% | 101% | 99% | 100% |
| ISP | 0.28% | 0.29% | 0.33% | 96% | 100% | 95% | 100% |
| DMVR | 0.83% | 1.11% | 1.14% | 100% | 97% | 100% | 97% |
| SBT | 0.41% | -0.03% | -0.02% | 94% | 100% |  |  |
| LMCS | 1.38% | 1.14% | 0.99% | 95% | 98% | 94% | 98% |
| SMVD | 0.25% | 0.23% | 0.23% | 98% | 102% | 97% | 101% |
| MIP | 0.33% | 0.35% | 0.37% | 96% | 101% | 96% | 102% |
| LFNST | 0.70% | 0.78% | 1.08% | 95% | 101% | 91% | 98% |
| JCCR | 0.54% | 0.40% | 0.14% | 99% | 100% | 100% | 101% |
| SAO | 0.08% | 0.15% | 0.31% | 100% | 95% | 100% | 99% |
| PROF | 0.48% | 0.14% | 0.08% | 99% | 100% | 99% | 100% |
| CCALF | -0.13% | 13.88% | 13.73% | 100% | 99% | 100% | 99% |

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 | 0.07% | 1.64% | 2.36% | 101% | 104% | 101% | 104% |
| DQ | 1.64% | 0.36% | -0.04% | 98% | 97% | 100% | 101% |
| CCLM | 0.00% | 3.21% | 3.57% | 99% | 99% | 100% | 100% |
| MTS | 0.61% | -0.02% | -0.13% | 98% | 99% | 98% | 100% |
| ALF | 4.12% | 25.04% | 19.58% | 99% | 92% | 91% | 83% |
| AFFINE | 3.06% | 2.27% | 2.54% | 72% | 92% | 73% | 93% |
| SbTMC | 0.69% | 0.69% | 0.63% | 101% | 97% | 101% | 94% |
| AMVR | 0.56% | 0.70% | 0.97% | 88% | 100% | 87% | 95% |
| GPM | 1.53% | 1.79% | 1.98% | 95% | 103% | 95% | 102% |
| CIIP | 0.43% | 0.41% | 0.82% | 97% | 99% | 95% | 99% |
| MMVD | 0.50% | 0.23% | 0.27% | 94% | 98% | 96% | 100% |
| BCW | 0.24% | 0.20% | 0.52% | 94% | 93% | 96% | 94% |
| MRLP | 0.08% | -0.13% | 0.08% | 99% | 101% | 100% | 99% |
| ISP | 0.11% | 0.04% | 0.47% | 99% | 101% | 99% | 100% |
| SBT | 0.63% | -0.47% | -0.28% | 92% | 101% |  |  |
| LMCS | 0.93% | -0.30% | -0.16% | 95% | 99% | 95% | 96% |
| MIP | 0.14% | 0.27% | 0.50% | 95% | 100% | 95% | 101% |
| LFNST | 0.27% | 1.20% | 0.88% | 91% | 97% | 92% | 99% |
| JCCR | 0.14% | 1.93% | 2.44% | 100% | 102% | 99% | 101% |
| SAO | 0.12% | 0.44% | 1.23% | 98% | 95% | 101% | 101% |
| PROF | 0.33% | 0.02% | 0.21% | 98% | 99% | 98% | 101% |
| CCALF | -0.15% | 18.55% | 13.78% | 100% | 100% | 101% | 99% |

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 | 15.25% | 14.99% | 15.00% | 54% | 101% | 51% | 96% |
| IBC Class TGM | 47.75% | 45.14% | 45.22% | 63% | 105% | 61% | 97% |
| BDPCM ClassF | 0.93% | 0.92% | 0.97% | 98% | 105% | 101% | 105% |
| BDPCM ClassTGM | 1.45% | 1.58% | 1.58% | 101% | 103% | 92% | 94% |
|  |  |  |  | **RA** |  |  |  |
| IBC Class F | 12.47% | 12.52% | 12.67% | 86% | 100% | 84% | 100% |
| IBC Class TGM | 22.47% | 22.09% | 22.48% | 90% | 104% | 89% | 102% |
| BDPCM ClassF | 0.70% | 0.68% | 0.93% | 99% | 100% | 100% | 103% |
| BDPCM ClassTGM | 0.79% | 1.03% | 0.98% | 100% | 101% | 92% | 84% |
|  |  |  |  | **LD** |  |  |  |
| IBC Class F | 6.14% | 5.76% | 6.96% | 86% | 102% | 84% | 100% |
| IBC Class TGM | 11.37% | 11.96% | 12.22% | 87% | 105% | 84% | 104% |
| BDPCM ClassF | 0.35% | -0.37% | 0.35% | 100% | 103% | 96% | 98% |
| BDPCM ClassTGM | 0.29% | 0.42% | 0.37% | 99% | 99% | 95% | 83% |

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

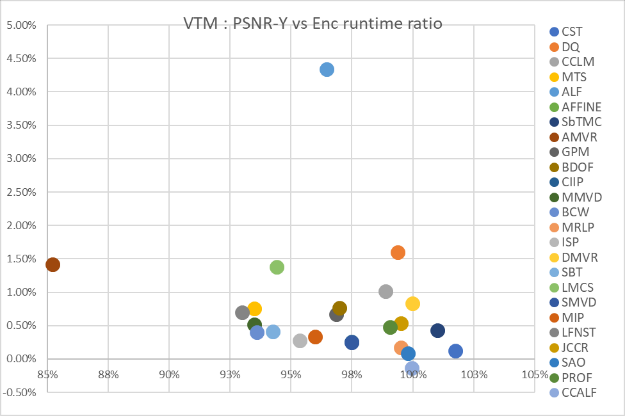
|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **AI** |  |  |  |
| **Acronym** | **BDR-Y** | **BDR-U** | **BDR-V** | **Tester EncTime** | **Tester DecTime** | **XChecker EncTime** | **XChecker DecTime** |
| PALETTE, YUV | 13.58% | 16.70% | 18.19% | 99% | 108% | 109% | 129% |
| PALETTE, RGB | 15.42% | 15.39% | 14.66% | 98% | 111% | 108% | 133% |
| ACT, RGB, Sensor | 14.85% | 0.79% | 6.32% | 75% | 99% |  |  |
| ACT, RGB, Computer | 7.83% | 2.55% | 3.50% | 97% | 101% |  |  |
|  |  |  |  | **RA** |  |  |  |
| PALETTE, YUV | 9.47% | 12.92% | 14.50% | 100% | 100% | 122% | 118% |
| PALETTE, RGB | 10.89% | 11.07% | 10.61% | 101% | 101% | 117% | 117% |
| ACT, RGB, Sensor | 25.95% | 4.01% | 10.60% | 85% | 99% |  |  |
| ACT, RGB, Computer | 12.36% | 4.93% | 5.94% | 92% | 95% |  |  |
|  |  |  |  | **LD** |  |  |  |
| PALETTE, YUV | 5.15% | 8.46% | 9.78% | 96% | 99% | 118% | 110% |
| PALETTE, RGB | 5.73% | 5.94% | 5.79% | 98% | 100% | 113% | 110% |
| ACT, RGB, Sensor | 37.93% | 7.00% | 17.57% | 88% | 96% |  |  |
| ACT, RGB, Computer |  |  |  |  |  |  |  |

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

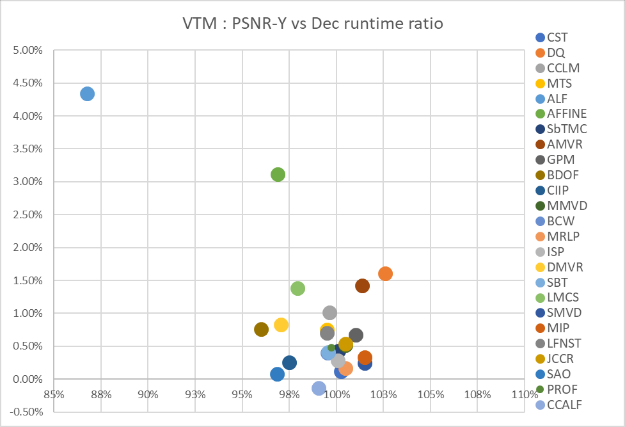
|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | AI |  | RA |  |  | LDB |  |
| Acronym | Sample usage | Sample usage | Ave mem BW | Max mem BW | Sample usage | Ave mem BW | Max mem BW |
| CCLM | 48.48% | 3.73% |  |  | 0.76% |  |  |
| ALF | 99.00% | 70.77% |  |  | 67.66% |  |  |
| AFFINE |  | 17.84% |  |  | 27.00% |  |  |
| SbTMC |  | 10.40% |  |  | 12.92% |  |  |
| AMVR |  | 5.43% |  |  | 2.51% |  |  |
| GPM |  | 2.44% |  |  | 6.00% |  |  |
| BDOF |  | 45.00% |  |  |  |  |  |
| CIIP |  | 0.90% |  |  | 1.55% |  |  |
| MMVD |  | 6.84% |  |  | 8.44% |  |  |
| BCW |  | 9.94% |  |  | 8.28% |  |  |
| MRLP | 6.52% | 0.59% |  |  | 0.23% |  |  |
| DMVR |  | 40.35% |  |  |  |  |  |
| SBT |  | 2.61% |  |  | 4.27% |  |  |
| SMVD |  | 2.89% |  |  |  |  |  |
| MIP | 23.77% | 5.09% |  |  | 2.40% |  |  |
| LFNST | 9.86% | 0.79% |  |  | 0.35% |  |  |
| JCCR | 10.96% | 0.50% |  |  | 0.11% |  |  |
| SAO | 31.18% | 6.92% |  |  | 7.76% |  |  |

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

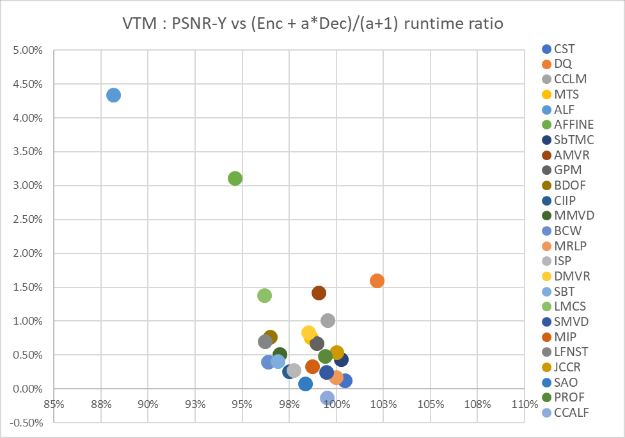
|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **VTM RA** |  |  |  |
| **Abbreviation** | **VTM3** | **VTM4** | **VTM5** | **VTM6** | **VTM7** | **VTM8** | **VTM9** |
| CST | 0.72% | 1.08% | 1.22% | 0.96% | 0.88% | 0.80% | 0.96% |
| DQ | 1.41% | 1.39% | 1.27% | 1.27% | 1.28% | 1.41% | 1.42% |
| CCLM | 3.94% | 4.01% | 3.84% | 3.57% | 3.60% | 3.26% | 3.43% |
| MTS | 1.25% | 0.82% | 0.37% | 0.68% | 0.70% | 0.71% | 0.73% |
| ALF | 3.61% | 3.71% | 4.78% | 4.65% | 4.63% | 7.06% | 7.18% |
| AFFINE | 2.43% | 2.47% | 2.39% | 2.82% | 2.80% | 2.80% | 2.93% |
| SbTMC | 0.52% | 0.43% | 0.40% | 0.48% | 0.43% | 0.43% | 0.41% |
| AMVR | 0.97% | 1.11% | 1.13% | 1.60% | 1.59% | 1.56% | 1.60% |
| GPM | 0.43% | 0.43% | 0.40% | 0.39% | 0.44% | 0.74% | 0.77% |
| BDOF | 1.02% | 0.63% | 0.67% | 0.67% | 0.66% | 0.66% | 0.66% |
| CIIP | 0.43% | 0.51% | 0.32% | 0.24% | 0.23% | 0.22% | 0.20% |
| MMVD | 0.81% | 0.52% | 0.59% | 0.52% | 0.51% | 0.51% | 0.50% |
| BCW | 0.48% | 0.45% | 0.46% | 0.43% | 0.41% | 0.40% | 0.41% |
| MRLP | 0.24% | 0.18% | 0.17% | 0.18% | 0.14% | 0.12% | 0.15% |
| ISP |  | 0.24% | 0.12% | 0.20% | 0.30% | 0.28% | 0.28% |
| DMVR |  | 0.80% | 0.87% | 0.87% | 0.89% | 0.88% | 0.90% |
| SBT |  | 0.33% | 0.34% | 0.31% | 0.31% | 0.31% | 0.32% |
| LMCS |  | 0.64% | 0.61% | 0.97% | 1.36% | 1.32% | 1.32% |
| SMVD |  | 0.26% | 0.24% | 0.27% | 0.26% | 0.26% | 0.24% |
| MIP |  |  | 0.28% | 0.32% | 0.37% | 0.34% | 0.34% |
| LFNST |  |  | 0.75% | 0.60% | 0.74% | 0.75% | 0.75% |
| JCCR |  |  | 0.28% | 0.35% | 0.32% | 0.41% | 0.41% |
| SAO | 0.80% | 0.63% | 0.16% | 0.13% | 0.12% | 0.10% | 0.11% |
| PROF |  |  |  | 0.41% | 0.39% | 0.38% | 0.40% |
| CCALF |  |  |  |  |  | 2.30% | 2.53% |



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



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



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

The AHG recommended the following:

* Consider the reported tool test results during tool adoption decision making
* Refine list of tested tools and test methodology for the next meeting cycle

Overall, there was not much change except for chroma-related features.

Bitstreams used in the testing had been uploaded to the server.

[JVET-S0014](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10381) 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 18th JVET meeting via Teleconference 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 20th May 2020. No further emails have been exchanged related to the AHG.

The results for VTM-9.0 relative to VTM-8.0 for the 420 test set are as follows.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | **Random Access** | | |
| **ratio** | | bit-rate savings | **ratio** | | bit-rate savings |
| VTM-8 | VTM9 | VTM8 | VTM9 |
| Class A1 | 2.4 | 2.4 | 0.05% | 2.4 | 2.4 | 0.05% |
| Class A2 | 1.8 | 1.8 | 0.03% | 1.9 | 1.9 | 0.02% |
| Class B | 2.3 | 2.3 | 0.03% | 2.5 | 2.5 | 0.03% |
| Class C | 2.1 | 2.1 | 0.04% | 2.6 | 2.6 | 0.05% |
| Class D | 2.1 | 2.1 | 0.05% | 2.9 | 2.9 | 0.02% |
| Class E | 3.1 | 3.1 | 0.01% |  |  |  |
| Class F | 5.8 | 5.8 | 0.03% | 35.4 | 35.4 | 0.04% |
| TGM | 12.4 | 12.4 | 0.05% | 109.0 | 108.9 | 0.05% |
| **Overall** | **2.3** | **2.3** | **0.03%** | **2.4** | **2.4** | **0.04%** |
| Enc Time[%] | 101% | | | 95% | | |
| Dec Time[%] | 103% | | | 102% | | |

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-9.0 relative to HEVC Main/Main10 are as follows.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | **Random Access** | | |
| **ratio** | | bit-rate savings | **ratio** | | bit-rate savings |
| HM-16.20 | VTM-9.0 | HM-16.20 | VTM-9.0 |
| Class A1 | 2.2 | 2.4 | -6.83% | 2.3 | 2.4 | -5.82% |
| Class A2 | 1.7 | 1.8 | -5.09% | 1.8 | 1.9 | -3.52% |
| Class B | 2.2 | 2.3 | -6.57% | 2.3 | 2.5 | -4.52% |
| Class C | 1.9 | 2.1 | -7.49% | 2.5 | 2.6 | -4.63% |
| Class D | 1.9 | 2.1 | -9.66% | 2.8 | 2.9 | -5.04% |
| Class E | 2.7 | 3.1 | -11.12% |  |  |  |
| Class F | 4.5 | 5.8 | -19.77% | 26.6 | 35.4 | -15.48% |
| TGM | 6.1 | 12.4 | -46.88% | 74.4 | 108.9 | -32.08% |
| **Overall** | **2.1** | **2.3** | **-7.33%** | **2.3** | **2.4** | **-4.61%** |
| Enc Time[%] | 2790% | | | 1270% | | |
| Dec Time[%] | 156% | | | 135% | | |

The results for VTM-9.0 relative to HEVC RExt are as follows.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | **Random Access** | | |
| **ratio** | | bit-rate savings | **ratio** | | bit-rate savings |
| HM-16.20 RExt | VTM-9.0 | HM-16.20 RExt | VTM-9.0 |
| Class A1 | 2.3 | 2.4 | -2.44% | 2.4 | 2.4 | -2.02% |
| Class A2 | 1.8 | 1.8 | 0.85% | 1.9 | 1.9 | 1.08% |
| Class B | 2.3 | 2.3 | -1.58% | 2.4 | 2.5 | -1.97% |
| Class C | 2.0 | 2.1 | -2.18% | 2.5 | 2.6 | -2.46% |
| Class D | 2.1 | 2.1 | -1.98% | 2.9 | 2.9 | -2.54% |
| Class E | 3.0 | 3.1 | -3.16% |  |  |  |
| Class F | 5.2 | 5.8 | -8.94% | 30.6 | 35.4 | -7.85% |
| TGM | 8.1 | 12.4 | -31.61% | 99.5 | 108.9 | -13.59% |
| **Overall** | **2.3** | **2.3** | **-1.72%** | **2.3** | **2.4** | **-1.50%** |
| Enc Time[%] | 2966% | | | 1225% | | |
| Dec Time[%] | 168% | | | 145% | | |

1. **Recommendations**

The AHG recommends:

* Close the AHG.

(Not compared to HEVC SCC, not tested with mixed lossy/lossless.)

(There was no effort at optimizing the encoder specifically for lossless. It was commented that a lot of encoder simplification could be done to optimize for that. It is not necessarily the case that VVC encoding needs to have high complexity for lossless coding.)

Lossless is basically “for free” from the decoder perspective.

[JVET-S0015](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10382) 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 18th Meeting (teleconference, 15 – 24 April 2020) and the 19th Meeting (teleconference, 22 June – 1 July 2020).

There were no emails besides AHG kickoff message sent to the JVET reflector during the AHG period.

The following contribution was identified as related to AHG15.

* [JVET-S0130](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10252), On chroma QP mapping, L. Li, X. Li, B. Choi, S. Wenger, S. Liu (Tencent)

***VTM Software related activities***

The two following quantization control techniques from VTM were exercised:

1. Perceptual QP adaptation (perceptQPA).
2. R-D based QP adaptation.

Both methods allow to select and transmit CU level delta QP value and can be used in VTM 9.

Bitstreams generated by perceptual QP adaptation were submitted to VVC Conformance AhG.

The AHG recommended to review all related contributions.

It was asked how much gain is available from R-D optimized QP adaptation and whether that is used in the HM anchor. It was noted that this has a large runtime impact. It was commented that this is probably not being used in the HM anchors.

[JVET-S0016](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10383) 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 18th JVET meeting by teleconference (15–24 April 2020), and the 19th JVET meeting by teleconference (22 June – 1 July 2020).

No email discussion was observed on the JVET email reflector.

It was identified that the CTU size of the current picture and its collocated reference picture can differ if the reference picture is an ILRP. This creates implementation difficulties due to the memory misalignment when fetching the collocated temporal motion data for the current VPDU. It was suggested to address this issue. Contribution JVET-S0174 is on that topic.

The following two contributions are identified for the AHG:

* JVET-S0224, “AHG16: Performance of a reasonably fast VVC software decoder” [F. Bossen (Sharp)]
* JVET-S0174, “AHG9: Miscellaneous cleanups” [R. Skupin, Y. Sanchez, K. Suehring, T. Schierl (HHI)]

The AHG recommended reviewing the input contributions.

[JVET-S0017](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10384) JVET AHG report: SEI message studies (AHG17) [S. McCarthy, J. Boyce, P. de Lagrange, A. Luthra, A. Tourapis, Y.-K. Wang, S. Wenger]Formularende

This document summarizes the activity of AHG17: SEI message studies between the 18th JVET Meeting (teleconference, 15-24 April 2020) and the 19th JVET Meeting (teleconference, 22 June – 01 July 2020).

The following contributions were identified as related to AHG17. It is noted that none of the contributions were identified as AHG17. Instead, all were identified as one or more of the following: AHG 8, 9, and 12.

***Contributions related to the VVC draft specification***

[JVET-S0099](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10221), AHG12: SEI message handling in subpicture extraction [R. Skupin, Y. Sanchez, K. Suehring (HHI), V. Drugeon (Panasonic)]

[JVET-S0175](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10297), AHG9: Cleanup of picture rate info and HRD operation without timing SEI messages [Y. Sanchez, R. Skupin, K. Suehring, T. Schierl (HHI)]

[JVET-S0176](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10298), AHG9: On the subpicture level information SEI message [Y.-K. Wang, Z. Deng (Bytedance)]

[JVET-S0177](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10299),AHG9: On the scalable nesting SEI message [Y.-K. Wang, Z. Deng (Bytedance)]

[JVET-S0178](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10300), AHG9: General SEI semantics and constraints [Y.-K. Wang, Z. Deng (Bytedance)]

***Contributions related to ITU-T H.SEI | ISO/IEC 23002-7***

**Modification of existing SEI messages**

[JVET-S0172](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10294), AHG9: On generalized cubemap projection SEI message [Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek)]

**Proposed new SEI messages**

[JVET-S0051](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10173), AHG9: Digital signature SEI message [J. Xu, Y.-K. Wang, L. Zhang, K. Zhang (Bytedance)]

[JVET-S0107](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10229), AHG9/AHG12: Recommended multi-layer composite picture SEI messages, [J. Boyce (Intel)]

[JVET-S0108](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10230), AHG8/AHG9: Refinement of proposed positioning information SEI message of output independent layers [E. Thomas (TNO)]

[JVET-S0213](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10335), AHG8/AHG9: Refinement of proposed positioning information SEI message of output independent layers with example bitstreams [E. Thomas (TNO)]

[JVET-S0214](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10336), AHG8/AHG9: Updates on the implementation of multi-layer decoding and output independent layer arrangement in VTM [E. Thomas (TNO)]

1. **Activities**

***Email activities***

The regular JVET e-mail reflector was used for discussions ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de)) with [AHG17] in message headers. There were no emails besides the AHG kickoff message sent to the JVET reflector during the AHG period.

***Activities related to 27-28 May 2020 HLS AHG meeting***

The following contributions were identified as related to hypothetical reference decoder (HRD) (Section 3.1.8 in the Agenda and [Draft] reports of the 27-28 May 2020 HLS AHG pre-meeting (JVET-S0137) and of the 19-21 June HLS AHG pre-meeting (JVET-S0237)). JVET-S0175 (aspects 1,2, and 3) was discussed during the 19-21 June pre-meeting.

[JVET-S0099](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10221) AHG12: SEI message handling in subpicture extraction [R. Skupin, Y. Sanchez, K. Suehring (HHI), V. Drugeon (Panasonic)]

[JVET-S0175](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10297) AHG9: Cleanup of picture rate info and HRD operation without timing SEI messages [Y. Sanchez, R. Skupin, K. Suehring, T. Schierl (HHI)]

[JVET-S0176](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10298) AHG9: On the subpicture level information SEI message [Y.-K. Wang, Z. Deng (Bytedance)]

[JVET-S0177](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10299) AHG9: On the scalable nesting SEI message [Y.-K. Wang, Z. Deng (Bytedance)]

[JVET-S0178](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10300) AHG9: General SEI semantics and constraints [Y.-K. Wang, Z. Deng (Bytedance)]

The following contributions were identified as related to DCI, VUI, and SEI (Section 3.1.9 in the Agenda and [Draft] reports of the 27-28 May 2020 HLS AHG pre-meeting (JVET-S0137) and of the 19-21 June HLS AHG pre-meeting (JVET-S0237)). JVET-S0172 was discussed during the 19-21 June pre-meeting.

[JVET-S0051](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10173) AHG9: Digital signature SEI message [J. Xu, Y.-K. Wang, L. Zhang, K. Zhang (Bytedance)]

[JVET-S0107](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10229) AHG9/AHG12: Recommended multi-layer composite picture SEI messages [J. Boyce (Intel)]

[JVET-S0108](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10230) AHG8/AHG9: Refinement of proposed positioning information SEI message of output independent layers [E. Thomas (TNO)]

[JVET-S0172](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10294) AHG9: On generalized cubemap projection SEI message [Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek)]

[JVET-S0213](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10335) AHG8/AHG9: Refinement of proposed positioning information SEI message of output independent layers with example bitstreams [E. Thomas (TNO)]

[JVET-S0214](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10336) AHG8/AHG9: Updates on the implementation of multi-layer decoding and output independent layer arrangement in VTM [E. Thomas (TNO)]

The AHG recommends to:

* Review all related contributions;
* Continue SEI messages studies.

It was remarked that we should encourage participants to remember to identify AHG17 (or what it will become) in titles when submitting related contributions.

Revisit to consider how future SEI messages would be specified – whether there needs to be an impact on the VVC spec for each SEI message added to the SEI spec (and whether there should be such an impact). It was noted that we have been implementing SEI messages in the VTM software (not in some other software).

AHG report reviews were completed at the end of the second JVET meeting session, at 1720 Monday 22 June.

# Project development (12)

## General (0)

## Text and software development (1)

[JVET-S0152](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10274) AHG2: Editorial input of a text integration for the May 2020 HLS AHG meeting outcome [Y.-K. Wang (Bytedance)]

[Add summary]

Moving forward based on this was agreed in the opening plenary; see notes in section 2.11.

[JVET-S0249](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10388) AHG3: Bugfix to LMCS with multiple slices in VTM-9.0 encoder [J. Lee, Y. Ahn (Digital Insights)] [late]

Discussed Wed 06/24 1550-1610 UTC (chaired by JRO)

In the current VTM, the forward LMCS function applies to an original picture at the encoder-side. If an original picture is divided into multiple slices, tiles, and sub-pictures, it is required to applying the forward LMCS function for each slice, respectively. However, VTM-9.0 encoder repeatedly applies the function to the whole original picture for the coding loop of slices. In this contribution, it is proposed that one-line source code change in VTM-9.0 software to fix this bug.

In addition, fundamental problems which repeatedly performed forward LMCS function for a whole picture per each slice remain even when the proposed method is applied. Therefore, a CTU-level forward LMCS function is additionally proposed to solve the above-mentioned problem.

The current VTM encoder does not support LMCS with multiple slices correctly, as the forward mapping would be applied multiple times. There is probably something that needs to be fixed, but it isnot clear yet which of the solutions would be more appropriate. The original proponents of LMCS had studied the first solution (which was provided in v1 of S0249), but mentioned that the second solution (CTU level from v2) might be better.

Decision (SW BF): Adopt JVET-S0249, solution from v1 of the submission.

Further study recommended on the CTU level variant of v2.

[JVET-S0257](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10396) SW Support of 360 SEI Messages [[Y. Wang](mailto:wangyang.cs@bytedance.com), [Y. He](mailto:yuwen.he@bytedance.com), [L.Zhang (Bytedance)](mailto:lizhang.idm@bytedance.com)] [late]

Discussed Wed 06/24 1610-1630 UTC (chaired by JRO)

The document provides a software support of 360 SEI messages used by 360Lib software. The software patch for VTM decoder can output 360 SEI messages (i.e., equirectangular projection SEI, generalized cubemap projection SEI) in a format that 360Lib software can use for project format conversion and viewport extraction directly.

GCMP is implemented as specified in VVC (which was not the case in 360Lib before, which had a different orientation of the faces). Furthermore, SEI messages can be decoded and directly be interpreted by 360Lib interface at the decoder output (by dumping the data into the conf file of 360Lib), and also the 360Lib produces the correct packing from the SEI message data fed into the encoder.

Decision (SW 360Lib & VTM interface): Adopt JVET-S0257

DIS ballot comments and Draft DoCR

“NOTE”s may be rephrased or converted to body text, and other editorial guidance from ISO CS may be applied in the final text.

## Test conditions (2)

[JVET-S0180](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10302) Addition of a GOP hierarchy of 32 for random access configuration for VTM [K. Andersson, J. Enhorn, R. Sjöberg, J. Ström, L. Litwic (Ericsson)]

This was discussed during 1900–1935 on 26 June (JRO)

It is proposed to include a GOP hierarchy of 32 for random access configuration to VTM and it is also suggested to use it for CTC. This will increase the number of pictures in the DPB by one compared to a GOP hierarchy of 16 such that the DPB requirements are 8, e.g. at the maxDpbPicBuf, instead of 7. It will also increase the end-to-end latency by additional 2x16/60 seconds for 60 Hz video which is expected to be acceptable for a wide range of random access applications. Enabling a GOP hierarchy of 32 also for sequences which not have an intra period which is a multiple of 32 requires adjustment of the intra period for those sequences such that the intra period becomes a multiple of 32, e.g. frame rate 50/60Hz will have an intra period of 64 and frame rate 30Hz or below will have an intra period of 32.

The BD rate effect of this change is as follows:

CTC SDR RA -3.0%, -6.3%, -6.4% (luma,Cb/Cr)

CTC HDR RA -7.8%, -5.2, -4.4%, -4.2% (deltaE, psnrL, wpsnrY, psnrY)

It is also asserted that the visual quality is improved.

Cross checker reports that the configuration has some reduction of pumping artifact (more stability over time), but also had the impression that some sequences had some more blurring in sequences with high motion and high amount of detail (e.g. Red Kayak), in particular at the frames of the additional highest temporal layer.

The proposal not only increases the GOP size, but also makes more adjustment on QPs (more quality on lowest temporal layer). A similar contribution (B0039) was brought in 2016, where additional adjustment of lambda had been made.

According to one expert’s opinion, the adjustment of QP may be more contributing to the gain than the larger GOP size. It was asked if adjustment of QPs was also exercised with GOP16. This was not exercised.

In 2016, one argument against the proposal was the increase of memory. This would however not be a problem with current VVC specification. Some concern is raised on the additional VTM encoder memory.

It is also mentioned that more benefit could be expected for higher frame rate sequences.

It was suggested to include this as an additional configuration, but not CTC at this moment. It should also be investigated as a possible configuration for verification test, provided that the visual quality is improved rather than introducing artifacts.

Decision (SW/nonCTC): Adopt JVET-S0180 as an additional configuration for RA.

[JVET-S0262](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10402) Crosscheck of JVET-S0180 (Addition of a GOP hierarchy of 32 for random access configuration for VTM) [C. Helmrich (HHI)] [late]

[JVET-S0244](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10366) AHG13: On RGB Common Test Condition Regarding LMCS [J. Zhao, Hendry, S. Kim (LGE)] [late]

This was discussed during 1935–1945 on 26 June (JRO)

This contribution reports the LMCS tool off performance for RGB sequences. Result show that LMCS performance on RGB sequences is questionable; it has quite large loss on many RGB sequences. It is unclear whether this is because LMCS is not suitable for RGB sequences or just VTM encoder was not doing a good job on evaluating LMCS parameters. To avoid the confusion and negative performance impact, it is proposed to turn LMCS off for RGB sequences in the non-420 common test condition. This is configuration setting change only.

For RGB Natural content, VTM9 encoder already decides to disable LMCS for 3 out of the 8 sequences. Using VTM9 as reference, average gain of turning off LMCS to all sequences is (-2.07%, 0.59%, -0.55%) for AI, (-1.77%, -2.31%, -1.59%) for RA, -(xx%, xx%, xx%) for LDB.

For RGB Screen Content, VTM9 encoder already decides to disable LMCS for 13 out of 14 sequences.. For the one sequence that keeps LMCS enabled, turning off LMCS gives gain of (-0.6%, -0.3%, -1.2%) for AI, (-0.2%, 0.5%, -0.9%) for RA, and (xx%, xx%, xx%) for LDB.

If using VTM9 with the mismatch fix proposed in JVET-S0234 as reference, turning off LMCS still performs better for most of the RGB sequences. For RGB natural content, the average gain is (-1.66%, 0.54%, -0.21%) for AI, (-1.28%, -2.29%, -1.08%) for RA, and (xx%, xx%, xx%) for LDB.

Results indicate that LMCS introduces loss for RGB test sequences (still also with the bug fix of S0234). This is likely due to the fact that the LMCS encoder has been designed for YUV.

Decision (CTC): Disable LMCS in non-420 CTC, RGB configuration file.

[JVET-S0263](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10403) Crosscheck of JVET-S0244: AHG13: On RGB Common Test Condition Regarding LMCS [X. Xiu (Kwai)] [late]

## Verification test planning (8)

[JVET-S0041](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10163) Status Report on SDR Verification Test Preparation [M. Wien (RWTH), V. Baroncini (VABTECH ltd)]

Had been presented in AHG meeting on 05-15

[JVET-S0043](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10165) Agenda and Report of the AHG4 Meeting on the SDR Verification Test on 2020-05-15 [M. Wien (RWTH), V. Baroncini (VABTECH), T. Suzuki (Sony)]

No need to present – reporting AHG discussions on 05-15 and planning made there, which is further reported and refined in S0253

[JVET-S0146](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10268) Status Report on 360º video Verification Test Preparation [M. Wien (RWTH), V. Baroncini (VABTECH ltd), Y. Ye (Alibaba)]

Had been presented in AHG meeting on 05-27

[JVET-S0149](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10271) Agenda and Report of the AHG4 Meeting on the 360 Verification Test on 2020-05-27 [M. Wien (RWTH), Y. Ye (Alibaba), V. Baroncini (VABTECH ltd), T. Suzuki (Sony)]

No need to present – reporting AHG discussions on 05-27 and planning made there, which is further reported and refined in S0253

[JVET-S0151](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10273) Status Report and Proposed Agenda for the AHG4 Meeting on HDR Verification Test Preparation [A. Segall (Sharp)]

Had been presented in AHG meeting on 05-29

[JVET-S0153](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10275) Agenda and Report of the AHG4 Meeting on the HDR Verification Test on 2020-05-29 [A. Segall, M. Wien, V. Baroncini, T. Suzuki]

No need to present – reporting AHG discussions on 05-29 and planning made there, which is further reported and refined in S0253

[JVET-S0246](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10385) Results of dry run subjective assessment of SDR UHD verification test [V. Baroncini, M. Wien]

The draft plan for VVC verification testing (Draft 2) [[JVET-R2009](http://phenix.int-evry.fr/jvet/doc_end_user/documents/18_Alpbach/wg11/JVET-R2009-v1.zip)] includes a set of UHD SDR test sequences under consideration for use in the formal verification tests of VVC. According to the timeline of this plan, a preselection and preparation of test sequences and corresponding rate points for viewing has been carried out as described in document JVET-S0041. Out of the 13 test sequences listed in JVET-R2009, 8 test sequences were selected. The selection process and the experts viewing session subsequently conducted are described in this document. Starting from the selection described in JVET-S0041, a set of 4 test sequences were selected to run a Dry Run formal subjective assessment. A set of 5 rate points was selected for the assessment of each test sequence. The results indicate that the selected rate points cover the intended MOS range for most of the test sequences. Modifications and improvements to the set of test sequences and to the VTM and HM QP selection are suggested.

Presented Tue 06-23 1455 UTC (chaired by JRO)

Some alignment of rate points for Neptune Fountain, where VTM saturates at highest rate. More intermediate points, and/or slightly lower lowest rate point.

It is also observed that in many cases where VTM is slightly worse in PSNR, it is slightly better in MOS, which seems to indicate that subjective benefit over HEVC is larger than PSNR benefit.

It is also suggested that a fifth sequence (Tall Buildings) should be used in the final verification test.

[JVET-S0253](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10392) Update on Verification Test Preparation [M. Wien, V. Baroncini, A. Segall, Y. Ye]

The status of the verification test preparation is summarized. In the SDR category, a close-to-final definition of test sequences and selection of rate points for VTM and HM in the UHD Random Access test case are presented. For the HD Low Delay test case, the identification of test sequences is in progress. For the HDR category, a candidate set of five QP and five HLG sequences with corresponding QP settings are proposed for visual inspection. A tone mapping procedure has also been determined to enable the viewing of the PQ content on available UHD displays. In the 360° video category, viewpaths have been designed. The applicable projection formats for the sequences have to be determined in order to define VTM and HM QPs for the rate points to be assessed visually.

Presented Tue 06-23 1310 UTC (chaired by JRO)

It was pointed that the scoring drawn from remote expert viewing should not be interpreted to allow conclusions of rate saving or quality improvement of VVC. Its only intent was identification of useful test cases (sequences, QP settings, etc.). The real verification test will be conducted with non-expert viewers, for which a first dry run is reported in S0246 (for the case of SDR UHD).

For SDR UHD, the initial selection of sequences and rate points seems largely appropriate. Should be re-run with VTM9 for the new alignment of chroma vs luma

SDR HD: Initial investigation of possible sequences. Total of 8 sequences, suggested to encode in LDB with same span of QPs as used earlier: VTM: 26, 30, 34, 38, 42, 46, and HM from 24 to 44

For HDR, some difficulties occurred in terms of configuring displays appropriately. It is planned to use PC playout (if possible) together with external display configuration, such that VVC streams could be re-encoded as HEVC with sufficiently high rate. When using the internal HEVC decoder of the displays (which is simpler to configure together with HDR mode switching), the rate is limited such that the re-encoding might not be transparent.

5-6 experts would be needed to participate. Currently, 6 experts were identified, but displays and playout configurations are somewhat different. However, this seems to be sufficient for a starting point.

To be done: HEVC transcoding for PC and internal playout, clarification of local setups and specific properties of displays, initial selection of QP points, generation of playlists. Mathias, Kenneth, Andrew and Vittorio will work offline on that together with the prospective expert viewers.

For 360, a set of 7 sequences was pre-selected, but some re-encoding is necessary, as lower QP points may be needed. Also, two sequences have artifacts in the first frame.

It was discussed whether a configuration with subpictures should be used and if yes, how many should be used. Some mentioning of typically 96 is made for viewport-dependent streaming. However, it is unclear if HM could be configured for an appropriate comparison using MCTS and flexible tiles.

It was further discussed if configuring VVC with 2 or 6 subpictures (and SP boundaries treated as picture boundaries) could give additional benefit for subjective quality of VVC. Current encodings don’t use subpictures, and for selecting test cases this is probably good enough. Further study should be conducted for including VVC with a subpicture configuration in the final verification test.

Before expert viewing can be started, viewport extraction needs to be performed. Proposed viewports are available.

To be done: Re-encoding of Kite Flite and Harbour without first frame, viewport extraction, then expert viewing. Mathias, Vittorio, Yan will contact people for that.

Follow-up presentation (slides in v2 of JVET-S0253)

This was discussed during at 2030 UTC on Saturday 26 June (JRO).

SDR HD

* Six candidate sequences available on ftp site
* Encoding in progress
* Upon availability of bitstreams
  + Check of RD curves, pre-screening for lowest / highest VTM QPs
  + Definition of 5 VTM / HM QP pairs
  + Setup of experts viewing session

HDR PQ:

* Three sites now available to perform remote expert viewing (all with LG OLED monitors)
* Work in progress to bring up two more sites with non-LG monitors
  + Doublecheck on processing steps on going
  + Playout of 4000nits material may require additional pre-processing when using an X550 setup

HDR HLG:

* Scan of material appeared to be ok
* Proceeding to QP selection as next step
* New versions HarbourBiking2 and KiteFliteWalking2 uploaded to ftp site (generated by Johannes)
* Re-encoding of sequences in progress (thanks to ByteDance and Alibaba)
* Viewport extraction done,
* Pre-screening for lowest / highest VTM QPs in progress
  + More effort: Consideration of projection formats (PERP, and PCMP <-> GCMP/HEC)
* Definition of 5 VTM / HM QP pairs
* Setup of experts viewing session

## Coding studies and tools on specific use cases (6)

[JVET-S0264](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10404) Performance Comparison of Screen Content Coding between HEVC and VVC [X. Xu, S. Liu (Tencent)] [late]

This was discussed during 1945–2000 on 26 June (JRO).

This document provides coding performance comparisons between HEVC and VVC, focusing on screen content materials. The simulation results using HEVC and VVC reference software (HM, SCM and VTM) are provided and compared. It is reported that VTM-9 software achieves around 61% BD rate reductions on 4:2:0 TGM class for 3 tested conditions as compared to HM-16.20; while the gains on 4:2:0 TGM 1080p class are 14%/27%/34% for AI/RA/LDB conditions when compared to SCM-8.6. The performance differences are roughly in line with 4:2:0 results when 4:4:4 materials are tested.

[Ed. The tables here are formatted as pictures!]

SCC performance comparisons between HEVC (HM and SCM) and VVC (VTM), 4:2:0 format



SCC performance comparison between HEVC (HM) and VVC (VTM), 4:4:4 format



SCC performance comparison between HEVC (SCM) and VVC (VTM), 4:4:4 format



The 4:2:0 test was without palette in VVC (as this is not in 420 profile), while SCM uses palette.

The SCM also used whole-frame IBC referencing, which is not supported in VVC.

Results indicate that VVC still achieves significant gain over HEVC SC profile. This is remarkable as the screen content specific tools are conceptually quite similar (except TSRC which is new), and even better designed for implementation such as small reference area for IBC. When IBC search range would be restricted in HEVC, the gap would probably be much larger.

No specific action was necessary on this.

[JVET-S0243](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10365) On operation beyond 10-bit [A. Browne, S. Keating, K. Sharman (Sony)] [late]

This contribution was discussed at 1530 on 24 June (JRO). It was originally categorized in section 5, but the notes were moved here since it is beyond the scope of VVC v1.

This submission considers the viability of a future 12-bit profile for VVC and whether VVC can be used unchanged at this operating point. Both the coding efficiency and encoder / decoder complexity are considered.

Above 12-bit an issue with the Golomb-Rice coding is reported as the cause of a significant reduction in performance from VVC. Remedies are suggested and further techniques are described, and it is reported that such modifications might allow VTM to be more efficient than HM. It is also indicated that these changes can improve on the existing performance of VVC at the top end of a future 12 bit profile. The submission also highlights the complexity increase of VVC/VTM over HEVC/HM.

A further issue with bitrates associated with processing RGB 4:4:4 content is described and future work is encouraged.

This is a follow-up of JVET-R0351. It is reported that results of the software branch for higher bit depth are largely unchanged in VTM9. VTM starts becoming less performant than HM beyond 60 dB. The contributor asserts that this is due to GR coding.

Further study in AHG – see notes under S0228.

[JVET-S0228](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10350) Transform coefficients range extension for high bit-depth [T. Zhou, T. Chujoh, E. Sasaki, T. Ikai (Sharp)]

This contribution was discussed together with those in section 5, but the notes were moved here since it is beyond the scope of VVC v1.

This contribution proposes a format range extension design for high bit depth coding. In HEVC format range extension (RExt), the extended precision flag (extended\_precision\_processing\_flag) is specified. When extended precision flag is equal to 1, it extends the transform coefficient range from 15 bit to BitDepth + 6 bit and modifies a bdShift value from 20 – BitDepth to 11. However, this extended precision flag was only supported in 16 bit profiles (Monochrome 16, Main 4:4:4 16 Intra, and Main 4:4:4 16 Still Picture) and variables in 10 bit case are also changed according to the flag. This contribution proposes to use BitDepth + 5 and bdShift to 10 in the range of 10 to 16 bit case in VVC. It is reported that high precision design provides better coding performance compared with the current bit depth precision in 12, 14 bit case as well as 16 bit case.Discuss with parent bodies as possible v2 item. Requires requirement study and studying the need for it – including the question if VVC is an attractive alternative to HEVC in this area.

Set up AHG to study potential need for alignments of tools, benefit of VVC tools for high bit rate sequences, testing conditions for higher bit depth, native higher bit depth sequences, etc.

It is pointed out that this could also be highly relevant for future HDR solutions.

[JVET-S0229](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10351) Bug fix of BDOF for high bit-depth [T. Chujoh, E. Sasaki, T. Ikai (Sharp)]

This contribution was discussed together with those in section 5, but the notes were moved here since it is beyond the scope of VVC v1.

At the previous April meeting, JVET-R0351 indicated that several coding tools do not work well in case of a high bit-depth coding. BDOF is one of them. In this contribution, a bug fix of specification and software for BDOF when the bit-depth is greater than 12-bit is proposed. As experimental results show, the performance has been improved when InternalBitDepth is equal to 14. This proposal does not change the specification when the bit-depth is from 8-bit to 12-bit and keep the internal bit precision of BDOF even if the bit-depth is greater than 12-bit.It is pointed out that the results may be difficult to interpret, as 10-bit sequences were used also for higher bit depth.

No urgent need for action was identified. At least for 10 bit video, nothing is wrong. Further study was recommended to see if there is a need for making changes in higher bit depths than that. This could be part of the AHG study mentioned under S0228.

[JVET-S0251](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10390) Crosscheck of JVET-S0229 (Bug fix of BDOF for high bit-depth) [Adrian Browne, Karl Sharman, Steve Keating (Sony)] [late]

[JVET-S0259](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10398) Crosscheck of JVET-S0229 (Bug fix of BDOF for high bit-depth) [[Y. Kidani](mailto:yo-kidani@kddi.com), [K. Kawamura (KDDI)](mailto:ki-kawamura@kddi.com)]

## Test material (1)

[JVET-S0218](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10340) 4K HLG test sequences for HDR verification test [S. Iwamura, S. Nemoto, A. Ichigaya (NHK)] [late]

2055–2115 on 26 June (JRO)

This contribution provides new 4K test sequences with Hybrid Log-Gamma (HLG) transfer characteristics. A total of 12 new sequences are provided as candidates for VVC HDR verification test. All the sequences are captured in 8K cameras without pre-compression and down converted into 4K resolution using HDRTools. Note that the chroma location type of those provided sequences is type-2. In the 18th JVET meeting, it was pointed out that the chroma location type of existing 7 HLG test sequences (H2\_HLG1 to H2\_HLG7) was type-0 and the preference of recreation of those sequences as type-2 sequences was expressed. As per the request, the recreated existing sequences as type-2 are also provided in this contribution. Furthermore, during intermediate AHG meeting between 18th and 19th JVET meeting, 5 candidate sequences and suggested QP range were selected. The coding experiments for those sequences with the selected QP range are also provide.

The new sequences (captured in Amsterdam) come only with type-2 chroma location.

The sequences with type-2 chroma location are all named H3\_... (as a new category of HLG, where H2\_... is continued to be used for HLG with type-0)

Sequences are made available in the ftp test sequence site under /ahg/candidates\_hdr/HLG/JVET-S0218 on the test sequences ftp site.

5 of those sequences (three new “Amsterdam” and two from previous H2 category) had already been preselected to be used in the verification test. Those two with type-0 chroma location should be replaced by those modified with type-2 chroma location (H3 category) in the final verification test.

It was asked whether 8K versions could be made available. This would be very valuable for conducting 8K verification tests. The proponent says that it is not clear if copyright could be granted for those.

Decision(CTC): Update CTC for HDR such that type-2 sequences are used in HLG class.

Revisit: Express thanks in resolutions.

## Conformance (0)

## Implementation studies (AHG16) (1)

[JVET-S0224](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10346) AHG16: Performance of a reasonably fast VVC software decoder [F. Bossen (Sharp)]

2010–2030 on 26 June (JRO)

Performance of a reasonably fast VVC software decoder is provided: it is asserted to run about 30 times faster than VTM on an 8-core processor when processing 4K bitstreams (CTC RA). No claim of optimality is made as the optimized decoder was written from scratch in a short amount of time.

The table below lists 4K bitstreams (generated with VTM version 9.0, RA configuration of common test conditions) for which the bit rate is 40Mbps or less (maximum rate permitted by Level 5.1). Experiments were run on a computer featuring a single Xeon W processor with 8 cores (Skylake). “Real time” performance (60 frames per second or more) is achieved in all cases with the optimized decoder, while VTM processes between 2.8 and 4.6 frames per second.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sequence | QP | Frames | Bitrate [Mbps] | VTM [s] | VTM [fps] | Optimized [fps] |
| Tango | 22 | 294 | 27.9 | 93.792 | 3.13 | 95.4 |
| FoodMarket | 22 | 300 | 17.0 | 89.978 | 3.33 | 103.8 |
| Campfire | 27 | 300 | 30.7 | 93.977 | 3.19 | 110.8 |
| CatRobot | 22 | 300 | 33.7 | 103.032 | 2.91 | 86.9 |
| DaylightRoad | 27 | 300 | 10.3 | 81.181 | 3.70 | 109.3 |
| ParkRunning | 32 | 300 | 22.2 | 107.255 | 2.80 | 92.1 |
| DayStreet | 22 | 300 | 20.4 | 88.508 | 3.39 | 103.4 |
| FlyingBirds | 22 | 300 | 15.9 | 69.801 | 4.30 | 121.6 |
| PeopleInShoppingCenter | 22 | 300 | 11.6 | 65.853 | 4.56 | 127.2 |
| SunsetBeach | 27 | 300 | 26.6 | 80.717 | 3.72 | 109.2 |

The three blocks with highest run time consumption are inter pred, ALF and deblocking. Consumption of scaling and inverse transform is very small.

Though the optimized code runs significantly faster, the percentage of run time consumed by individual tools (as measured by tool off tests) does not change significantly compared to the findings of AHG13.

Compared to a similarly optimized HEVC decoder, the runtime increase is around 1.5-2x.

It was asked if the runtime would be significantly slower for higher bit rates. This would probably be the case.

No specific action was necessary on this.

## Profile/level specification (1)

See also section 4.5 for studies of coding tools and operation beyond the bit depth supported in VVC v1 profiles.

[JVET-S0187](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10309) Request for a Constrained Main 10 Profile in VVC Version 1 [W. Wan (Broadcom), R. Foray (Allegro DVT), 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), D. Nicholson (Ektacom), X. Ducloux, P. Haskell (Harmonic Inc.), J. Le Tanou (MediaKind), C. Hau (NBCUniversal), A. Luthra (Picsel Labs), T. Suzuki (Sony), E. Chai (Ubilinx), J.-M. Thiesse (VITEC)]

# Low-level tool technology proposals (12)

This category was discussed 1535-1720 UTC on Tuesday 06/23, and 1300-1500, 1520-1550 UTC on Wednesday 06/24 (chaired by JRO)

See also JVET-R0243, JVET-R0228, JVET-S0229, JVET-S0251 and JVET-S0259. Those contributions were originally placed in this section and were discussed with these contributions, but the notes for those contribution were later moved to section 4.5 since they are beyond the scope of VVC V1.

[JVET-S0170](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10292) Use of ACT with IBC [S. Keating, K. Kondo (Sony)]

In the current draft of VVC, ACT is not included for IBC blocks. It is asserted that this omission is a bug and it is proposed that ACT should be included for IBC blocks as is the case in the VTM software, i.e. the text should be aligned to the software.

This aspect is also included in S0233. See further notes for that contribution.

The results of AHG13 (tool off tests) indicate that the combination has benefit for screen content, and complexity-wise this is not critical.

[JVET-S0215](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10337) AHG2: On residual coding syntax [M. G. Sarwer, Y. Ye (Alibaba)]

This contribution proposes three aspects.

The first aspect is related to coeff\_sign\_flag. It is asserted that, in VVC draft 9, the conditions to check if the coeff\_sign\_flag is context coded or bypass coded do not reflect the intention of the design. A bug report (#855) was submitted regarding this issue. In the proposed method, the necessary conditions to specify if coeff\_sign\_flag is context coded or by-pass coded is derived based on the variable lastScanPosPass1 instead of RemCcbs. It is asserted that the proposed solution is aligned with the design intention and with the VTM software.

The second and third aspects of this contribution propose semantic bug fix of sig\_coeff\_flag and sb\_coded\_flag, respectively to align with the VTM software.The software/text misalignments relate to TSRC

It is agreed that the aspect 1 is valid, and that the suggested solution of aligning the text with the software is reasonable, as the method as expressed in the text is broken as it would not switch to bypass coded bins in certain cases (which is not the intent, as the budget of context coded bins would be exceeded).

It is agreed that the second and third aspects are also valid, and the way of implementing as in software is probably correct, as the scanning order and last position inference rule is different from RRC.

It is however pointed out that the third aspect as suggested here would not change the decoder operation. It could therefore be seen as editorial. Though the proposed solution for aspect 3 more clearly expresses how the software operates, the case that all coefficients in a subblock are zero could be less well understood. It is also asked whether the statement that subblocks have 16 coefficients is correct. It is also pointed out that it may not be necessary describing all corner cases

Decision (text BF/implementation of existing intent): Adopt JVET-S0215 aspects 1 and 2, align text with software.

Editor action item: To work out if aspect 3 is necessary and if it could potentially be better clarified.

[JVET-S0217](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10339) On deblocking filter for ACT [S. Iwamura, S. Nemoto, A. Ichigaya (NHK)]

This contribution proposes cleanup of deblocking filter condition for blocks coded with adaptive colour transform (ACT). When input signal format is 4:4:4 RGB and ACT is activated, boundary strength (bS) derivation is done in YCgCo domain when ACT is applied to the current coding block. However, deblocking filter is applied in RGB domain according to bS value derived in YCgCo domain. This discrepancy may cause undesirable deblocking filter operation. To avoid this, two solutions are proposed in this contribution.

* solution 1: Additionally check whether ACT is enabled or not for the current coding block in bS derivation
* solution 2: When ACT is enabled for the current block, modify tu\_coded\_flag equal to 1.

The simulation results of shows X.X% BD-rate change without encoding and decoding time increase.

It is asserted that solution 1 is undesirable, as it would need to modify deblocking filter specifically for 444 coding.

Also solution 2 requires low level changes in decision logic of decoding process. Basically, the deblocking strength is determined over components.

It is pointed ou that the suggested solution includes overriding the value of syntax elements, which is not something we regularly do in our specs. This could be fixed by introducing corresponding variables.

It is pointed out by one expert that the proposed might sometimes cause overfiltering.

The problem does not as much affect G (which is matching Y). G is asserted to be most relevant.

The use case targeted here is very specific, and RGB 444 coding at QP37 where selected benefits are shown may not be very common. At this late stage, and without more clear evidence, it is not obvious that a low-level change is justified.

The proposal also has an element of editorial improvement of boundary strength derivation for deblocking.

Editor action item (clarification of text): Consider the suggested change in 8.8.3.5

[JVET-S0222](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10344) On CABAC parameters [F. Bossen (Sharp)]

CABAC parameters comprise initValue and shiftIdx, where initValue parameters are used to determine initial probability estimates based on quantization parameter (QP) and slice type, and where shiftIdx parameters determine a learning rate for each context. These parameters have been retrained with each major release of VTM. The retraining process used the test set (common test conditions) and not a separate training set. This is not ideal as it may lead to overfitting to the test set. Furthermore, the current VVC draft text does not reflect values for initValue and shiftIdx used in any version of VTM. It is proposed to change the VVC draft to reflect values of CABAC parameters that are derived from an extended training set.This contribution implements what had been agreed in the XX meeting: Retraining all CABAC initialization with a larger dataset by the time of finalization of the VVC standard. The dataset of “test 2” included all data sets of all CTCs (also 4:4:4 data), and the sequences from the verification test. Currently, the text does not the reflect the initialization as used in software (which was done to avoid permanent changes of those tables).

Results are shown with reference to the initial training of VTM2.

For large resolution, results indicate that the difference is minor for UHD and HD regardless if training includes only verification test sequences or the entire set, whereas low resolutions suffer (particularly class F) if only verification test sequences are used or not).

The general opinion is that verification test data should not be included in the training set, and that the training set should be generic enough to reflect various characteristics of content.

The results seem to indicate that the VTM9 CTC sequences have large enough variety to obtain reasonable CABAC initialization.

Decision (align text with software/implementation of original intent): Adopt JVET-S0222, version to include the CABAC initialization table as generated for VTM9 with all CTC sequences (but not verification test sequences) in the spec text.

[JVET-S0231](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10353) On Signalling of TU Luma Coded Flag for CU with ACT [L.-F. Chen, X. Li, S. Liu (Tencent)]

This is identical to JVET-S0233 aspect 1. However, also the configuration is tested where the software would be aligned with text, i.e. sending the CBF when ACT is enabled. It is reported that this results in a loss of 0.1%.

[JVET-S0232](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10354) Removal of redundant clipping operations on inter prediction samples in forward luma mapping [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai), Tzu-Der Chuang, Ching-Yeh Chen, Chih-Wei Hsu, Yu-Wen Huang (MediaTek)]

When LMCS is applied, for inter and CIIP modes, forward luma mapping is applied to convert the inter prediction samples of luma component before they are added with the corresponding residual samples. In this contribution, one mismatch is identified between VVC draft 9 and VTM-9.0 software on the clipping operations that are applied to luma inter prediction samples when the LMCS is applied. Specifically, in VVC draft 9, the luma inter prediction samples of the CIIP mode are clipped to the full range of internal bit-depth after the forward luma mapping is applied. Meanwhile, such clipping operation is not applied to luma prediction samples of inter modes. On the other hand, in VTM-9.0, the inter prediction samples of luma component for both inter and CIIP modes are always clipped after the forward luma mapping is applied. It is asserted that all the above clipping operations are redundant. For a more consistent and clean design, it is proposed to remove all those unnecessary clipping operations from the current specification and the reference software. Simulation results prove the redundancy of the removed clipping operations by providing bit-exact BD-rate performance.

This relates to ticket #1027.

It was agreed by other experts that the clipping is not needed in the forward mapping. There are bitstream constraints in the spec that prescribe that the values are never out of range, so clipping would only be required in case of a non-conformant bitstream.

Decision (editorial cleanup spec & cleanup software): Adopt JVET-S0232, remove the unnecessary clipping in forward mapping of LM.

[JVET-S0261](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10401) Crosscheck of JVET-S0232 Removal of redundant clipping operations on inter prediction samples in forward luma mapping [J. Chen (Alibaba)] [late]

[JVET-S0233](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10355) Suggested bug fixes for ACT text in VVC draft 9 [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, C.-W. Kuo, X. Wang (Kwai)]

This contribution identifies two specification bugs of the ACT mode in VVC draft 9. It is asserted that the behavior of VTM-9.0 is correct. Therefore, it is proposed to align the VVC specification with the reference software.

Aspect 2 is identical with JVET-S0170 (see notes there)

Aspect 1 is identical with S0231. This relates to ticket #754 which points out a mismatch between text and software. In intra mode, the condition that the CBF flag is skipped in ACT is not implemented in the text spec. The proposal aligns the spec with the software.

Decision (text BF / implementation of existing intent): Adopt JVET-S0233 (both aspects).

[JVET-S0234](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10356) Mismatch between text specification and reference software on chroma residual scaling when ACT is enabled [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, C.-W. Kuo, X. Wang (Kwai)]

This contribution reports one mismatch between VVC draft 9 and test model software VTM-9.0 on chroma residual scaling when the ACT is applied. In VVC draft 9, when the ACT is applied to one CU, it residual samples are firstly converted from YCgCo space to RGB space before the chroma residual scaling is applied. However, in VTM-9.0, the chroma residual samples are directly scaled in the YCgCo space which are then converted back to the RGB space. Because the reconstructed luma samples used for determining chroma residual scaling factors are made in the RGB domain, the chroma residual scaling should be applied in the same domain as well. Therefore, in this contribution, software patches are provided to align the software with the specification. Simulation results reportedly show that the proposed changes lead to average {G, B, R} BD-rate impacts of {-0.41%, 0.05%, -0.34%}, {-0.49%, -0.02%, -0.51%} and {xx%, xx%, xx%} for AI, RA and LDB configurations, respectively, for RGB camera-captured contents.

The proposal contains an aspect that proposes to align the software with the spec in that chroma scaling is always done in the R/B domain. The software applies chroma scaling in the corresponding Co/Cg domain. However, there is another part of proposal which relates to the reconstruction in chroma scaling, which is currently neither in the text nor in the software.

It is not clear from here what the benefit of doing only the alignment of software with text would be (which could be seen as implementation of existing intent, as it does not make much sense applying CS across different color spaces). The proponents assert that this alignment gives the majority of the compression benefit, also without the additional change. It is however expressed that the encoder would require additional modifications that are not simple to implement, whereas with the additional change no such modification is necessary. Also several experts expressed that the modification design-wise makes sense, as CS should be used when ACT is enabled in the current block, as this indicates that there is some non-zero residual. It is however pointed out that another condition is missing after “otherwise”.

Was considered as candidate for adoption (implementation of existing intent) after initial review.

It was confirmed later by crosscheckers that the software matches the text spec. Another expert confirmed that the missing condition (that was already in the software) is correctly implemented in the text of v3 upload.

Decision (align SW with text/implementation of existing intent): Adopt JVET-S0234

[JVET-S0260](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10400) Cross-check of JVET-S0234: Mismatch between text specification and reference software on chroma residual scaling when ACT is enabled [[J. Zhao (LGE)](mailto:jie.zhao@lge.com)] [late]

[JVET-S0240](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10362) Editorial Cleanup for BCW (Bi-prediction with CU-level Weights) [W. Lim, G. Bang (ETRI)] [late]

This contribution proposes to clarify BCW (Bi-prediction with CU-level Weights) weight derivation process. According to the decoding process of BCW described in 8.5.6.6.2 Default weighted sample prediction process in VVC draft 9, the weight values, w0 and w1, are derived by referring to the look-up table, bcwWLut[k]={4, 5, 3, 10, -2}. However, the value 4 in the look-up table is never referred because of the conditional branches related to CIIP. This contribution proposes an editorial cleanup for the process to be clear in the current VVC specification and the process remains identical.The suggested benefit that a value can be removed from a LUT. On the other hand, another expert mentions that the current design may be easier to understand.

Nothing is broken. The unused value “4” in the LUT may just be a leftover.

Potential Editor action item.

[JVET-S0242](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10364) Cleanup on merge\_idx [J. Y. Lee (Sejong University), W. Lim, G. Bang (ETRI)] [late]

Since the syntax merge\_idx is used to check various merge candidates in the regular merge mode and CIIP. However, merge\_idx in CIIP contributes to small coding peformance, so the contribution proposes the cleanup about merge\_idx. No obvious benefit was evident (even some loss for minor change), low level change, nothing broken.

No action was taken on this.

# High-level syntax (HLS) proposals (XXX)

[JVET-S0137](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10259) Agenda and report of the 27-28 May 2020 HLS AHG meeting [G. J. Sullivan, Y.-K. Wang (AHG meeting coordinators)]

[Add summary]

[JVET-S0237](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10359) Agenda and report of the 19-21 June 2020 HLS AHG pre-meeting [G. J. Sullivan, Y.-K. Wang (AHG pre-meeting coordinators)]

[Add summary – Note that S0237 includes and updates the notes from S0137.]

By the end of Day 3 of the AHG pre-meeting, approximately ***157 (77%) of the 120+84 input documents*** had been reviewed, resulted in **76 recommendations** for normative action, **24** editorial action items, and ***23 revisits/deferred***:

1. (5) 3.1.1 High level tool control (24/(16+11)): 4 recommendations, 4 editorial action items, 2 revisits
2. (3) 3.1.2 General and misc. HLS topics (31/(16+15)): 12+9 recommendations, 1 editor action item, 3 deferred/revisits
3. (3) 3.1.3 General constraints information (GCI) (32/(25+7)): 11 recommendations, 6 editor action items, 3 revisits
4. (0) 3.1.4 SPS, PPS, and APS cleanups (17/(9+8)): 8 recommendations, 1 editor action item
5. (7) 3.1.5 PH and SH cleanups (10/(10+4)): 3 recommendations, 3 deferred/revisits
6. (1) 3.1.6 Reference picture lists cleanups (10/(8+2)): 7 recommendations, 2 editor action items, 1 revisit
7. (1) 3.1.7 Signalling of virtual boundaries (7/(2+5)): 4 recommendations, 2 editor action items, 1 revisit
8. (23) 3.1.8 Hypothetical reference decoder (HRD) (5/(12+14)): 10 recommendations, 1 editor action item, 2 deferred
9. (6) 3.1.9 DCI, VUI, and SEI (1/(3+3)): 1 recommendation, 1 revisit
10. (7) 3.1.10 HLS editorial inputs (0/(4+3))
11. (2) 3.2 Subpictures, slices, and tiles (12/(7+5)): 2 recommendations, 4 editor action items, 2 revisits
12. (7) 3.3 Scalability and RPR cleanups (8/(8+5)): 5 recommendations, 3 editor action items, 3 deferred

## AHG9: General high-level syntax (105+74)

### High level tool control (16+11 – Closed)

[JVET-S0144](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10266) AHG9: A summary of proposals on high level tool control [L. Zhang, Y.-K. Wang (Bytedance)]

This contribution was discussed in the HLS AHG meeting at 0835 UTC on 27 May and in the HLS AHG pre-meeting at 1305 UTC on 19 June, then in the main JVET meeting at 2230 on 22 June (GJS) and 1900 on 23 June (GJS).

This contribution provides a summary of the 25 proposals on High level tool control (the agenda item 3.1.1 in JVET-S0137 and JVET-S0237).

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. The following actions are proposed:

1. Removal of SPS BDOF/DMVR/PROF control present flag

Remove the syntax elements sps\_bdof\_control\_present\_in\_ph\_flag, sps\_dmvr\_control\_present\_in\_ph\_flag and sps\_prof\_control\_present\_in\_ph\_flag and instead condition the presence of ph\_bdof\_disabled\_flag, ph\_dmvr\_disabled\_flag and ph\_prof\_disabled\_flag on the existing syntax elements sps\_bdof\_enabled\_flag, sps\_dmvr\_enabled\_flag and sps\_affine\_prof\_enabled\_flag, respectively. (S0044)

Each of these flags was said to save at most one bit per picture. This would increase overhead in some common uses. No clear need for action was evident, so no action was recommended.

1. On TMVP derivation considering inter-layer reference picture
   1. Disable TMVP when either RefPic or ColRefPic is inter-layer reference picture (ILRP), but not both. (S0089 #1)
   2. Enable TMVP with combination of STRP and ILRP on RefPic or ColRefPic, and disable TMVP with combination of LTRP and ILRP. (S0089 #2)
   3. Enable TMVP when either RefPic or ColRefPic is ILRP. (S0089 #3)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| RefPic  (target reference picture) | ColRefPic  (reference picture of collocated block) | Current VVC | Solution #1 | Solution #2 | Solution #3 |
| STRP | ILRP | X | X | O | O |
| ILRP | STRP | X | X | O | O |
| LTRP | ILRP | O | X | X | O |
| ILRP | LTRP | O | X | X | O |

Much of the behaviour was originally from HEVC.

It was commented that this has a low-level impact and we should avoid any potentially unnecessary changes in this area. No clear need for action was evident, so no action was recommended.

1. On maximum number of subblock merge candidates

Change the range of the value of sps\_five\_minus\_max\_num\_subblock\_merge\_cand from 0..5 − sps\_sbtmvp\_enabled\_flag to 0..5 and change the derivation of maximum number of subblock merge candidates in PH as follows: (S0088)

if( sps\_affine\_enabled\_flag *&& sps\_five\_minus\_max\_num\_subblock\_merge\_cand < 5* )

MaxNumSubblockMergeCand = 5 − sps\_five\_minus\_max\_num\_subblock\_merge\_cand (88)

else

MaxNumSubblockMergeCand = sps\_sbtmvp\_enabled\_flag && ph\_temporal\_mvp\_enabled\_flag

Some participants said that it was intentional not to want to consider ph\_temporal\_mvp\_enabled\_flag.

There was no agreement that the proposal was needed, so no action was recommended.

1. On PDPC control
   1. Add an SPS flag to control PDPC on/off and check it in the intra prediction process. (S0072, S0136)
      1. For all color formats, add an SPS PDPC disabled flag (named sps\_pdpc\_disabled\_flag) (S0072 method 1), or an SPS PDPC enabled flag (named sps\_pdpc\_enabled\_flag). (S0136)
      2. Only for 4:4:4 and 4:2:2 cases, add an SPS PDPC disabled flag (named sps\_pdpc\_disabled\_flag). (S0072 method 3)
   2. Add a PDPC constraint flag in the general constraint information (GCI) syntax structure. (S0136, S0072 v2)

There is currently no high-level control syntax for PDPC, although there is some form of on-off switching for it. The proponent indicated that being able to disable it could provide a benefit in some cases (e.g., for SCC and 4:4:4 – verbally commented to be as much as 2% for an SCC sequence with some specialized configuration that had some tools disabled – ordinarily a much smaller impact on PSNR, but asserted to be a visual improvement for still pictures in some cases).

It was commented that adding this control would involve a low-level change.

It was noted that approach a.ii would not affect the Main 10 (4:2:0) profile.

It was commented that HMVP also doesn’t have a high-level flag.

See also the notes for the next item.

1. On intra reference sample filtering control
   1. Add an SPS flag to control intra reference sample filtering on/off and check it in intra prediction process. (S0072, S0150)
      1. For all color formats, add an SPS disabled flag (named sps\_intra\_reference\_filter\_disabled\_flag). (S0072 method 2, S0150)
         1. Furthermore, add sps\_intra\_smoothing\_disabled\_present\_in\_sh\_flag when sps\_intra\_reference\_filter\_disabled\_flag is equal to 0, and add sh\_intra\_smoothing\_disabled\_flag when sps\_intra\_smoothing\_disabled\_present\_in\_sh\_flag is equal to 1. (S0150)
      2. Only for 4:4:4 and 4:2:2 cases, add an SPS disabled flag (named sps\_intra\_reference\_filter\_disabled\_flag). (S0072 method 3)
   2. Add an intra reference filtering constraint flag in the GCI syntax structure to constrain the added SPS flag. (S0072 v2)

It was commented that adding this control would involve a low-level change.

This was further discussed in the HLS AHG pre-meeting on Friday 19 June at 1305 UTC, together with the previous item (note that S0150 is a constribution submitted after the AHG meeting in May).

This item and the previous one raise similar issues and for similar reasons – trying to avoid using spatial neighbours for some sort of blending operation that may not be beneficial for SCC usage.

There was discussion of whether a benefit with still pictures for high QP is really important.

Mixed content was mentioned, in which camera captured regions would be better with the blending enabled and SCC regions perhaps being better without it.

There is some disabling of PDPC already in the design, but not for the same cases, so it was said that some low-level change would be involved.

No action was recommended due to the late stage of the process and some questioning of the degree of benefit.

AHG discussion stopped here at 0920 UTC on 27 May.

This topic was discussed in the HLS AHG at 0030 UTC on 28 May.

1. On TSRC
   1. Remove no\_tsrc\_constraint\_flag. (S0073, option 3 in section 3.3)
   2. Change the semantics of no\_tsrc\_constraint\_flag (removal: *italic*; addition: **bold**):
      1. Add "When no\_transform\_skip\_constraint\_flag is 1, the value of no\_tsrc\_constraint\_flag shall be one." (S0062, method 3)
      2. Change the semantics to be as follows (S0069, option 1):

**no\_tsrc\_constraint\_flag** equal to 1 specifies that sh\_ts\_residual\_coding\_disabled\_flag shall be equal to *0* **1 or sps\_transform\_skip\_enabled\_flag shall be equal to 0**. no\_tsrc\_constraint\_flag equal to 0 does not impose such a constraint. **When no\_transform\_skip\_constraint\_flag is equal to 1, the value of no\_tsrc\_constraint\_flag shall be equal to 1.**

* + 1. Change the semantics to be as follows (S0069, option 2):

**no\_tsrc\_constraint\_flag** equal to 1 specifies that sh\_ts\_residual\_coding\_disabled\_flag shall be equal to *0* **1 when sps\_transform\_skip\_enabled\_flag is equal to 1**. no\_tsrc\_constraint\_flag equal to 0 does not impose such a constraint. **When no\_transform\_skip\_constraint\_flag is equal to 1, the value of no\_tsrc\_constraint\_flag shall be equal to 1.**

* + 1. Change the semantics to be as follows (S0105):

**no\_tsrc\_constraint\_flag** equal to 1 specifies that sh\_ts\_residual\_coding\_disabled\_flag shall be equal to *0* **1**. no\_tsrc\_constraint\_flag equal to 0 does not impose such a constraint. **When no\_transform\_skip\_constraint\_flag is equal to 1, the value of no\_tsrc\_constraint\_flag shall be equal to 1.**

* + 1. Add a semantic constraint to no\_tsrc\_constraint\_flag to disable DQ and SDH in SPS level (S0073, option 1 in section 3.1)

**no\_tsrc\_constraint\_flag** equal to 1 specifies that sh\_ts\_residual\_coding\_disabled\_flag shall be equal to *0* **1 and sps\_dep\_quant\_enabled\_flag and sps\_sign\_data\_hiding\_enabled\_flag are both equal to 0**. no\_tsrc\_constraint\_flag equal to 0 does not impose such a constraint.

* + 1. Add a semantic constraint to no\_tsrc\_constraint\_flag to disable DQ and SDH in all slices (S0073, option 2 in section 3.2)
  1. Infer sh\_ts\_residual\_coding\_disable\_flag to be equal to !sps\_transform\_skip\_enabled\_flag instead of 0. (S0062, method 1)
  2. Add an SPS flag for TSRC, use it to control the presence of sps\_dep\_quant\_enabled\_flag and sps\_sign\_data\_hiding\_enabled\_flag, and change the semantics of no\_tsrc\_constraint\_flag to constrain the SPS flag instead of the SH flag. (S0062, method 2)
  3. Change both semantics of no\_tsrc\_constraint\_flag and sh\_ts\_residual\_coding\_disabled\_flag: (S0069, option 3) as follows (removal: *italic*; addition: **bold**)

**no\_tsrc\_constraint\_flag** equal to 1 specifies that sh\_ts\_residual\_coding\_disabled\_flag shall be equal to *0* **1**. no\_tsrc\_constraint\_flag equal to 0 does not impose such a constraint. **When no\_transform\_skip\_constraint\_flag is equal to 1, the value of no\_tsrc\_constraint\_flag shall be equal to 1.**

**sh\_ts\_residual\_coding\_disabled\_flag** equal to 1 specifies that the syntax structure residual\_coding( ) is used to parse the residual samples of a transform skip block for the current slice. slice\_ts\_residual\_coding\_disabled\_flag equal to 0 specifies that the syntax structure residual\_ts\_coding( ) is used to parse the residual samples of a transform skip block for the current slice. When slice\_ts\_residual\_coding\_disabled\_flag is not present, *it is infered to be equal to 0.***the following applies:**

* **If sps\_transform\_skip\_enabled\_flag is equal to 0, the value of sh\_ts\_residual\_coding\_disabled\_flag is inferred to be equal to 1.**
* **Otherwise, the value of sh\_ts\_residual\_coding\_disabled\_flag is inferred to be equal to 0.**

A suggested principle was to not have GCI constraint flags that constrain combinations.

The no\_tsrc\_constraint\_flag was suggested to be problem in this regard (as it disables three things: TSRC and SDH and DQ). Disabling SDH and DQ has a significant coding efficiency impact. It was thus suggested to remove this constraint flag (item “a” above).

The other aspects (some of which relate to bugs in the specification of the implications of that flag) would also be resolved by that action.

AHG Recommendation (cleanup/bug fix): Remove the no\_tsrc\_constraint\_flag.

Discussion in AHG sessions 1-8 stopped here.

Discussion in AHG pre-meeting session 9 began here on 19 June at 1330.

1. On residual coding

Add the following SPS and PH flags, and revise SH gating conditions and inferences: (S0093)

* 1. Addition of the SPS flag sps\_residual\_control\_present\_in\_sh\_flag.
  2. Addition of picture header flags for DQ and SDH.
  3. Modification of gating conditions for sh\_dep\_quant\_enabled\_flag, sh\_sign\_data\_hiding\_enabled\_flag, and sh\_ts\_residual\_coding\_disabled\_flag to ensure that at most one of these flags are signalled at the slice level.
  4. Modifications of inference rules for sh\_dep\_quant\_enabled\_flag, sh\_sign\_data\_hiding\_enabled\_flag, and sh\_ts\_residual\_coding\_disabled\_flag to match the desired behaviour.

It was commented that when SDH or DQ is enabled, it is now necessary to repeat the enabling indication in every SH. The proposal is to implicitly disable these when TSRC is disabled in the SH. It was commented that the interaction between these features is relevant only for very high quality coding, where saving something in the SH is not so relevant.

There had been extensive discussion of the SDH/DQ interaction with TSRC at the previous meeting. It was commented that we should not further tinker with this unless we find some aspect that is really a bug, and that is not the case here. Thus, no action was recommended on this.

1. On presence of explicit scaling list

Allow the aps\_chroma\_present\_flag of the scaling list APS NAL unit referenced by the PH to be equal to 0 when ChromaArrayType is greater than 0. (S0049, aspect 9)

This flag is already in the syntax, but is required to be 1 for colour formats that have chroma.

It was commented that ALF and LMCS act similarly to what is proposed, and that a previous problem with allowing this had gone away due to an action of the previous meeting.

In the current design, there is no provision to use a scaling list for chroma without using a scaling list for luma.

It was commented that the flag was only added to avoid sending scaling lists that are completely irrelevant, and sending flat chroma scaling lists does not cost many bits.

Although there may be some arguable inconsistency with ALF and LMCS, it was said that we should not change this since there is no real bug. Thus, no action was recommended on this.

1. On chroma QP table signalling
2. Change the range of sps\_num\_points\_in\_qp\_table\_minus1[ i ] from 0..63 + QpBdOffset to 0..62 + QpBdOffset. (S0130 aspect 1)

AHG Recommendation (spec bug fix/expression of existing intent): Adopt this aspect.

1. Add an SPS flag (named sps\_chroma\_qp\_identical\_to\_luma\_flag) to skip signalling of chroma QP information when chroma QPs are set equal to luma QPs. (S0130 aspect 2)

This would be a syntax shortcut for generating a chroma QP table that indicates chroma QP to be identical to the luma QP. Relative to what the VTM currently does, this would save 6 bits when the tables are identical and add one bit for when they are not, at the SPS level. The proponent noted that this is motivated as a shortcut for a reasonable case rather than really as a bit savings issue. It was commented that in the 4:2:0 case the QP table would typically not be identical. No clear need for action was identified, so no action was recommended on this.

1. On ALF APS constraints

Add an SPS flag (named sps\_one\_aps\_per\_slice\_one\_filter\_per\_aps\_flag) to support the following case and change the signalling of aps\_adaptation\_parameter\_set\_id, sh\_alf\_aps\_id\_luma, sh\_alf\_aps\_id\_chroma from u(5)/u(3) to u(v). (S0134):

1. Each ALF APS contains up to 1 luma filter, up to 1 chroma filter, and no cross-component filters, and each slice in the CLVS uses 0 or 1 ALF APSs for luma adaptive loop filtering, 0 or 1 ALF APSs for chroma adaptive loop filtering, and applies no cross-component adaptive loop filtering.
2. Allow maximum of 115 ALF APSs.

The use case is BEAMing with different encoders using different ALF parameters in different slices.

As far as the syntax is concerned, this would be only a high-level change.

However, the memory usage for the proposal would assume the decoder stores filters in a particular way to save memory. If the decoder does not do this, there would be a problem for the decoder memory. It was thus commented that this would actually have a low-level impact.

No action was recommended on this, as it would be a late change that has a low-level impact, and we do not have evidence that the current design has a problem for most use cases.

1. On deblocking filter parameters
2. Inference of chroma DB offsets
   * 1. If pps\_chroma\_tool\_offsets\_present\_flag is equal to 1, infer the values of the chroma DB offsets in the PH and SH, when not present, to be equal to the chroma DB offsets in the PPS and PH, respectively, instead of inferring the values from the luma DB offsets in the same header (as in the current VVC text). Otherwise, infer the values from the luma DB offsets in the same header (as in the current VVC text) (S0053, aspect 1)
     2. Infer the chroma DB offsets in the PH and SH to be equal to the values of the chroma DB offsets in the PPS and PH, respectively, when not present, regardless of the value of pps\_chroma\_tool\_offsets\_present\_flag. But this solution is not recommended. (S0053, aspect 1, alternative solution)

It was commented that aspect a.i is more sensible than the current design, as it makes use of information sent for chroma at a higher level.

AHG Recommendation (logical cleanup): Adopt S0053 as proposed (approach a.i).

1. Removal the condition check of pps\_deblocking\_filter\_override\_enabled\_flag for signalling the ph\_deblocking\_filter\_override\_flag. (S0121, aspect 2)

It was noted that this is a purely editorial change, to avoid checking an unnecessary condition in the syntax logic.

Editor action item: The editor is strongly suggested to remove this unnecessary condition check.

1. Semantics of pps\_chroma\_tool\_offsets\_present\_flag

Change the semantics such that the chroma deblocking tc and β offset syntax elements may be (instead of "are") present in the PHs or the SHs of pictures referring to the PPS when the flag is equal to 1. (S0053, aspect 2)

It was noted that this is an editorial bug fix, simply to make the semantics accurate.

AHG Recommendation (editorial bug fix): Adopt S0053 aspect 2 to fix the semantics error.

1. Change the inference rules of non-present syntax elements PH/SH SAO, ALF, CCALF flags. (S0121, aspect 1)
2. Infer ph\_sao\_luma\_enabled\_flag to be equal to sps\_sao\_enable\_flag instead of 0.
3. Infer ph\_alf\_enabled\_flag to be equal to sps\_alf\_enable\_flag instead of 0.
4. Infer ph\_sao\_chroma\_enabled\_flag to be as follows, instead of 0:

* If sps\_sao\_enable\_flag is equal to 1 and ChromaArrayType is not equal to 0, ph\_sao\_chroma\_enabled\_flag is inferred to be equal to 1.
* Otherwise, ph\_sao\_chroma\_enabled\_flag is inferred to be equal to 0.

1. Infer ph\_alf\_cb\_flag/ph\_alf\_cr\_flag to be 0 if one of the following two conditions are true, and to be 1 otherwise:

* ChromaArrayType is equal to 0.
* ph\_alf\_enabled\_flag is equal to 0.

1. Infer ph\_cc\_alf\_cb\_enabled\_flag/ph\_cc\_alf\_cr\_enabled\_flag to be 0 if one of the following two conditions are true, and to be 1 otherwise:

* sps\_ccalf\_enabled\_flag is equal to 0.
* ph\_alf\_enabled\_flag is equal to 0.

1. Infer sh\_alf\_cb(r)\_flag as follows:

* If sh\_alf\_enabled\_flag or ph\_alf\_cb(r)\_flag is equal to 0, sh\_alf\_cb(r)\_flag is inferred to be equal to 0.
* Otherwise (both sh\_alf\_enabled\_flag and ph\_alf\_cb(r)\_flag are equal to 1), sh\_alf\_cb(r)\_flag is inferred to be equal to 1.

1. Infer sh\_cc\_alf\_cb(r)\_enabled\_flag as follows:

* If sh\_alf\_enabled\_flag or ph\_cc\_alf\_cb(r)\_enabled\_flag is equal to 0, sh\_cc\_alf\_cb(r)\_enabled\_flag is inferred to be equal to 0.
* Otherwise (both sh\_alf\_enabled\_flag and ph\_cc\_alf\_cb(r)\_enabled\_flag are equal to 1), sh\_cc\_alf\_cb(r)\_enabled\_flag is inferred to be equal to 1.

In the discussion, it was said that these changes are just to better express the existing design intent.

It was agreed that there is a problem in the existing semantics.

However, it was said that the proposed semantics should be carefully studied and there may be a simpler way to address the problem.

This topic was not closed in the AHG pre-meeting. It was further discussed in the main JVET meeting at 2230 on 22 June (GJS) after offline study. See also items 14 and 15, which are alternatives to each other. This is all basically editorial, as the intent is well established.

Decision (editorial bug fix/expression of existing intent): Adopt approach in item 15.b (or editorial equivalent).

1. Change the semantics of some PH syntax elements related to ALF and SAO as follows, asserted to address the inconsistency in the semantics reported in JVET-S0121: (S0252 late)

(Convention for text changes proposed: “quoted text” is proposed to be removed and text inside delimiters < > is proposed to be added by proposals)

**ph\_alf\_enabled\_flag** equal to 1 specifies that the adaptive loop filter is enabled and may be used for the current picture. ph\_alf\_enabled\_flag equal to 0 specifies that adaptive loop filter <may or may not be enabled> "is disabled and not used" for the current picture. When not present, ph\_alf\_enabled\_flag is inferred to be equal to 0.

**ph\_alf\_cb\_flag** "equal to 0 specifies that the adaptive loop filter is disabled and not applied to the Cb colour component for the current picture. ph\_alf\_cb\_flag" equal to 1 specifies that the adaptive loop filter is enabled and may be applied to the Cb colour component for the current picture. <ph\_alf\_cb\_flag equal to 0 specifies that the adaptive loop filter may or may not be enabled for the Cb colour component of the current picture.>When ph\_alf\_cb\_flag is not present, it is inferred to be equal to 0.

**ph\_alf\_cr\_flag** "equal to 0 specifies that the adaptive loop filter is disabled and not applied to the Cr colour component for the current picture. ph\_alf\_cr\_flag" equal to 1 specifies that the adaptive loop filter is enabled and may be applied to the Cr colour component for the current picture. <ph\_alf\_cr\_flag equal to 0 specifies that the adaptive loop filter may or may not be enabled for the Cr colour component of the current picture.> When ph\_alf\_cr\_flag is not present, it is inferred to be equal to 0.

**ph\_cc\_alf\_cb\_enabled\_flag** equal to 1 specifies that the cross-component adaptive loop filter for the Cb colour component is enabled and may be used for the current picture. ph\_cc\_alf\_cb\_enabled\_flag equal to 0 specifies that cross-component adaptive loop filter for the Cb colour component <may or may not be enabled> "is disabled and not used" for the current picture. When not present, ph\_cc\_alf\_cb\_enabled\_flag is inferred to be equal to 0.

**ph\_cc\_alf\_cr\_enabled\_flag** equal to 1 specifies that the cross-compoent adaptive loop filter for the Cr colour component is enabled and may be used for the current picture. ph\_cc\_alf\_cr\_enabled\_flag equal to 0 specifies that cross-component adaptive loop filter for the Cr colour component <may or may not be enabled> "is disabled and not used" for the current picture. When not present, ph\_cc\_alf\_cr\_enabled\_flag is inferred to be equal to 0.

**ph\_sao\_luma\_enabled\_flag** equal to 1 specifies that SAO is enabled and may be used for the luma component of the current picture. ph\_sao\_luma\_enabled\_flag equal to 0 specifies that SAO <may or may not be enabled> "is disabled and not used" for the luma component of the current picture. When ph\_sao\_luma\_enabled\_flag is not present, it is inferred to be equal to 0.

**ph\_sao\_chroma\_enabled\_flag** equal to 1 specifies that SAO is enabled and may be used for the chroma component of the current picture. ph\_sao\_chroma\_enabled\_flag equal to 0 specifies that SAO <may or may not be enabled> "is disabled and not used" for the chroma component of the current picture. When ph\_sao\_chroma\_enabled\_flag is not present, it is inferred to be equal to 0.

This is an alternative to item 13.

1. Change the semantics of PH syntax elements related to ALF and SAO as follows, asserted to address the inconsistency in the semantics reported in JVET-S0121: (S0255 late – slightly clarified during meeting discussion)

(Convention for text changes proposed: “quoted text” is proposed to be removed and text inside delimiters < > is proposed to be added by proposals)

Sub-variation a.

<When pps\_alf\_info\_ph\_flag is equal to 1,> **ph\_alf\_enabled\_flag** equal to 1 specifies that the adaptive loop filter is enabled and may be used for the current picture, and ph\_alf\_enabled\_flag equal to 0 specifies that adaptive loop filter is disabled and not used for the current picture. When not present, ph\_alf\_enabled\_flag is inferred to be equal to 0."

<When pps\_alf\_info\_ph\_flag is equal to 1,> **ph\_alf\_cb\_flag** equal to 1 specifies that the adaptive loop filter is enabled and may be applied to the Cb colour component for the current picture, and ph\_alf\_cb\_flag equal to 0 specifies that the adaptive loop filter is disabled and not applied to the Cb colour component for the current picture. When ph\_alf\_cb\_flag is not present, it is inferred to be equal to 0.

<When pps\_alf\_info\_ph\_flag is equal to 1,> **ph\_alf\_cr\_flag** equal to 1 specifies that the adaptive loop filter is enabled and may be applied to the Cr colour component for the current picture, and ph\_alf\_cr\_flag equal to 0 specifies that the adaptive loop filter is disabled and not applied to the Cr colour component for the current picture. When ph\_alf\_cr\_flag is not present, it is inferred to be equal to 0.

<When pps\_alf\_info\_ph\_flag is equal to 1,> **ph\_cc\_alf\_cb\_enabled\_flag** equal to 1 specifies that the cross-component adaptive loop filter for the Cb colour component is enabled and may be used for the current picture, and ph\_cc\_alf\_cb\_enabled\_flag equal to 0 specifies that the cross-component adaptive loop filter for the Cb colour component is disabled and not used for the current picture. When not present, ph\_cc\_alf\_cb\_enabled\_flag is inferred to be equal to 0.

<When pps\_alf\_info\_ph\_flag is equal to 1,> **ph\_cc\_alf\_cr\_enabled\_flag** equal to 1 specifies that the cross-component adaptive loop filter for the Cr colour component is enabled and may be used for the current picture, ph\_cc\_alf\_cr\_enabled\_flag equal to 0 specifies that the cross-component adaptive loop filter for the Cr colour component is disabled and not used for the current picture. When not present, ph\_cc\_alf\_cr\_enabled\_flag is inferred to be equal to 0.

<When pps\_alf\_info\_ph\_flag is equal to 1,> **ph\_sao\_luma\_enabled\_flag** equal to 1 specifies that SAO is enabled and may be used for the luma component of the current picture, and ph\_sao\_luma\_enabled\_flag equal to 0 specifies that SAO is disabled and not used for the luma component of the current picture. When ph\_sao\_luma\_enabled\_flag is not present, it is inferred to be equal to 0.

<When pps\_alf\_info\_ph\_flag is equal to 1,> **ph\_sao\_chroma\_enabled\_flag** equal to 1 specifies that SAO is enabled and may be used for the chroma component of the current picture, and ph\_sao\_chroma\_enabled\_flag equal to 0 specifies that SAO is disabled and not used for the chroma component of the current picture. When ph\_sao\_chroma\_enabled\_flag is not present, it is inferred to be equal to 0.

Sub-variation b.

<When pps\_alf\_info\_ph\_flag is equal to 1,> **ph\_alf\_enabled\_flag** equal to 1 specifies that the adaptive loop filter is enabled for the current picture, and ph\_alf\_enabled\_flag equal to 0 specifies that adaptive loop filter is disabled for the current picture. When not present, ph\_alf\_enabled\_flag is inferred to be equal to 0."

<When pps\_alf\_info\_ph\_flag is equal to 1,> **ph\_alf\_cb\_flag** equal to 1 specifies that the adaptive loop filter is enabled for the Cb colour component for the current picture, and ph\_alf\_cb\_flag equal to 0 specifies that the adaptive loop filter is disabled for the Cb colour component for the current picture. When ph\_alf\_cb\_flag is not present, it is inferred to be equal to 0.

<When pps\_alf\_info\_ph\_flag is equal to 1,> **ph\_alf\_cr\_flag** equal to 1 specifies that the adaptive loop filter is enabled for the Cr colour component for the current picture, and ph\_alf\_cr\_flag equal to 0 specifies that the adaptive loop filter is disabled for the Cr colour component for the current picture. When ph\_alf\_cr\_flag is not present, it is inferred to be equal to 0.

<When pps\_alf\_info\_ph\_flag is equal to 1,> **ph\_cc\_alf\_cb\_enabled\_flag** equal to 1 specifies that the cross-component adaptive loop filter for the Cb colour component is enabled for the current picture, and ph\_cc\_alf\_cb\_enabled\_flag equal to 0 specifies that the cross-component adaptive loop filter for the Cb colour component is disabled for the current picture. When not present, ph\_cc\_alf\_cb\_enabled\_flag is inferred to be equal to 0.

<When pps\_alf\_info\_ph\_flag is equal to 1,> **ph\_cc\_alf\_cr\_enabled\_flag** equal to 1 specifies that the cross-component adaptive loop filter for the Cr colour component is enabled for the current picture, ph\_cc\_alf\_cr\_enabled\_flag equal to 0 specifies that the cross-component adaptive loop filter for the Cr colour component is disabled for the current picture. When not present, ph\_cc\_alf\_cr\_enabled\_flag is inferred to be equal to 0.

<When pps\_alf\_info\_ph\_flag is equal to 1,> **ph\_sao\_luma\_enabled\_flag** equal to 1 specifies that SAO is enabled for the luma component of the current picture, and ph\_sao\_luma\_enabled\_flag equal to 0 specifies that SAO is disabled for the luma component of the current picture. When ph\_sao\_luma\_enabled\_flag is not present, it is inferred to be equal to 0.

<When pps\_alf\_info\_ph\_flag is equal to 1,> **ph\_sao\_chroma\_enabled\_flag** equal to 1 specifies that SAO is enabled for the chroma component of the current picture, and ph\_sao\_chroma\_enabled\_flag equal to 0 specifies that SAO is disabled for the chroma component of the current picture. When ph\_sao\_chroma\_enabled\_flag is not present, it is inferred to be equal to 0.

This is another alternative to item 13.

1. Invocation of the decoding process for symmetric motion vector difference reference indices specified in clause 8.3.5

In clause 8.1.2, add the following text as a step after the invocation of the decoding process for generating unavailable reference pictures specified in clause 8.3.4: "At the beginning of the decoding process for each B slice, the decoding process for symmetric motion vector difference reference indices specified in clause 8.3.5 is invoked for derivation of the variables RefIdxSymL0 and RefIdxSymL1.", and at the beginning of clause, add the following: "This process is invoked at the beginning of the decoding process for each B slice, after decoding of the slice header as well as the invocation of the decoding process for reference picture list construction for the slice as specified in clause 8.3.2, but prior to the parsing and decoding of any coding unit." (S0191)

It was commented that this is really an editorial bug fix proposal, and some correction is needed, but that it is editorially preferable to avoid having parsing specified in a way that is dependent on the decoding process specification (when feasible).

It was suggested that something also be done for 8.3.6 for the derivation of the collocated picture, and the proposal was revised to also cover this aspect.

This was further discussed in the main JVET meeting at 1900 on 23 June (GJS) after offline study. It was confirmed that the problem report is valid.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Make either of the following changes regarding the inferences of sps\_scaling\_matrix\_for\_lfnst\_disabled\_flag and sps\_scaling\_matrix\_designated\_colour\_space\_flag: (S0196)
   1. Remove the inferences of both flags, as they are asserted not used when not present.
   2. Change the inferred value from 1 to 0 for both flags.

It was commented that these are simply editorial suggestions.

Editor action item: The editor is suggested to remove the unnecessary inferences.

1. Make one of the following changes to disallow the ACT and LFNST combination: (S0197)
   1. When sps\_lfnst\_enabled\_flag is equal to 1, sps\_act\_enabled\_flag is not signalled and is inferred to be 0.
   2. When sps\_act\_enabled\_flag is equal to 1, sps\_lfnst\_enabled\_flag is not signalled and inferred to be 0.
   3. Add a constraint: The values of sps\_act\_enabled\_flag and sps\_lfnst\_enabled\_flag shall not both be equal to 1.

The proponent indicated that this is the only case with three cascaded transforms in the decoding process, and that experiments with RGB content showed no benefit for the combination.

Another participant said that on the OldTownCross test sequence in the RA case, the combination of ACT and LFNST provides 2.8% gain, and that overall it also provides gain on some other content.

Test results were shown, with different test results for different test sequences. It was commented that an encoder could hypothetically make a smart decision about when to enable the combination.

It was commented that the cascading of ACT with LFNST is not really an implementation problem.

Some participants preferred to leave this to the encoder to be able to choose.

It was not clear that there is a real problem that needs to be solved by this change, so no action was recommended.

1. Signal an SPS flag to specify whether ph\_joint\_cbcr\_sign\_flag is present in PHs. When not present, the value of ph\_joint\_cbcr\_sign\_flag is inferred to be equal to 1. (S0201)

The proponent indicated that only 3 test sequences out of 26 in the CTC use the sign flag. One of these is SlideShow, which is screen content.

The argument, aside from 1 bit per picture bit savings, is consistency with how BDOF is handled. Another participant said there had been a proposal to change BDOF signalling, for a similar consistency reason, with no action recommended.

It was not clear that there is a real problem that needs to be solved by this change, so no action was recommended.

1. Make the following syntax and semantics changes to infer the values of ph\_dmvr\_disabled\_flag and ph\_bdof\_disabled\_flag to be equal to 1 (DMVR/BDOF disabled) when the picture is not qualified to use bi-prediction, to fix the asserted issue that currently they are inferred to be equal to 0 (DMVR/BDOF enabled) when the picture is not qualified to use bi-prediction: (S0205)

Change the picture header structure syntax and semantics as follows (additions in **bold fonts**, removals in *italic fonts*):

|  |  |
| --- | --- |
| **presenceFlag = 0** |  |
| if( ph\_inter\_slice\_allowed\_flag ) { |  |
| ... |  |
| if( sps\_mmvd\_fullpel\_only\_flag ) |  |
| **ph\_mmvd\_fullpel\_only\_flag** | u(1) |
| *presenceFlag = 0* |  |
| if( !pps\_rpl\_info\_in\_ph\_flag ) /\* This condition is intentionally not merged into the next,  to avoid possible interpretation of RplsIdx[ i ] being unspecified. \*/ |  |
| presenceFlag = 1 |  |
| else if( num\_ref\_entries[ 0 ][ RplsIdx[ 0 ] ] > 0 &&  num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] > 0 ) |  |
| presenceFlag = 1 |  |
| if( presenceFlag ) { |  |
| **ph\_mvd\_l1\_zero\_flag** | u(1) |
| if( sps\_bdof\_control\_present\_in\_ph\_flag ) |  |
| **ph\_bdof\_disabled\_flag** | u(1) |
| if( sps\_dmvr\_control\_present\_in\_ph\_flag ) |  |
| **ph\_dmvr\_disabled\_flag** | u(1) |
| } |  |

Change the picture header structure syntax as follows:

**ph\_bdof\_disabled\_flag** equal to 1 specifies that bi-directional optical flow inter prediction based inter bi-prediction is disabled and not used in the slices associated with the PH. ph\_bdof\_disabled\_flag equal to 0 specifies that bi-directional optical flow inter prediction based inter bi-prediction is enabled and may be used in the slices associated with the PH.

When not present, the value of ph\_bdof\_disabled\_flag is inferred as follows:

* If **presenceFlag is equal to 1** *sps\_bdof\_control\_present\_in\_ph\_flag is equal to 0*, the value of ph\_bdof\_disabled\_flag is inferred to be equal to 1 − sps\_bdof\_enabled\_flag.
* Otherwise (**presenceFlag is equal to 0** *sps\_bdof\_control\_present\_in\_ph\_flag is equal to 1*), the value of ph\_bdof\_disabled\_flag is inferred to be equal to 1.

**ph\_dmvr\_disabled\_flag** equal to 1 specifies that decoder motion vector refinement based inter bi-prediction is disabled and not used in the slices associated with the PH. ph\_dmvr\_disabled\_flag equal to 0 specifies that decoder motion vector refinement based inter bi-prediction is enabled and may be used in the slices associated with the PH.

When not present, the value of ph\_dmvr\_disabled\_flag is inferred as follows:

* If **presenceFlag is equal to 1** *sps\_dmvr\_control\_present\_in\_ph\_flag is equal to 0*, the value of ph\_dmvr\_disabled\_flag is inferred to be equal to 1 − sps\_dmvr\_enabled\_flag.
* Otherwise (**presenceFlag is equal to 0** *sps\_dmvr\_control\_present\_in\_ph\_flag is equal to 1*), the value of ph\_dmvr\_disabled\_flag is inferred to be equal to 1.

This is only editorial. Currently there is an inference rule that sometimes infers values that are not used. The current expression is done this way just to make the inference rule simple.

It was suggested to change the expression of the inference rule so that values are not inferred when they are not used.

Editor action item: The editor may consider ways of improving the expression, although no clear bug has been identified.

1. Add sps\_ltdf\_enabled\_flag for controlling the on/off of long deblocking filters, and add a GCI flag (no\_ltdf\_constraint\_flag) to constrain the new sps\_ltdf\_enabled\_flag. (S0226)

R0300 had reported that there was sometimes an over-smoothing phenomenon and suggested to be able to control the long deblocking filter. It was commented that the long DBF is the main difference between VVC and HEVC deblocking.

It was commented that there is already a way to control overall DBF strength.

There had been a proposal at the previous meeting for separate control of the long filter at the slice level, but it had not been determined necessary at the time. There had also been analysis of the question at the meeting before that.

This would have a low-level impact, as it would be necessary to support the switching within the DBF process.

It was not clear that there is a real problem that needs to be solved by this change, so no action was recommended.

1. Make either of the following changes to resolve an asserted inconsistency between the semantics of sps\_mmvd\_fullpel\_only\_flag and the related syntax parsing process: (S0227)
   1. Change the syntax condition for ph\_mmvd\_fullpel\_only\_flag from "if( sps\_mmvd\_fullpel\_only\_flag )" to " if( !sps\_mmvd\_fullpel\_only\_flag )".
   2. Rename sps\_mmvd\_fullpel\_only\_flag to sps\_mmvd\_fullpel\_only\_enabled\_flag, and switch the phrases "uses" and "may use" for the value 1 and 0 in the semantics of this SPS flag.

It was commented that option a has a problem.

AHG recommendation (logical cleanup): Adopt option b. (The naming of the flag is an editorial matter left to the discretion of the editor – removing “\_only” was suggested.)

1. Change the LMCS data syntax and semantics as well as the related decoding process texts as in S0245 (S0245 aspect 1 late) as editorial clarification

The proponent was not present at the time of AHG discussion. It was discussed in the JVET meeting at 1915 on 23 June (GJS).

This is only an editorial matter.

It was commented that we do not use an explicit index variable for selecting the parameters of the SPS or PPS or VPS, so we should not do that for APSs either, if feasible.

For ALF, it is possible to have multiple APSs that are active at the same time, so it is necessary to distinguish between them in some way. However, for LMCS and scaling lists, this is not necessary.

No action was thus taken on the proposal.

1. Change scaling list data semantics as well as the related decoding process texts as in S0245 (S0245 aspect 2 late)

See the notes for item 23 above.

This discussion in the JVET meeting ended at 1935 on 23 June.

[JVET-S0044](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10166) AHG9: Cleanup of high-level signalling of BDOF, DMVR and PROF [M. Pettersson, R. Sjöberg, M. Damghanian, J. Enhorn, Z. Zhang, J. Ström, R. Yu, D. Liu (Ericsson)]

[JVET-S0049](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10171) AHG9/AHG8/AHG12: On parameter sets and picture header [Y.-K. Wang, L. Zhang, Z. Deng, K. Zhang (Bytedance)]

Aspect 9 of this contribution belongs to this category.

[JVET-S0053](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10175) AHG9: Inference of chroma deblocking offset values in the PH and SH [Z. Zhang, M. Pettersson, M. Damghanian, J. Enhorn, K. Andersson, J. Ström, R. Sjöberg, R. Yu, D. Liu (Ericsson)]

[JVET-S0062](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10184) AHG9: On no\_tsrc\_constraint\_flag [K. Naser, F. Le Leannec, T. Poirier, P. de Lagrange (InterDigital)]

[JVET-S0072](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10194) AHG9: On PDPC and reference sample filtering of non-420 sequences [M. G. Sarwer, Y. Ye (Alibaba)]

[JVET-S0254](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10393) Crosscheck of JVET-S0072 (AHG9: On PDPC and reference sample filtering of non-420 sequences) [C.-Y. Lai (MediaTek)] [late]

[JVET-S0069](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10191) AHG9: General constraint information on features related to transform skip mode [S.-T. Hsiang, O. Chubach, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

Aspect 2 of this contribution belongs to this category.

[JVET-S0073](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10195) AHG9: Bug-fix of the constraint flag of VVC [M. G. Sarwer, Y. Ye (Alibaba)]

Aspect 2 of this contribution belongs to this category.

[JVET-S0088](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10210) AHG9: Clean-up on derivation of the MaxNumSubblockCand [N. Park, J. Nam, H. Jang, J. Lim, S. Kim(LGE)]

[JVET-S0089](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10211) AHG8: On TMVP derivation using inter-layer reference picture [N. Park, J. Nam, H. Jang, J. Lim, S. Kim(LGE)]

[JVET-S0093](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10215) On slice header flags related to residual coding [J. Samuelsson, S. Deshpande, F. Bossen, A. Segall (Sharp)]

[JVET-S0148](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10270) Crosscheck of JVET-S0093 (On slice header flags related to residual coding) [J. Gan (Canon)]

[JVET-S0105](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10227) AHG9: Modification of general constraint information [S. McCarthy, P. Yin, T. Lu, F. Pu, W. Husak, T. Chen (Dolby)]

The aspect on changing the semantics of no\_tsrc\_constraint\_flag belongs to this category.

[JVET-S0121](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10243) AHG9: On deblocking filter, ALF, and SAO enabling flags in PH and SH [N. Hu, V. Seregin, Y. He, M. Karczewicz (Qualcomm)]

[JVET-S0130](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10252) On chroma QP mapping [L. Li, X. Li, B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-S0134](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10256) AHG9/AHG12: Relaxing an ALF APS constraint [A. Aminlou, M. M. Hannuksela (Nokia)]

[JVET-S0136](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10258) AHG9: On signaling of PDPC enabling/disabling flag in SPS [X. Xiu, Y.-W. Chen, H.-J. Jhu, T.-C. Ma, X. Wang (Kwai)]

[JVET-S0150](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10272) AHG9: On high-level syntax for smoothing intra prediction tools [A. Filippov, V. Rufitskiy, E. Alshina (Huawei)]

[JVET-S0191](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10313) AHG9: On decoding process for symmetric motion vector difference reference indices [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-S0196](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10318) AHG9: On inference rules of the SPS scaling matrix related flags [M. G. Sarwer, Y. Ye (Alibaba)]

[JVET-S0197](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10319) AHG9: On ACT and LFNST [M. G. Sarwer, Y. Ye (Alibaba)]

[JVET-S0201](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10323) AHG9: On signaling the JCCR sign information in PH [C.-W. Kuo, X. Xiu, H.-J. Jhu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-S0205](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10327) AHG9: Inference value of DMVR/BDOF disabled flag in PH [K. Unno, K. Kawamura (KDDI)]

[JVET-S0226](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10348) AHG9: On high level syntax for longer tap deblocking filter [A. M. Kotra, N. Hu, M. Coban, V. Seregin, J. Chen, M. Karczewicz (Qualcomm)]

[JVET-S0227](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10349) AHG9: On MMVD flag in SPS and PH [Y. Kidani, K. Unno, K. Kawamura (KDDI)]

[JVET-S0245](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10367) AHG9: Editorial clarifications of APS ID for LMCS\_APS and SCALING\_APS [Y. Ahn, J. Lee, D. Sim (Digital Insights), S. Park (Hyundai Motors)] [late]

[JVET-S0252](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10391) PH semantics of ALF and SAO syntax elements [J. Samuelsson, S. Deshpande, A. Segall (Sharp), L. Li, X. Li, B. Choi (Tencent)] [late]

[JVET-S0255](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10394) AHG9: Semantics fix to ALF and SAO enabling flags in PH [N. Hu, V. Seregin, M. Karczewicz (Qualcomm), O. Chubach, C.-Y. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)] [late]

### General and misc. HLS topics (16+17 – One TBP and revisit for item 24)

[JVET-S0210](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10332) On definition of the VVC Still Picture profiles [M. Pettersson, R. Sjöberg, M. Damghanian, J. Enhorn, J. Ström, R. Yu, D. Liu (Ericsson)]

TBP.

[JVET-S0139](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10261) AHG9: A summary of proposals on general and misc. HLS topics [Y.-K. Wang (Bytedance)]

This contribution was discussed in the HLS AHG meeting at 0515 UTC on 27 May and in the HLS AHG pre-meeting at 1630 UTC on 19 June and 1300 UTC on 21 June, and in the main JVET meeting at 2120 UTC on 24 June.

This contribution provides a summary of the 31 proposals on general and misc. HLS topics (the agenda item 3.1.2 in JVET-S0137 and JVET-S0237).

It is suggested that this summary, in terms of a list of proposed items, is used for the reviewing of these proposals, such that the discussions can be in a more structured and efficient manner. The following actions are proposed:

1. Remove the support of the separate colour plane coding from VVCv1, by removing the syntax elements sps\_separate\_colour\_plane\_flag and sh\_colour\_plane\_id and the related text. If such functionality is desired in the future, the SPS and SH extension mechanisms could be used. Another option is to rename these syntax elements to be reserved bits. (S0052)

AHG Recommendation (cleanup): Remove these syntax elements and the associated decoding process as proposed.

1. Add a constraint: The value of sps\_field\_seq\_flag shall be the same in all SPSs that are referred to by CLVSs in a CVS. (S0056 aspect 1)

No action seemed necessary on this, as the decoding process is not affected.

1. Add a constraint: When sps\_field\_seq\_flag is equal to 1, all fields that compose the same frame shall refer to the same PPS. (S0056 aspect 2)

The concept of fields belonging to the same frame did not seem adequately defined, and no action was recommended on this.

1. Add a constraint: When sps\_video\_parameter\_set\_id is equal to 0, parameter sets referred to by all VCL NAL units shall have the same value of nuh\_layer\_id as the VCL NAL units. (S0075 aspect 1 – also covered in another summary document S0141)

This was deferred for consideration in relation to S0141 regarding inference of an OLS when there is no VPS – adding a NOTE may be sufficient. See the notes for S0141 item 2 in section 6.1.8.

1. Do the following for setting of PictureOutputFlag after receiving the first slice of a picture and before receiving other slices of the picture: (S0077)
2. Add a constraint that when a picture contains a mix of RASL\_NUT with NAL unit type(s) other than RADL\_NUT or a mixed of RADL\_NUT with other NAL unit type(s) other than RASL\_NUT, then the following applies:
   * 1. If interlace coding is not used (i.e., sps\_field\_seq\_flag is equal to 0), there shall be at least one non-leading picture between the picture and its associated IRAP picture.
     2. Otherwise, if interlace coding is used (i.e., sps\_field\_seq\_flag is equal to 1), there shall be at least two non-leading pictures between the picture and its associated IRAP picture.
3. Add a NOTE to clarify the derivation of PictureOutputFlag that when decoder received the first slice of the current picture and the NAL unit type of the slice is either RASL\_NUT or RADL\_NUT and the value of pps\_mixed\_nalu\_types\_in\_pic\_flag is equal to 1, if decoder has not received any non-leading picture from the last IRAP picture, then decoder can determine that the current picture is a RASL picture.

It was noted that PictureOutputFlag is not really needed until all slices of the picture have been decoded, and thus suggested to move the derivation of this flag to the end of the decoding process of the picture.

AHG Recommendation (cleanup): Move the derivation of this flag to the end of the decoding process of the picture.

1. Invoke the derivation process for NoOutputOfPriorPicsFlag only once per AU, that is, before the decoding process of the first picture in the CVSS AU but after parsing the slice header of the first slice of the current picture. When NoOutputOfPriorPicsFlag is equal to 1, the process of removing pictures stored in the DPB without outputting them is invoked only once per access unit. (S0078)

AHG Recommendation (BF/expression of existing intent): Adopt.

1. Fix an asserted bug (the derivation of prevTid0Pic that is used in the POC decoding process does not consider the value of ph\_non\_ref\_pic\_flag), by adding the following constraint: (S0081)

Let picture picA and picB be two pictures with TemporalId equal to 0, it is a constraint of conformance bitstream that DiffPicOrderCnt( picB, picA ) shall not be greater than MaxPicOrderCntLsb / 2 when all of the following conditions are satisfied:

* The values of nuh\_layer\_id of picA and picB are the same.
* picA and picB are not RADL picture or RASL picture.
* The value of ph\_non\_reference\_picture\_flag of picA and picB are both equal to 0.
* picB is the first picture with TemporalId equal to 0 that follows picA in output order.

An alternative approach was suggested, to modify the derivation of prevTid0Pic to consider only pictures with ph\_non\_ref\_pic\_flag equal to 0. It was commented that this approach was taken in HEVC.

It was also commented that we should do the same with prevNonDiscardablePic and in C.4 and the semantics of delta\_poc\_msb\_cycle\_present\_flag.

AHG Recommendation (BF/expression of existing intent): Make the alternative suggested changes.

1. When the current picture is a RADL picture, allow RASL pictures with pps\_mixed\_nalu\_types\_in\_pic\_flag is equal to 1 in active entries in RefPicList[ 0 ] or RefPicList[ 1 ]. (S0084, spec text ticket #1035)

AHG Recommendation (BF/expression of existing intent): Adopt (the editor may also add a NOTE to explain that such RADL pictures would still be correctly decodable when random accessing from the CRA picture, due to the existence of subpicture-level constraints).

1. Do one of the following to the NOTE in the definition of RASL picture: (S0110 aspect 1)
2. Remove the sentence "RASL pictures are not used as reference pictures for the decoding process of non-RASL pictures."
3. Change the sentence to be: "RASL pictures with mixed\_nalu\_types\_in\_pic\_flag equal to 0 are not used as reference pictures for the decoding process of non-RASL pictures."

AHG Recommendation (BF/expression of existing intent): Adopt “b” in principle; editor to produce the precise wording.

1. When aud\_irap\_or\_gdr\_au\_flag is equal to 1, in the AUD syntax, *optionally* signal the OLS index of the OLS represented by the CVS (aud\_cvs\_ols\_idx) and the highest temporal sublayer present in the CVS (aud\_cvs\_htid\_plus1), each conditioned by its own presence flag, with the following additional details: (S0087)
2. aud\_cvs\_htid\_plus1 equal to 0 specifies that all the pictures in the CVS starting with the AUD NAL unit are IRAP pictures or GDR pictures with ph\_recovery\_poc\_cnt equal to 0. aud\_cvs\_htid\_plus1 greater than 0 specifies that all the pictures in the CVS starting with the AUD NAL unit have TemporalId less than aud\_cvs\_htid\_plus1.
3. aud\_cvs\_ols\_idx specifies that the CVS starting with the AUD NAL unit does not contain any other layers than those included in the OLS with OLS index equal to aud\_cvs\_ols\_idx.
4. When aud\_cvs\_htid\_plus1 is present, it is used to derive the value of Htid. Otherwise, Htid is set by external means (like in VVC Draft 9).
5. When aud\_cvs\_ols\_idx is present, it is used to derive the value of TargetOlsIdx. Otherwise, TargetOlsIdx is set by external means (like in VVC Draft 9).
6. The sub-bitstream extraction process is modified so that the highest temporal sublayer and the target OLS given as inputs to the process are used in modifying the AUD NAL units in the output sub-bitstream.

It was noted that this requires AUD syntax rewriting for extraction.

A participant suggested to consider using the AUD content only if such information is not provided by external means. Others said that any external means and the AUD content (if present) should be required to match each other. Another participant said this could have a similar concept as for parameter sets – it needs to be available – either in the bitstream or by external means.

Another participant commented that dropping of some NAL units may cause mismatch, although we would not need to specify a decoder response to accidental dropping that produces non-conforming bitstreams.

The spirit is to allow the information to be signalled “in band”. If not present, the current scheme would apply such that external means is needed.

Something similar had been proposed at the January 2020 (Brussels) meeting in JVET-Q0256, using a different NAL unit rather than the AUD. This proposal would make the AUD have variable length.

It was commented that having a different NAL unit might help deal with the rewriting issue.

This was initially deferred for further study until the main meeting to propose an approach with a distinct NAL unit and text such that the information needs to be available – either in the bitstream or by external means. See the notes for item 27 for the later resolution of this.

1. Add a rule to select among OLSs matching BitstreamToDecode: When TargetOlsIdx is not provided via external means, it is set equal to the OLS with the lowest index that contains all layers of AU 0 of BitstreamToDecode and the highest number of output layers. (S0103 aspect 1)

Currently, there is no default, and TargetOlsIdx needs to be provided.

This was initially deferred for further study until the main meeting in conjunction with the previous item above. See the notes for item 27 for the later resolution of this.

1. Do one of the following to enable setting of PictureOutputFlag equal to 0 for pictures in CVSS AUs (for correct picture output behavior when random accessing from a DRAP AU): (S0104)
2. Add sps\_pic\_in\_cvss\_au\_no\_output\_flag, which equal to 1 specifies that a picture in a CVSS AU referring to the SPS is not output (regardless of the ph\_pic\_output\_flag value in the PH).
3. Add an external-means-determined variable NoOutputBeforeDrapFlag for CVSS AUs. PictureOutputFlag is set equal to 0 for pictures in CVSS AUs with NoOutputBeforeDrapFlag equal to 1.

It was asked whether this proposed behaviour is consistent with DRAP being only an SEI message, since this is proposing a change in the main body. DRAP was also an SEI message in HEVC.

It was commented that the distinction between “output” and “display” might allow a system to not display an IRAP picture although the decoder would conceptually “output” it.

It was commented that DRAP could be used for various purposes – not just recovery but also for fast-forward.

Option “b” might be considered similar in spirit with some of these suggestions.

It was commented that it had been intended for DRAP to not affect the main spec, and it seemed too late to change that intent.

No action was recommended for this (within the scope of v1).

1. In order to enable signalling the picture rate information without requiring signalling a complete HRD model, allow general\_nal\_hrd\_params\_present\_flag and general\_vcl\_hrd\_params\_present\_flag to be both equal to 0, and when that condition is true, only signal the following HRD parameters syntax elements: num\_units\_in\_tick, time\_scale, general\_same\_pic\_timing\_in\_all\_ols\_flag, fixed\_pic\_rate\_general\_flag[ i ], fixed\_pic\_rate\_within\_cvs\_flag[ i ], and elemental\_duration\_in\_tc\_minus1[ i ]. (S0109)

It was asked whether these can be sent in AVC and HEVC without HRD parameters, and the proponent said this was possible. It was also asked what these would mean if fixed\_pic\_rate\_general\_flag[ i ] and fixed\_pic\_rate\_within\_cvs\_flag[ i ] are equal to 0.

HEVC has a specification of a correspondence between POC and timing in a special case.

It was commented that the semantics of some of these parameters depend on the HRD specification, so the parameters would not make sense without the HRD model (as currently specified).

This was deferred for further study to determine whether it is feasible and desirable to signal picture rate information in the bitstream without signalling HRD parameters in the bitstream. See S0175 aspect 6 in section 3.1.8.

1. Add a prediction constraint on the pictures following a recovery point picture in both decoding and output order, as follows: When the current picture follows a recovery point picture having the same value of nuh\_layer\_id in both decoding order and output order, there shall be no picture referred to by an active entry in RefPicList[ 0 ] or RefPicList[ 1 ] that precedes that recovery point picture in output order or decoding order of the associated GDR picture in the layer with the nuh\_layer\_id equal to the nuh\_layer\_id of the reference picture. (S0114)

It was commented that this would prohibit using “clean” areas of “partially dirty” pictures prior to the recovery point. This seems against the spirit of the intent of the GDR design, so no action was recommended on this.

1. Make the following changes: (S0124)
2. Add derivation of TemporalId, ph\_non\_ref\_pic\_flag, and parameter sets to the decoding process for generating unavailable reference pictures (in order to enable checking of some constraints for them).
3. Remove the constraint that each inter-layer reference picture entry in RefPicList[ 0 ] or RefPicList[ 1 ] of a slice shall be an active entry.
4. Invoke the decoding process for generating unavailable reference pictures for ILRPs or constrain that ILRPs shall not be equal to "no reference picture".

It was commented that aspects b and c are not necessary. Part of the motivation for item b is to enable more use of signalling the RPL in the PH or SPS rather than SH – e.g., for bit savings.

As proposed “parameter set information” was vague, and specifying inference of ph\_pic\_parameter\_set\_id instead was suggested.

AHG Recommendation (BF/expression of existing intent): Adopt aspect a, modified as described.

(Note: This may also need to be an errata item for HEVC.)

1. Move the signalling of WPP enabling flag and the entry point offsets present flag from SPS to PPS, and enable the signalling of only the tile entry points when both tiles and WPP are enabled. (S0128)

Part of the motivation of the first proposed change is to enable the second proposed change.

No strong need for action was identified on this, so no action was recommended.

Discussion of this topic area stopped here at the mid-term AHG meeting and resumed at 1630 UTC on 19 June in the AHG pre-meeting.

1. Make the following changes on end of sequence (EOS) NAL units (S0155):
   1. In clause 3 (Definitions), the NOTE as part of the definition of CLVS picture, the phrase "the first PU in the layer of the bitstream that follows an EOS NAL unit in decoding order", change "EOS NAL unit" to "EOS NAL unit **in the layer**".
   2. In clause 7.4.2.2 (NAL unit header semantics), instead of requiring the nuh\_layer\_id of an EOS NAL unit to be equal to the nuh\_layer\_id of the associated VCL NAL unit, it is specified that the nuh\_layer\_id of an EOS NAL unit shall be equal to one of the nuh\_layer\_id values of the layers present in the CVS.
   3. In clause 7.4.2.4.3 (Order of PUs and their association to AUs), it is specified that, when present, the next PU of a particular layer after an EOS NAL unit that belongs to the same layer shall be an IRAP or GDR PU.
   4. In clause 7.4.2.4.4 (Order of NAL units and coded pictures and their association to PUs), it is specified that, when an EOS NAL unit is present in a PU, it shall be the last NAL unit among all NAL units within the PU other than other EOS NAL units (when present) or an EOB NAL unit (when present).
   5. In clause 7.4.3.10 (End of sequence RBSP semantics), it is specified that, when present, the EOS RBSP specifies that the next subsequent PU that belongs to the same layer as the EOS NAL unit in the bitstream in decoding order (if any) is an IRAP or GDR PU.

AHG Recommendation (cleanup/BF/expression of existing intent): Adopt.

1. Add either of the following constraints related to EOS NAL units in multi-layer bitstreams (S0174 aspect 2):
2. The picture referred to by each ILRP entry, when present, in RefPicList[ 0 ] or RefPicList[ 1 ] of a slice of the current picture shall not be a RASL picture when the associated CRA has NoOutputBeforeRecoveryFlag equal to 1 and the current picture is not a RASL picture.
3. It is a requirement of bitstream conformance that when a layer k that depends on a layer m and the layer m contains an EOS NAL unit in AU n, layer k shall also contain an EOS NAL in AU n or the next AU n + 1 must contain a CLVSS picture for layer k.

A wording clarification for this was suggested: When an AU auA contains an EOS NAL unit in a layer layerA, for each layer layerB that is present in the CVS and has layerA as a reference layer, the first picture in layerB in decoding order in an AU following auA in decoding order shall be a CLVSS picture.

It was commented that option “a” doesn’t cover some GDR cases and that option “b” seemed more aligned with practical use cases.

AHG Recommendation (cleanup/BF/expression of existing intent): Adopt option b, as clarified.

1. In clause A.4.2 (Profile-specific level limits), change the definitions of the two level limits on the relationship between the CPB removal times for AU 0 and for AU n ( n > 0 ) and the number of slices i.e., items c and d, from being based on MaxSlicesPerPicture and the maximum picture size to be based on MaxSlicesPerPicture \* ( the number of pictures in the AU ) and the maximum AU size. (S0156 aspect 1)
2. Alternatively, change the two level limits to be based on MaxSlicesPerAu, which is rename of the existing MaxSlicesPerPicture without changing its value, and change "the number of slices in each picture in AU" to "the number of slices in AU". (S0156 aspect 1 alt, late)

AHG Recommendation (cleanup/BF/expression of existing intent): Adopt alternative “a”.

1. In clause A.4.2 (Profile-specific level limits), change the definitions of the two level limits on the relationship between the CPB removal times for AU 0 and for AU n ( n > 0 ) and the number of tiles i.e., items i and j, from being based on MaxTileCols \* MaxTileRows and the maximum AU size to be based on MaxTileCols \* MaxTileRows \* ( the number of pictures in the AU ) and the maximum AU size. (S0156 aspect 2)
2. Alternatively, change the two level limits to be based on MaxTilesPerAu, which replaces the existing MaxTileRows, where the value of MaxTilesPerAu is set equal to MaxTileRows \* MaxTileCols, and change "the number of tiles in each picture in AU" to "the number of tiles in AU". (S0156 aspect 2 alt, late)

AHG Recommendation (cleanup/BF/expression of existing intent): Adopt alternative “a”.

It was noted that this implies that the minimum tile size can be as small as a single CTU in certain cases.

1. In clause C.4 (Bitstream conformance), the 6th constraint, change "DpbOutputTime[ n ] greater than DpbOutputTime[ currPic ]" to "DpbOutputTime[ n ] greater than CpbRemovalTime[ currPic ]". This is asserted to be a bug, because all decoded pictures in the DPB are always decoded earlier than decoding of the current picture, and thus CpbRemovalTime[ n ] in the context is always less than CpbRemovalTime[ currPic ]. This is also asserted to be a bug in the latest HEVC spec. (S0156 aspect 3)

AHG Recommendation (BF/expression of existing intent): Adopt. Also clarify that the number of decoded pictures in the DPB is the number that is computed in the sentence. This is noted to also affect HEVC.

Discussion in AHG session 10 stopped here in the HLS AHG pre-meeting at 1720 UTC on 19 June.

Discussion in AHG session 17 began here in the HLS AHG pre-meeting at 1300 UTC on 21 June.

1. Change "less than" in the following condition (that's part of the specification of the first picture of an AU) to "less than or equal to": 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. (S0160 aspect 5)

AHG Recommendation (editorial bug fix/expression of existing intent): Adopt.

1. Remove the following constraint from the definition of the two still picture profiles: The referenced SPS shall have max\_dec\_pic\_buffering\_minus1[ sps\_max\_sublayers\_minus1 ] equal to 0. (S0160 aspect 6)

It was commented that this affects the ability to extract a picture from a Main profile bitstream.

AHG Recommendation (editorial bug fix/expression of existing intent): Adopt. (Also affects HEVC)

1. Make sure that each VUI syntax element that describes a property of the bitstream has an inferred/default value when sps\_vui\_parameters\_present\_flag is equal to 0. (S0160 aspect 8)

Revisit after offline study to determine whether action is needed. Defaults should indicate unspecified and/or unconstrained indications.

1. Change an existing constraint such that the value of ph\_poc\_msb\_cycle\_present\_flag is required to be equal to 0 when vps\_independent\_layer\_flag[ GeneralLayerIdx[ nuh\_layer\_id ] ] is equal to 0 and there is an ILRP entry in RefPicList[ 0 ] or RefPicList[ 1 ] of a slice of the current picture (instead of "and there is a picture in the current AU in a reference layer of the current layer"). (S0160 aspect 9, late)

Several participants confirmed the need for this.

AHG Recommendation (editorial bug fix/expression of existing intent): Adopt.

1. Add the following constraints to resolve an asserted bug that may cause POC derivation process not working correctly for IRAP pictures in an independent non-output layer in which pictures other than IRAP pictures are not used for inter-layer prediction and hence would be removed during sub-bitstream extraction: (S0241 late)
   1. It is a requirement of bitstream conformance that the value of sps\_poc\_msb\_cycle\_flag shall be equal to 1 when both of the following conditions are true:

* The value of sps\_video\_parameter\_set\_id is not equal to 0.
* The SPS is referred to by at least a VCL NAL unit with layer id equal to nuh\_layer\_id and value of NumSubLayersInLayerInOLS[ i ][ GeneralLayerIdx[ nuh\_layer\_id ] ] is equal to 0 for any value of i in the range 0 TotalNumOlss − 1, inclusive, and vps\_independent\_layer\_flag[ GeneralLayerIdx[ nuh\_layer\_id ] ] is equal to 1.
  1. It is a requirement of bitstream conformance that the value of ph\_poc\_msb\_cycle\_present\_flag shall be equal to 1 when all the following conditions are true:
* The picture associated with the picture header is an IRAP picture or GDR picture with associated ph\_recovery\_poc\_cnt equal to 0 that is not a CLVSS picture.
* The POC difference between the current picture and the previous IRAP picture or GDR picture with ph\_recovery\_poc\_cnt equal to 0 in the same layer in decoding order is equal to or greater than MaxPicOrderCntLsb / 2.
* The value of sps\_video\_parameter\_set\_id is greater than 0 and the value of NumSubLayersInLayerInOLS[ i ][ GeneralLayerIdx[ nuh\_layer\_id ] ] is equal to 0 for i in the range 0 TotalNumOlss − 1, inclusive, and vps\_independent\_layer\_flag[ GeneralLayerIdx[ nuh\_layer\_id ] ] is equal to 1.

It was commented that the constraint that the output of the bitstream extraction process shall be a conforming bitstream imposes this requirement indirectly. It was also commented that the second bullet of aspect “b” is somewhat circular. Adding a NOTE was suggested.

Editor action item: The editor is strongly suggested to add a NOTE to explain this issue. This affects such scenarios as single-layer intra-picture-only trick play.

1. Enable signalling of TargetOlsIdx and Htid in the bitstream as follows: (S0163)
2. Add operation point information (OPI) NAL unit for carrying syntax elements indicating TargetOlsIdx and Htid.
3. Including an extension mechanism in OPI NAL unit similar to that in DCI and all parameter sets.
4. Allowing OPI NAL unit in all AUs with IRAP or GDR slices (and thus may become IRAP or GDR AUs as a result of layer and/or subpicture extraction), and requiring the content of the OPI NAL unit to be the same within a CVS.
5. TargetOlsIdx and Htid remain valid for one or more CVSs, until they are updated by another OPI NAL unit or through external means.
6. When both AUD and OPI NAL units are present in an AU, the OPI NAL unit shall be the next NAL unit after the AUD NAL unit. When no AUD NAL unit is present in an AU and the OPI NAL unit is present in the AU, the OPI NAL unit shall be the first NAL unit in the AU. No more than one instance of the OPI NAL unit shall be present in an AU.
7. Allowing to have neither external means nor the OPI NAL unit present for the first AU of the bitstream.
8. When no target OLS index is provided in the OPI NAL unit or through external means for the first AU of the bitstream, TargetOlsIdx is inferred to be equal to the lowest OLS index that contains the largest number of layers and the largest number of output layers among all OLSs.
9. When no highest temporal ID is provided in the OPI NAL unit or through external means for the first AU of the bitstream, Htid is inferred equal to vps\_ptl\_max\_tid[ vps\_ols\_ptl\_idx[ TargetOlsIdx ] ].
10. Assigning nal\_unit\_type equal to 12 (which was earlier used for RSV\_IRAP\_12) for the OPI NAL unit.
11. TemporalId of OPI NAL unit shall be equal to 0 and TemporalId of the containing AU shall also be 0.
12. Allowing any nuh\_layer\_id value for the OPI NAL unit. Consequently, in the sub-bitstream extraction process, the OPI NAL unit is added among the NAL units that are not removed based on nuh\_layer\_id values.

If item h above is adopted, the following items are also proposed:

1. In the current VVC draft, if no VPS is present, then vps\_ptl\_max\_tid[ vps\_ols\_ptl\_idx[ TargetOlsIdx ] ] is not inferred. This document proposes to infer it equal to sps\_max\_sublayers\_minus1 when no VPS is present.
2. It is proposed to consider changing the syntax element name of vps\_ptl\_max\_tid[ i ] and change its semantics to be more generic.

The proposed semantics are (the bolded italics text at the end of the sentence added): vps\_ptl\_max\_tid[ i ] specifies the TemporalId of the highest sublayer representation for which the level information is present in the i-th profile\_tier\_level( ) syntax structure in the VPS ***and present in the OLSs with index olsIdx such that vps\_ols\_ptl\_idx[ olsIdx ] is equal to i*.**

This contribution was the result of offline work after the May AHG meeting. The proposal is to add an “operation point information NAL unit”. The information could be in the bitstream or provided by external means. It would be at the beginning of an AU when present.

A default would be specified if this is not present – see aspect “g”.

It was commented that this is a substantial action, but appears to resolve a key open issue in the specification.

It was asked why it is necessary to be able to have the additional NAL unit in the bitstream; this is to provide some in-bitstream means of specifying non-default OLS behaviour.

After discussion, it was suggested that if external means is available, it would override the in-bitstream information.

AHG Recommendation (cleanup): Adopt, modified as suggested to specify the ability to override by external means (text with the modification to be provided in a revision).

1. Make the following changes to the constraints on RPLs for RADL pictures and subpictures, considering multi-layer coding as well as its combination with subpictures (S0167) (additions in **bold**, removals in *italic*):

* When the current picture is a RADL picture, there shall be no active entry in RefPicList[ 0 ] or RefPicList[ 1 ] that is any of the following:
  + A RASL picture with pps\_mixed\_nalu\_types\_in\_pic\_flag is equal to 0

NOTE 4 – This means that an active entry of the RPLs of a RADL picture can refer to a RASL picture with pps\_mixed\_nalu\_types\_in\_pic\_flag equal to 1 **and the referenced RASL picture may either belong to the same layer or a different layer than the layer containing the current RADL picture**. However, when decoding starts from the associated CRA picture, such a RADL picture can still be correctly decoded, because the RADL subpicture(s) in that referenced RASL picture **with sps\_subpic\_treated\_as\_pic\_flag equal to 1** would be correctly decoded, as the RADL picture would only refer to the RADL subpictures in the referenced RASL picture, as imposed by the next constraint that disallows RADL subpictures referring to a RASL subpicture.

* + A picture that precedes the associated IRAP picture in decoding order
* When the current subpicture, with nuh\_layer\_id equal to a particular value layerId and subpicture index equal to a particular value subpicIdx **and sps\_subpic\_treated\_as\_pic\_flag[ subPicIdx ] equal to 1**, is a RADL subpicture, there shall be no active entry in RefPicList[ 0 ] or RefPicList[ 1 ] that is any of the following:
  + A picture [Removing: *with nuh\_layer\_id equal to layerId*] **for which the value of nuh\_layer\_id may or may not be equal to layerId** containing a RASL subpicture with subpicture index equal to subpicIdx
  + **A RASL picture for which the value of nuh\_layer\_id is not equal to layerId and the value of sps\_num\_subpics\_minus1 is equal to 0**
  + A picture that precedes the picture containing the associated IRAP subpicture in decoding order

The first part of the proposal was supported as a clarification.

It was agreed that we should not insert “**with sps\_subpic\_treated\_as\_pic\_flag equal to 1**” and “**and sps\_subpic\_treated\_as\_pic\_flag[ subPicIdx ] equal to 1**” because if the RASL pictures discussed in the NOTE have all I slices, they can be correctly decoded, and the subpicture-level constraint would apply even if the sps\_subpic\_treated\_as\_pic\_flag[ subPicIdx ] is equal to 0.

AHG Recommendation (expression of existing intent): Adopt, modified to not insert two phrases as noted above.

1. Make the following changes, considering the combination of GDR, subpictures, and virtual boundaries (S0168):
2. (Option 1) Do nothing or rewrite virtual boundary information in the SPS in the subpicture sub-bitstream extraction process (without actual proposed changes).
3. (Option 2) Add a requirement of bitstream conformance that the extracted first subpicture for the sub-bitstream shall contain an intra-coded area and the following processing are required in sub-bitstream extraction:
   * 1. Locate the first subpicture with an intra-coded area in the GDR picture or the following recovering pictures. This located subpicture becomes the new GDR subpicture.
     2. Change the value of nal\_unit\_type of the new GDR subpicture to GDR\_NUT when the new GDR subpicture is not in the current GDR picture.
     3. Rewrite the virtual boundary information in the SPS in terms of the new GDR subpicture.
     4. Adjust the value of ph\_recovery\_poc\_cnt in the PH when the new GDR subpicture is not the current GDR picture.
4. (Option 3, which is on top of option 2) When sps\_gdr\_enabled\_flag is equal to 1, add sps\_gdr\_subpic\_intra\_starting\_present\_flag in the SPS. In the PH, when ph\_recovery\_poc\_cnt is greater than 0 and sps\_gdr\_subpic\_intra\_starting\_present\_flag is equal to 1, add ph\_subpic\_intra\_starting\_poc\_cnt[ i ] for each subpicture, which specifies "the intra-coded starting point of the i-th decoded subpicture in output order".

The question is whether we need some kind of subpicture-level information about GDR. We do not have area-specific information about what areas have been refreshed. It was commented that this concept had been discussed before. The contribution considers the implication of this for subpictures.

The proposed additional information is essentially metadata that would provide some extra information but would not be completely necessary and would not affect the decoding process. Such information – if determined helpful – could be developed as something to be considered for later specification, e.g., as an SEI message.

It was noted that we do not have any constraint that the picture must contain some intra-coded area in order to be identified as a GDR picture. How the refresh is done is a matter left up to the encoder.

It was asked whether it is really important to try to do something special for the combination of subpictures with GDR.

Further study of the need for a potential SEI approach (after version 1) is encouraged. No current action was recommended.

1. Add a constraint: The recovering pictures of a GDR picture shall precede the recovery point picture in decoding order. (S0188 aspect 1)

The draft standard says that all pictures that follow the recovery point picture in output order (and that picture itself) will be correct.

A “recovering picture” is defined as a picture (that follows the GDR picture in decoding order) that precedes the recovery point picture in output order.

An example is a CRA. A CRA is basically a GDR picture with a zero recovery period, but it may be followed in decoding order by RASL pictures, which are pictures that follow the GDR picture in decoding order and precede it in output order. RASL pictures would violate the proposed constraint.

Otherwise, a GDR picture could be used as a CRA replacement.

It was not clear that there is a need to establish the proposed constraint, so no action was recommended.

1. Add a constraint: When pps\_mixed\_nalu\_types\_in\_pic\_flag is equal to 1 for a picture, the picture shall not be a recovering picture or the recovery point picture associated with a GDR picture. (S0188 aspect 2)

It was noted that GDR NAL unit types cannot be mixed with other types.

It was commented that the proposed constraint would probably be ordinarily applied by encoders, but it was said that the constraint may not really be necessary.

An example that would violate the constraint was expressed as a GDR followed by a picture that mixes the “dirty area” with something else and then has a later recovery picture.

It was noted that we allow mixing of trailing and STSA pictures and it was said that this could be OK in a recovering picture.

It was not clear that there is a need to establish the proposed constraint, so no action was recommended.

1. Add a constraint: The value of recoveryPointPocVal of a layer shall be equal to or greater than the recoveryPointPocVal of a reference layer of the layer. (S0188 aspect 3)

It was commented that R0274 had also proposed this and it was determined not to be necessary.

It was not clear that there is a need to establish the proposed constraint, so no action was recommended.

1. Move the syntax element ph\_recovery\_poc\_cnt to be signalled after ph\_poc\_msb\_cycle\_val. (S0188 aspect 4)

This is proposed due to resolve a semantics dependency issue, to order the syntax so that the variables computed from a syntax element do not depend on a later syntax element.

This change would require parsing the SPS before using the ph\_recovery\_poc\_cnt to identify the distance to a recovery point. A system could scan through the data for recovery point identification without parsing the SPS.

Because of this consideration, no action was recommended on this.

It was remarked that in the semantics of ph\_recovery\_poc\_cnt and possibly in a NOTE in 8.3.4.2, there is a lack of consideration of the case with recovery POC distance of 0.

AHG Recommendation (editorial BF/expression of existing intent): Fix the description to consider the case with a recovery POC distance of 0. (Possibly also affecting HEVC and AVC.)

1. Modify the decoding process for generating unavailable reference pictures to set the values of nuh\_layer\_id and PicOrderCntVal of unavailable inter-layer reference pictures and mark those pictures as “used for long-term reference”. (S0192 aspect 1)

It was commented that this aspect had been discussed at the May AHG meeting, and that inter-layer reference pictures cannot be unavailable.

It was said that the reason for this existing constraint is for picture loss detection.

There was an editorial issue discussed – in the RPL derivation there is a process that considers the forbidden possibility of an ILRP that is not present in the DPB. This is not an error, but is not strictly necessary. There is a NOTE below that describes the potential inference of an unintentional loss.

1. Change the definition of still picture profiles to contain one AU only instead of one picture only. (S0091 aspect 1, S0202 aspect 2)
2. If yes, add the following two constraints: (S0202 aspect 2)
   * 1. When sps\_video\_parameter\_set\_id is not equal to 0, there shall be one OLS specified in the VPS that contains all the layer present in the bitstream and the OLS has only one output layer.
     2. The value of max\_dec\_pic\_buffering\_minus1[ sps\_max\_sublayers\_minus1 ] in the DPB parameters shall not be less than the maximum of direct reference layers of any layer in the bitstream.

This would include inter-layer prediction, motion vectors, etc.

See also item 46 of S0138, discussion whether to either change general\_one\_picture\_only\_constraint\_flag to general\_one\_au\_only\_constraint\_flag. (S0091 #1) or remove general\_one\_picture\_only\_constraint\_flag (S0160 #7).

The AHG recommended to further discuss this in the main meeting, together with the parent bodies. This was further discussed in the main JVET meeting at 2130 UTC on 24 June.

It was commented that JPEG XT uses scalability somewhat in this way (without motion vectors) to create a still picture profile, and there is such a usage of metadata for that purpose (see the “progressive refinement SEI message). These were the only examples that were recalled during the discussion.

It was commented that including inter-picture referencing would have a major effect on the nature of the still picture profiles and should not be done.

It was noted that this could be used for multiview coding, multi-camera, multiexposure, multi-focal-length usage.

There was discussion of whether creating some *additional* profile(s) like this could be desirable.

1. Add either of the following constraint for a bitstream conforming to the Main 10 Still Picture profile or Main 4:4:4 10 Still Picture profile (S0202 aspect 1):
2. When sps\_video\_parameter\_set\_id is greater than 0, there shall be an OLS specified in the VPS that contains only the layer that is present in the bitstream.
3. The value of sps\_video\_parameter\_set\_id shall be equal to 0.

It was asked whether the picture output flag would also need to be 1 for a picture in the Main 10 Still Picture profile. It was commented that perhaps we should have a constraint that applies to all bitstreams that requires that the bitstream must have at least one picture that is in an output layer that has pic\_output\_flag equal to 1.

AHG Recommendation (sensibility constraint): Require that the bitstream shall contain at least one picture with pic\_output\_flag equal to 1 that is in an output layer.

1. In the PTL syntax structure, change the signalling of sublayer\_level\_idc[ i ] to be in descending order of i, i.e., from the maxNumSubLayersMinus1 − 1 to 0, inclusive. (S0203 aspect 1, S0207)

This is for semantics purposes, so that the syntax order would be the same order as the inference dependency order.

AHG Recommendation (cleanup): Adopt, together with the next item.

1. In the PTL syntax structure, change the signalling of ptl\_sublayer\_level\_present\_flag[ i ] to be in descending order of i. (S0203 aspect 2)

This would match the order for item 37 and was agreed; see the notes for that item.

1. In the PTL syntax structure, move the sub-profile fields to be immediately before general\_level\_idc, which saves two lines of syntax, "if( profileTierPresentFlag ) {" and "}". (S0216)

It was commented that the general PTL info is the most important to systems and decoders and should be kept together, so no action was recommended on this.

1. Add an inference rule: When not present, ph\_poc\_msb\_cycle\_present\_flag is inferred to be equal to 0. (S0239 late, bug ticket #1118)

It was commented that we could either do this inference or avoid using the flag when it is not present.

AHG Recommendation (editorial bug fix/expression of existing intent): either infer ph\_poc\_msb\_cycle\_present\_flag to be equal to 0 when it is not present or avoid referring to the flag when it is not present.

[JVET-S0052](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10174) AHG9: Removing separate colour plane coding from VVCv1 [Y.-K. Wang, Z. Deng (Bytedance), J. Boyce (Intel)]

[JVET-S0056](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10178) AHG9: On field coding [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-S0075](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10197) AHG9: On constraints and inference values when VPS is not present [Hendry, S. Paluri, S. Kim (LGE)]

Aspect 1 of this contribution belongs to this category.

[JVET-S0077](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10199) AHG9: On derivation of PictureOutputFlag for RASL [Hendry, H. Jang, J. Nam, S. Paluri, S. Kim, J. Lim (LGE)]

[JVET-S0078](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10200) AHG9: On derivation of NoOutputOfPriorPicsFlag [Hendry, S. Paluri, S. Kim (LGE)]

[JVET-S0081](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10203) AHG9: On non-referenced picture and POC derivation [Hendry, H. Jang, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-S0084](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10206) AHG9: On RPL constraint of RADL picture [Hendry (LGE)]

[JVET-S0110](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10232) AHG9: On HLS Editorial cleanup [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Aspect 1 of this contribution belongs to this category.

[JVET-S0087](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10209) AHG9: On target OLS and sublayers for decoding [M. M. Hannuksela (Nokia)]

[JVET-S0103](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10225) AHG9: On OLS identification [R. Skupin, Y. Sanchez, K. Suehring, T. Schierl (HHI)]

Aspect 1 of this contribution belongs to this category.

[JVET-S0104](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10226) AHG9: On DRAP output [Y. Sanchez, R. Skupin, K. Suehring, T. Schierl (HHI)]

[JVET-S0109](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10231) AHG9: Signalling of picture rate [B. Heng, W. Wan (Broadcom)]

[JVET-S0114](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10236) AHG9: On GDR RPL constraint [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-S0124](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10246) AHG9: On unavailable reference pictures [V. Seregin, Y. He, M. Coban, A. K. Ramasubramonian, M. Karczewicz (Qualcomm)]

[JVET-S0128](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10250) AHG12: On entry point signalling [M. Coban, V. Seregin, Y. He, Y.-J. Chang, M. Karczewicz (Qualcomm)]

[JVET-S0155](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10277) AHG9: On EOS NAL units [Y.-K. Wang, Z. Deng (Bytedance)]

[JVET-S0174](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10296) AHG9: Miscellaneous cleanups [R. Skupin, Y. Sanchez, K. Suehring, T. Schierl (HHI)]

Aspect 2 of this contribution belongs to this category.

[JVET-S0156](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10278) AHG9: On level definitions and bitstream conformance [Y.-K. Wang, Z. Deng (Bytedance)]

[**JVET-S0160**](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10282) **AHG9/AHG12/AHG8: Miscellaneous HLS cleanups [Y.-K. Wang, Z. Deng, L. Zhang, K. Zhang (Bytedance)]**

Aspects 5, 6, 8, and 9 of this contribution belong to this category.

[JVET-S0163](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10285) AHG9: On target OLS and sublayers for decoding [M. M. Hannuksela (Nokia), R. Skupin (HHI), Hendry (LG Electronics), B. Choi (Tencent)]

[JVET-S0167](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10289) AHG9: Constraints on reference picture lists of a RADL picture [L. Chen, S.-T. Hsiang, C.-W. Hsu, O. Chubach, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-S0168](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10290) AHG9: On GDR subpictures for sub-bitstream extraction [L. Chen, C.-Y. Chen, C.-W. Hsu, O. Chubach, S.-T. Hsiang, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-S0188](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10310) AHG9: On gradual decoding refresh [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-S0192](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10314) AHG9: On reference picture list with generating unavailable reference picture [B. Choi, S. Wenger, S. Liu (Tencent)]

Aspect 1 of this contribution belongs to this category.

[JVET-S0091](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10213) AHG8/AHG9: On constraints of still picture [K. Abe, T. Nishi, T. Toma, V. Drugeon (Panasonic)]

Aspect 1 of this contribution belongs to this category.

[JVET-S0202](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10324) AHG9: On Still Picture Profile and multi layers aspect [H. Jang, Hendry, J. Nam, N. Park, S. Paluri, S. Kim, J. Lim (LGE)]

[JVET-S0203](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10325) AHG9: On signalling of sublayer level idc [Hendry (LGE)]

[JVET-S0207](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10329) AHG9: Order of the sublayer\_level\_idc[ i ] syntax elements [Z. Zhang, R. Sjöberg, M. Pettersson, M. Damghanian, J. Ström (Ericsson)]

[JVET-S0216](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10338) AHG9: Parsing order of profile\_tier\_level( ) [K. Naser, F. Le Leannec, T. Poirier, M. Kerdranvat (InterDigital)]

[JVET-S0239](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10361) AHG9: Clean-up on derivation of POC [N. Park, Hendry, J. Nam, H. Jang, J. Lim, S. Kim(LGE)] [late]

[JVET-S0241](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10363) AHG9: On signalling of POC MSB information in picture header [Hendry, H. Jang, N. Park, S. Kim, J. Lim (LGE) [late]]

### General constraints information (GCI) (25+7 – Closed)

[JVET-S0138](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10260) AHG9: A summary of proposals on general constraints information [Y. He (Qualcomm), Y.-K. Wang, Z. Deng (Bytedance)]

This contribution was discussed in the HLS AHG meeting at 2110 UTC on 27 May and in the HLS AHG pre-meeting at 1900 UTC on 19 June, and in the main JVET meeting at 2155 UTC on 24 June and at 1310 on 25 June (GJS).

This contribution provides a summary of the 31 proposals on general constraints information (GCI) (the agenda item 3.1.3 in JVET-S0137 and JVET-S0237).

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. The following actions are proposed:

**On the GCI syntax structure**

1. Approaches to enable skipping all GCI syntax elements
   1. Add a presence flag for general\_constraint\_info( ) syntax structure. (S0050 #1, S0127)
      1. Infer the values of the GCI flags to 0. (S0050 #1a, S0127)
      2. Infer the values of max\_bitdepth\_constraint\_idc to 8 and the value of max\_chroma\_format\_constraint\_idc value to 3. (S0050 #1). Or infer the value of max\_bitdepth\_constraint\_idc to 2 and max\_chroma\_format\_constraint\_idc to 1. (S0127)

Editor action item: Consider the name of max\_bitdepth\_constraint\_idc to clarify its semantics.

* + 1. Move the alignment bits outside the GCI syntax structure and change the GCI reserved bytes to bits (S0050 #1b).
  1. Move the extension length indicator (gci\_num\_reserved\_bytes) from last to first (gci\_num\_constraint\_bytes) in the GCI syntax structure to enable skip all GCI SE signaling when all GCI SEs values are 0. The value of gci\_num\_reserved\_bytes shall be equal to either 0 or 9. (S0092)

It was commented, and agreed, that inference rules should not really be needed; the flags would just have semantics when they are present (just an editorial matter).

It was questioned whether people would really use the flags if they can be skipped.

It was noted that the number of flags is substantial, so having some ability to skip them is desirable.

AHG Recommendation: Agree in spirit to allow some form of skipping the GCI syntax. The exact method was agreed to be for further study to be determined later.

This was further discussed in the HLS AHG pre-meeting at 1900 UTC on 19 June after offline discussion.

A side activity had been conducted for the above. The result from that side activity was a design proposed in S0179: Signal the GCI syntax structure between the general PTL fields and sub-profile fields in the PTL syntax structure. Signal the gci\_present\_flag at the beginning of the GCI syntax structure and use it to condition the GCI fields, move the byte alignment to the end of the GCI syntax structure, and change the reserved bytes to reserved bits.

The semantics were reviewed and refined (essentially editorially) in group discussion, to be uploaded in a v2 of S0179.

AHG Recommendation (cleanup): Adopt S0179-v2.

Editor action item: The editor is requested to review the clarity of semantics for reserved syntax elements and reserved values of syntax elements, to not only prohibit use in bitstreams conforming to this version of the Specification, but also to clarify that decoders shall allow presence of reserved syntax elements and ignore values of reserved syntax elements when they are present. Where relevant, decoders shall also allow reserved values of existing syntax elements that do not affect the decoding process and picture output (e.g., transfer function and matrix coefficients) and interpret those as having an unspecified meaning, and encoders for the current version shall not use such values.

1. Categorize GCI SEs into substructures
2. Into 11 sub-structures (format, functionality, NALU, partition, pred, intra, inter, transform/quantization/residual, loop filter, layer, SEI) and add inference value in the semantics (S0105), each substructure is gated by a present flag and, when not present, the value of the corresponding constraint flag is inferred to be 0 (S0105 alt)
3. Into 3 sub-structures (capability, coding tool, NALU) (S0111)
4. Rearrange GCI SEs to put intra-related GCI flags together, and inter-related GCI flags together (S0129 #3)

Approach c was said to be essentially a subset of approach a.

AHG Recommendation: Adopt approach “a”.

It was later recommended that the order of GCI syntax elements should be aligned with the SPS syntax elements. This was included into the side activity for items 4 to 22, and the report of that side activity is in S0161 (see notes under item 4) below).

It was commented that we should not have category-wise skipping. Although some interest was expressed by a proponent, no action was recommended on that aspect.

**New GCI SEs**

1. Weighted prediction
2. Two GCI flag, one for each of sps\_weighted\_pred\_flag and sps\_weighted\_bipred\_flag (S0050 #2, S0105, S0131)
3. One GCI flag for both sps\_weighted\_pred\_flag and sps\_weighted\_bipred\_flag (S0058)

There are currently no weighted prediction constraint flags.

AHG Recommendation: Adopt approach “b”.

1. no\_virtual\_boundaries\_constraint\_flag to constrain sps\_virtual\_boundaries\_enabled\_flag (S0050 #2, S0105, S0131)

AHG Recommendation: J. Boyce was asked to coordinate further study offline and make a recommendation for items 4-22.

The side activity also included an effort trying to align the order of GCI syntax elements with the SPS syntax elements, related to item 2) above.

The outcome of the side activity was included in S0161.

This was further discussed in the HLS AHG pre-meeting at 1930 UTC on 19 June after offline discussion.

Additional recommendations in S0161 included the following:

* 1. Remove any constraints that existing constraint flags impose on other constraint flags (as previously agreed)
  2. Rename max\_bitdepth\_constraint\_idc to max\_bitdepth\_minus8\_constraint\_idc (a matter of editorial clarity)
  3. Remove no\_aps\_constraint\_flag (since there are already constraint flags for each tool that uses an APS and since the flag only controlled presence within the bitstream without controlling presence by external means, which is hard to control).

An alternative is proposed in S0073-v2 aspect 1 option 1, which disables presence in the bitstream and also disables the use of any APS references. It was commented that S0050 item 5 proposes the same modification.

AHG Recommendation (cleanup): Adopt S0161 except additional recommendation “c”, for which we instead adopt S0073-v2 aspect 1 option 1 and editorial recommendation “b”.

There was further discussion in the main JVET meeting at 1310 on 25 June (GJS) regarding consistency matters found during editing integration.

The decision on S0161-v3 includes an agreed item on adding max\_log2\_ctu\_size\_constraint\_idc, u(2)-coded, to constrain sps\_log2\_ctu\_size\_minus5. (S0066) It was later agreed to change max\_log2\_ctu\_size\_constraint\_idc to gci\_three\_minus\_max\_log2\_ctu\_size\_constraint\_idc such that the value 0 does not impose a constraint.

Decision (cleanup): Adopt the above-described modification.

The decision on S0161-v3 includes an agreed item to signal GCI fields in the order of different categories, including format, functionality, NAL units, partition, prediction, intra, inter, transform/quantization/residual, loop filter, layer, others, and within each category, the order of the fields are the same as the corresponding syntax elements in the SPS or other syntax structures. The following changes have later been made: 1) gci\_intra\_only\_constraint\_flag, gci\_all\_layers\_independent\_constraint\_flag, and gci\_one\_au\_only\_constraint\_flag placed at the beginning of the GCI syntax structure, named as the "general category"; 2) gci\_no\_idr\_rpl\_constraint\_flag placed in the "NAL unit type related" category instead of intra coding tool mechanism; 3) gci\_no\_palette\_constraint\_flag and gci\_no\_ibc\_constraint\_flag merged (in the order as in S0161-v1) into the "intra" category with other intra tools related GCI flags, instead of having their own "prediction mode" category; 4) gci\_no\_virtual\_boundaries\_constraint\_flag placed in the "loop filter" category instead of the "partitioning" category.

Decision (cleanup): Adopt the above-described modifications.

The notes of the above discussion of 25 June end here.

There was further discussion of general\_non\_packed\_constraint\_flag and general\_non\_‌projected\_‌constraint\_‌flag. It was suggested to either move them to VUI or move them outside the GCI structure.

AHG Recommendation (cleanup): Move general\_non\_packed\_constraint\_flag and general\_non\_‌projected\_‌constraint\_‌flag to the VUI. After the general\_interlaced\_source\_flag.

There was further discussion of single\_layer\_constraint\_flag. It was suggested to just remove the flag. Another suggestion was to move it outside the GCI structure into the PTL structure.

It was noted that the value of the VPS ID being 0 is another clear indication of a lack of layering usage, and those are observable in the bitstream earlier than the PTL information. Another suggestion was to have a no\_vps\_nal\_unit\_constraint\_flag.

This was further discussed in the main JVET meeting at 2200 UTC on 24 June. It was suggested to move the flag outside the GCI structure into the PTL structure and rename it, e.g., to multi\_layer\_enabled\_flag and change the sublayer loop count to a fixed 7 bit loop with constraints (or editorial equivalent).

|  |  |
| --- | --- |
| profile\_tier\_level( profileTierPresentFlag, maxNumSubLayersMinus1 ) { | **Descriptor** |
| if( profileTierPresentFlag ) { |  |
| **general\_profile\_idc** | u(7) |
| **general\_tier\_flag** | u(1) |
| general\_constraint\_info( ) |  |
| } |  |
| **general\_level\_idc** | u(8) |
| **multi\_layer\_enabled\_flag** | u(1) |
| for( i = 0; i < 7; i++ ) |  |
| **ptl\_sublayer\_level\_present\_flag**[ i ] | u(1) |
| for( i = 0; i < maxNumSubLayersMinus1; i++ ) |  |
| if( ptl\_sublayer\_level\_present\_flag[ i ] ) |  |
| **sublayer\_level\_idc**[ i ] | u(8) |
| if( profileTierPresentFlag ) { |  |
| **ptl\_num\_sub\_profiles** | u(8) |
| for( i = 0; i < ptl\_num\_sub\_profiles; i++ ) |  |
| **general\_sub\_profile\_idc**[ i ] | u(32) |
| } |  |
| } |  |

The notes of the above discussion of 24 June end here.

There was further discussion of this syntax in the main JVET meeting at 1320 on 25 June (GJS) regarding an issue found in the frame\_only\_constraint\_flag.

With some refinements incorporated in group discussion, this became as shown below.

|  |  |
| --- | --- |
| profile\_tier\_level( profileTierPresentFlag, MaxNumSubLayersMinus1 ) { | **Descriptor** |
| if( profileTierPresentFlag ) { |  |
| **general\_profile\_idc** | u(7) |
| **general\_tier\_flag** | u(1) |
| } |  |
| **general\_level\_idc** | u(8) |
| if( profileTierPresentFlag ) |  |
| general\_constraints\_info( ) |  |
| **ptl\_frame\_only\_constraint\_flag** | u(1) |
| **ptl\_multi\_layer\_enabled\_flag** | u(1) |
| for( i = 0; i < MaxNumSubLayersMinus1; i++ ) |  |
| **ptl\_sublayer\_level\_present\_flag**[ i ] | u(1) |
| while( !byte\_aligned( ) ) |  |
| **ptl\_reserved\_zero\_bit** | u(1) |
| for( i = 0; i < MaxNumSubLayersMinus1; i++ ) |  |
| if( ptl\_sublayer\_level\_present\_flag[ i ] ) |  |
| **sublayer\_level\_idc**[ i ] | u(8) |
| if( profileTierPresentFlag ) { |  |
| **ptl\_num\_sub\_profiles** | u(8) |
| for( i = 0; i < ptl\_num\_sub\_profiles; i++ ) |  |
| **general\_sub\_profile\_idc**[ i ] | u(32) |
| } |  |
| } |  |

Decision (cleanup): Adopt syntax modification as per above.

The notes of the above discussion of 25 June end here.

1. no\_explicit\_scaling\_list\_constraint\_flag/no\_scaling\_list\_constraint\_flag to constrain
2. sps\_explicit\_scaling\_list\_enabled\_flag shall be equal to 0 (S0050 #2, S0058 S0066, S0067, S0105)
3. and aps\_params\_type shall not be equal to 2 (S0066)
4. no\_mtt\_constraint\_flag to constrain SPS MTT SEs sps\_max\_mtt\_hierarchy\_depth\_intra\_slice\_luma, sps\_max\_mtt\_hierarchy\_depth\_inter\_slice and sps\_max\_mtt\_hierarchy\_depth\_intra\_slice\_chroma (S0058)
5. max\_luma\_transform\_size\_32\_constraint\_flag or no\_luma\_transform\_size\_64\_constraint\_flag to constrain sps\_max\_luma\_transform\_size\_64\_flag (S0058, S0066)
6. no\_long\_term\_ref\_pic\_constraint\_flag to constrain sps\_long\_term\_ref\_pics\_flag (S0058)
7. max\_log2\_ctu\_size\_constraint\_idc (u(2)) to constrain sps\_log2\_ctu\_size\_minus5 (S0066)
8. max\_layers\_constraint\_idc to constrain vps\_max\_layers\_minus1 (S0113)
9. max\_sublayers\_constraint\_idc to constrain vps\_max\_sublayers\_minus1 (S0113)
10. max\_subpics\_constraint\_idc to constrain sps\_num\_subpics\_minus1 (S0113)
11. no\_pic\_partition\_constraint\_flag to constrain pps\_no\_pic\_partition\_flag (S0113)
12. no\_rectangular\_slice\_constraint\_flag to constrain pps\_rect\_slice\_flag (S0113)
13. one\_slice\_per\_subpicture\_constraint\_flag to constrain pps\_single\_slice\_per\_subpic\_flag (S0113)
14. no\_conformance\_window\_constraint\_flag to contrain sps\_conformance\_window\_flag (S0131)
15. general\_single\_ols\_per\_layer\_set\_constraint\_flag to constraint no two OLSs contain the same layer set (S0103#2)
16. no\_scalability\_constraint\_flag to constraint scalable and layered coding (S0105)
17. no\_360\_video\_constraint\_flag to constrain sps\_ref\_wraparound\_enabled\_flag, and equirectangular projection SEI messages or generalized cubemap projection SEI messages (S0105)
18. lossless\_coding\_constraint\_flag to constrain all picture are losslessly coded (S0054 #8)
19. no\_scc\_constraint\_flag to constrain sps\_ibc\_enabled\_flag, sps\_bdpcm\_enabled\_flag and sps\_palette\_enabled\_flag (S0105)
20. no\_VUI\_constraint\_flag to constrain sps\_vui\_parameters\_present\_flag (S0113)
21. SEI related new GCI flags
22. no\_scalable\_nesting\_SEI\_constraint\_flag to constrain scalable nesting SEI (S0105)
23. no\_subpic\_level\_SEI\_constraint\_flag to constrain subpicture level SEI (S0105)
24. no\_filler\_payload\_SEI\_constraint\_flag to constrain filler payload SEI (S0105)
25. no\_user\_data\_reg\_SEI\_constraint\_flag to constrain user data registered by Recommendation ITU T.35 SEI (S0105)
26. no\_user\_data\_unreg\_SEI\_constraint\_flag to constrain data unregistered SEI (S0105)
27. no\_film\_grain\_SEI\_constraint\_flag to constrain film grain characteristics SEI (S0105)
28. no\_parameter\_set\_incl\_SEI\_constraint\_flag to constrain parameter sets inclusion indication SEI (S0105)
29. no\_decoded\_picture\_hash\_SEI\_constraint\_flag to constrain decoded picture hash SEI (S0105)
30. no\_mcdv\_SEI\_constraint\_flag to constrain mastering display colour volume SEI (S0105)
31. no\_cll\_SEI\_constraint\_flag to constrain content light level SEI (S0105)
32. no\_drap\_sei\_constraint\_flag to constrain DRAP indication SEI (S0105, S0113)
33. no\_alt\_transfer\_char\_SEI\_constraint\_flag to constrain alternative transfer characteristics SEI (S0105)
34. no\_ambient\_view\_envir\_SEI\_constraint\_flag to constrain ambient viewing environment SEI (S0105)
35. no\_ccv\_SEI\_constraint\_flag to constrain content colour volume SEI (S0105)
36. no\_omni\_video\_SEI\_constraint\_flag to constrain ERP, GCMP, sphere rotation, region-wise packing and omnidirectional viewport SEI (S0105, S0113)
37. no\_field\_frame\_SEI\_constraint\_flag to constrain frame-field information SEI (S0105)
38. no\_sar\_SEI\_constraint\_flag to constrain sample aspect ratio SEI (S0105)
39. general\_non\_HRD\_constraint\_flag to constrain BP, PT and DU SEI (S0113)

No action was recommended on these SEI-message-related constraints.

**GCI SEs syntax/semantics changes and constraining GCI and non-GCI SE values based on values of GCI SEs: Subpicture, slices, and tiles related**

1. When one\_tile\_per\_pic\_constraint\_flag is equal to 1, NumTilesInPic shall be equal to 1. (S0050 #3b)

This proposal seemed editorial.

Editor action item: Check/clarify as appropriate.

1. When one\_subpic\_per\_pic\_constraint\_flag is equal to 1,
2. sps\_num\_subpics\_minus1 shall be equal to 0. (S0050 #3c, S0112)

Aspect “a” seemed editorial.

Editor action item: Check/clarify aspect “a” as appropriate.

1. sps\_subpic\_info\_present\_flag shall be equal to 0. (S0105)

It was commented that aspect “b” would interfere with some BEAM usage involving the sh\_subpic\_id, so no action was recommended on that.

1. no\_mixed\_nalu\_types\_in\_pic\_constraint\_flag shall be equal to 1 (S0054 #3, S0106 #5, S0112, S0131)

Some reluctance was expressed for aspect “c” in regard to BEAM. We often allow tools to be not used without requiring associated constraint flags to be equal to 1, so no action was recommended on that.

It was noted that the software has some configuration issues for the constraint flags, such that it tends to set the constraint flags whenever some feature is not being used. This could cause splicing/concatenation problems. The software coordinator suggested to have configuration support for multiple modes for these flags in the software – e.g. a) set the flag if the feature is disabled, b) explicitly control the value of the flag. Volunteers for this software work were solicited.

1. When one\_slice\_per\_pic\_constraint\_flag is equal to 1, pps\_rect\_slice\_flag shall be equal to 1. (S0050#5c, S0106 #6)

Such a change did not seem necessary, so no action was recommended on this.

1. When one\_slice\_per\_pic\_constraint\_flag is equal to 1, pps\_num\_slices\_in\_pic\_minus1 shall be equal to 0. (S0050#5c)

Such a change did not seem necessary, so no action was recommended on this.

Editor action item: Consider clarifying semantics – e.g., when pps\_rect\_slice\_flag is 1, then pps\_num\_slices\_in\_pic\_minus1 needs to be equal to 0 (which is already required).

1. When one\_tile\_per\_pic\_constraint\_flag and one\_slice\_per\_pic\_constraint flag are both equal to 1, the value of pps\_no\_pic\_partition\_flag shall be equal to 1. (S0050 #5, S0112)

Such a change did not seem necessary, so no action was recommended on this.

**GCI SEs syntax/semantics changes and constraining GCI and non-GCI SE values based on values of GCI SEs: Single-layer, single-picture related**

1. Change the semantics of single\_layer\_constraint\_flag equal to 1 from "single\_layer\_constraint\_flag equal to 1 specifies that sps\_video\_parameter\_set\_id shall be equal to 0" to one of the following: (S0090)
2. Option 1: single\_layer\_constraint\_flag equal to 1 specifies that one of the following conditions shall be fulfilled (1) sps\_video\_parameter\_set\_id is equal to 0; (2) The value of vps\_max\_layers\_minus1 in the referred VPS is equal to 0 and all VCL NAL units in the CVS have the same value of nuh\_layer\_id.
3. Option 2: single\_layer\_constraint\_flag equal to 1 specifies that all VCL NAL units in the CVS shall have the same value of nuh\_layer\_id.

Currently this flag can only be set to 1 if there is no VPS. These proposals allow it to be set to 1 under additional circumstances. Option 2 fits the name of the flag, but there was the question of what is the intent for the use of the flag. Is it for not using the VPS or is it for just indicating having one layer? Some participants said the intent for adoption of the flag was consistent with option 2.

AHG Recommendation: Adopt option 2.

1. When single\_layer\_constraint\_flag is equal to 1, all\_layers\_independent\_constraint\_flag shall be equal to 1. (S0050 #4, S0054 #6)

Such a change did not seem necessary, so no action was recommended on this.

1. When general\_one\_picture\_only\_constraint\_flag is equal to 1,
2. no\_mixed\_nalu\_types\_in\_pic\_constraint\_flag shall be equal to 1 (S0050 #4)
3. no\_trail\_constraint\_flag shall be equal to 1 (S0050 #4, S0054 #5)
4. no\_stsa\_constraint\_flag shall be equal to 1 (S0050 #4, S0054 #5)
5. no\_rasl\_constraint\_flag shall be equal to 1 (S0050 #4, S0054#5)
6. no\_radl\_constraint\_flag shall be equal to 1 (S0050 #4, S0054 #5)

The first picture in the bitstream needs to be IRAP or GDR.

In the current draft, we cannot indicate conformance to the Main 10 Still Picture profile without sending the constraint flag. There is also a max dec pic buffering issue.

In HEVC, the Main Still Picture profile has its own value of profile\_idc, and there were profile compatibility flags, which are not present in VVC.

AHG Recommendation: Use a different profile\_idc for Main 10 Still Picture (we already require Main 10 profile decoders to decode such bitstreams). Do not require the constraint flag to be 1 as part of the profile definition.

It was asked whether we need the general\_one\_picture\_only\_constraint\_flag. See the notes for item 46 below.

See the notes for item 23 S0139 in 6.1.2 on the signalling relationship for the still picture profile(s).

It was noted that there is also a proposal S0129 to have a one-picture-only indication in the SPS.

It was commented that all expressed constraints on the values of GCI flags should be removed, as these should just be specified with one-way meaning.

AHG Recommendation: Remove all constraints that require GCI flags to be equal to a value that imposes a constraint.

AHG discussion for Sessions 1-8 stopped here 2315 UTC Wednesday 27 May.

AHG discussion for Sessions 11-12 started here 20:40 UTC Friday 19 June.

**GCI SEs syntax/semantics changes and constraining GCI and non-GCI SE values based on values of GCI SEs: Intra only related**

1. When intra\_only\_constraint\_flag is equal to 1,
2. all\_layers\_independent\_constraint\_flag shall be equal to 1 (S0050 #4, S0106 #4. S0112)
3. no\_ref\_pic\_resampling\_constraint\_flag shall be equal to 1 (S0050 #4, S0112, S0131)
4. no\_res\_change\_in\_clvs\_constraint\_flag shall be equal to 1 (S0050 #4)
5. no\_sbt\_constraint\_flag shall be equal to 1 (S0050 #4, S0060, S0106 #1, S0112, S0129 #3, S0131)
6. no\_trail\_constraint\_flag shall be equal to 1 (S0106 #2, S0112)
7. no\_stsa\_constraint\_flag shall be equal to 1 (S0106 #2, S0112)
8. no\_rasl\_constraint\_flag shall be equal to 1 (S0106 #2, S0112)
9. no\_radl\_constraint\_flag shall be equal to 1 (S0106 #2, S0112)
10. no\_cra\_constraint\_flag shall be equal to 1 (S0106 #3)
11. no\_gdr\_constraint\_flag shall be equal to 1 (S0106 #3)
12. no\_idr\_constraint\_flag shall be equal to 0 (S0106 #3)
13. no\_mixed\_nalu\_types\_in\_pic\_constraint\_flag shall be equal to 1 (S0112)
14. sps\_weighted\_pred\_flag shall be equal to 0. (S0061)
15. sps\_weighted\_bipred\_flag shall be equal to 0. (S0061)
16. sps\_long\_term\_ref\_pics\_flag shall be equal to 0. (S0061)
17. sps\_inter\_layer\_ref\_pics\_present\_flag shall be equal to 0. (S0061)
18. sps\_idr\_rpl\_present\_flag shall be equal to 0. (S0061)
19. sps\_rpl1\_same\_as\_rpl0\_flag shall be equal to 0. (S0061)
20. sps\_num\_ref\_pic\_lists[ i ] shall be equal to 0. (S0061)
21. sps\_sbtmvp\_enabled\_flag shall be equal to 0. (S0061)
22. sps\_six\_minus\_max\_num\_merge\_cand shall be equal to 0. (S0061)
23. sps\_log2\_parallel\_merge\_level\_minus2 shall be equal to 0. (S0061)
24. sps\_explicit\_mts\_inter\_enabled\_flag shall be equal to 0. (S0061)
25. pps\_rpl1\_idx\_present\_flag shall be equal to 0 (S0061)
26. pps\_rpl\_info\_in\_ph\_flag shall be equal to 0 (S0061)
27. pps\_ref\_wraparound\_enabled\_flag shall be equal to 0 (S0061)
28. pps\_output\_flag\_present\_flag shall be equal to 0 (S0112)
29. ph\_pic\_output\_flag shall be equal to 1 (S0112)
30. ph\_inter\_slice\_allowed\_flag shall be equal to 0 (S0061, S0112)
31. ph\_non\_ref\_pic\_flag shall be equal to 1 (S0112)

No action on a-l, per previous discussions about constraining constraint flags. For the others, it was commented that it is desirable to be able to extract all the I pictures from a bitstream and set the intra\_only\_constraint\_flag to 1 without needing to rewrite headers. No action was recommended for this, to avoid the need for header rewriting just to avoid constraint violations.

**GCI SEs syntax/semantics changes and constraining GCI and non-GCI SE values based on values of GCI SEs: Random access related**

1. When no\_cra\_constraint\_flag is equal to 1, no\_rasl\_constraint\_flag shall be equal to 1. (S0054 #4, S0112)

No action, per previous discussions about constraining constraint flags.

1. When no\_idr\_constraint\_flag is equal to 1 and no\_cra\_constraint\_flag is equal to 1, no\_radl\_constraint\_flag shall be equal to 1. (S0054 #4)

No action, per previous discussions about constraining constraint flags.

1. At least one of the no\_gdr\_constraint\_flag, no\_idr\_constraint\_flag, and no\_cra\_constraint\_flag shall be equal to 0. (S0050 #5, S0112)

No action, per a general desire to avoid constraining constraint flags.

**GCI SEs syntax/semantics changes and constraining GCI and non-GCI SE values based on values of GCI SEs: APS related**

1. When no\_alf\_constraint\_flag is equal to 1, aps\_params\_type shall not be equal to 0. (S0066)

No action was recommended on this, as it would prohibit presence of non-referenced APSs (which could, e.g., be referenced in a later CVS).

1. When no\_lmcs\_constraint\_flag equal to 1, aps\_params\_type shall not be equal to 1. (S0066)

No action was recommended on this, as it would prohibit presence of non-referenced APSs (which could, e.g., be referenced in a later CVS).

1. When no\_aps\_constraint\_flag is equal to 1,
2. no\_lmcs\_constraint\_flag shall be equal to 1. (S0050 #4, S0067#1, S0105)
3. no\_ccalf\_constraint\_flag shall be equal to 1. (S0050 #4)
4. no\_explicit\_scaling\_list\_constraint\_flag shall be equal to 1. (S0050 #4, S0067 #2, S0105)
5. sps\_ccalf\_enabled\_flag, ph\_num\_alf\_aps\_ids\_luma, ph\_alf\_cb\_flag, ph\_alf\_cr\_flag, sh\_num\_alf\_aps\_ids\_luma, sh\_alf\_cb\_flag, and sh\_alf\_cr\_flag all be equal to 0. (S0050 #5, S0073 #1.1)
6. (alternative to 38.d and 38.f) sps\_chroma\_alf\_enabled\_flag (newly added as part of this item), sps\_chroma\_alf\_enabled\_flag and sh\_num\_alf\_aps\_ids\_luma shall be equal to 0 (S0073 #1.2)
7. (alternative to 38.d and 38.e) sps\_alf\_enabled\_flag and sps\_ccalf\_enabled\_flag shall both be equal to 0 (S0073 #1.3)

No additional action was needed on this, per previous discussions about constraining constraint flags and per action recommended earlier for sub-item d as noted elsewhere in the notes.

**GCI SEs syntax/semantics changes and constraining GCI and non-GCI SE values based on values of GCI SEs: Video format related**

1. The value of the u(4)-coded max\_bitdepth\_minus8\_constraint\_idc shall be in the range of 0 to 8, inclusive. (S0046 #1, S0050 #3a).

AHG Recommendation (sensibility constraint): Adopt.

1. When max\_chroma\_format\_constraint\_idc is equal to 0, no\_chroma\_qp\_offset\_constraint\_flag shall be equal to 1. (S0046 #3, S0060, S0112, S0131).

No action, per previous discussions about constraining constraint flags.

1. When max\_chroma\_format\_constraint\_idc is equal to 0, no\_act\_constraint\_flag shall be equal to 1. (S0131)

No action, per previous discussions about constraining constraint flags.

**GCI SEs syntax/semantics changes and constraining GCI and non-GCI SE values based on values of GCI SEs: Others**

1. When no\_ref\_pic\_resampling\_constraint\_flag to 1, no\_res\_change\_in\_clvs\_constraint\_flag shall be equal to 1. (S0054 #7, S0105, S0112, S0131)

No action, per previous discussions about constraining constraint flags.

1. When no\_transform\_skip\_constraint\_flag is equal to 1, no\_bdpcm\_constraint\_flag shall be equal to 1. (S0050 #4, S0059, S0069#1, S0105, S0112, S0131)

No action, per previous discussions about constraining constraint flags.

1. When no\_affine\_motion\_constraint\_flag is equal to 1, no\_prof\_constraint\_flag shall be equal to 1. (S0046 #2, S0112, S0131)

No action, per previous discussions about constraining constraint flags.

1. When all\_layers\_independent\_constraint\_flag is equal to 1, the value of sps\_inter\_layer\_ref\_pics\_present\_flag shall be equal to 0. (S0050 #5)

It was noted that this constraint already expressed (indirectly), so no action was needed on this.

**GCI and profiles**

1. Either change general\_one\_picture\_only\_constraint\_flag to general\_one\_au\_only\_constraint\_flag. (S0091 #1) or remove general\_one\_picture\_only\_constraint\_flag (S0160 #7)

It was noted that a profile\_idc value already indicates one picture only.

It was commented that extraction from a Main profile bitstream might be a potential use of the flag.

This was further discussed in the main JVET meeting at 2200 UTC on 24 June.

It was noted that one bit of our current profile\_idc values is effectively a still-picture bit. Another bit could indicate 4:4:4 support.

Decision (cleanup): Use profile\_idc values that effectively move this bit to the MSB but do not identify it as a flag (Main 10 = 1, Main 10 Still = 64+1, Main 4:4:4 10 = 32+1=33, Main 4:4:4 10 Still = 64+32+1=97, and replace general\_one\_picture\_only\_constraint\_flag with general\_one\_au\_only\_constraint\_flag.

1. Constrain the values of max\_chroma\_format\_constraint\_idc and max\_bitdepth\_constraint\_idc in main 10 profile. (S0094)

It was noted that these syntax elements are defined in a backwards way from the way other constraints are expressed. No other action on this.

AHG Recommendation (consistency cleanup): Make the maximum bit depth to be 16 − max\_bitdepth\_‌constraint\_idc and the maximum chroma format be 3 − max\_chroma\_format\_constraint\_idc.

GCI editorial changes

Editor action item: The editor is asked to consider the below suggestions.

1. Rename "max\_bitdepth\_constraint\_idc" to "max\_bitdepth\_minus8\_constraint\_idc". (S0105)

No action on this per the decision on the previous item.

1. Rename "general\_non\_packed\_constraint\_flag" to "general\_non\_packed\_SEI\_constraint\_flag", and "general\_non\_projected\_constraint\_flag" to "general\_non\_projected\_SEI\_constraint\_flag". (S0105)

No action (capital letters, not very necessary, being moved anyway).

1. Move the constraint "When general\_frame\_only\_constraint\_flag is equal to 1, the value of sps\_field\_seq\_flag shall be equal to 0" from SPS semantics to GCI semantics (S0054 #1, S0105, S0209 #2) and/or rename general\_frame\_only\_constraint\_flag" to "no\_field\_seq\_constraint\_flag" and change the semantics to constrain sps\_field\_seq\_flag (S0195 #2).
2. Move the constraint "When no\_mixed\_nalu\_types\_in\_pic\_constraint\_flag is equal to 1, the value of pps\_mixed\_nalu\_types\_in\_pic\_flag shall be equal to 0" from PPS semantics to GCI semantics. (S0054 #2, S0209 #2)
3. Replace the while-loop for GCI byte alignment with 6 zero-valued bits. (S0209 #3)
4. Prefix all syntax elements in the general constraint information with 'gci\_'. (S0209 #4)

New submissions (for the June 10th submission deadline) on adding new GCI fields, or removing or changing existing GCI fields

1. Add a "no\_ts\_rrc\_constraint\_flag" (S0238 late)

This was not just an editorial proposal. The prior related flag had been agreed to be removed in earlier discussion. The proposal suggested to add a flag to require sh\_tsrc\_disabled\_flag to be equal to 0. The CTC use would match this flag being 1.

It was commented that this does not constrain a tool but rather a combination. The regular residual coding would still be present in the decoder.

No action was recommended on this.

1. Remove general\_non\_packed\_constraint\_flag and general\_non\_projected\_constraint\_flag (S0195 #1)

See notes elsewhere, agreeing to move these flags.

1. Add new GCI flags
   1. no\_subpic\_info\_constraint\_flag to constrain sps\_subpic\_info\_present\_flag (S0195 #3)
   2. no\_idr\_rpl\_constraint\_flag to constrain sps\_idr\_rpl\_present\_flag (S0195 #3)
   3. no\_hrd\_constraint\_flag to constrain vps\_general\_hrd\_params\_present\_flag and sps\_general\_hrd\_params\_present\_flag (S0195 #3)
   4. no\_bidirectional\_prediction\_constraint\_flag to constrain pps\_rpl1\_idx\_present\_flag and num\_ref\_entries[ 1 ][ rplsIdx ] (S0209 #1)
   5. no\_parallel\_merge\_constraint\_flag to constrain sps\_log2\_parallel\_merge\_level\_minus2 (S0209 #1)
   6. no\_switchable\_cabac\_init\_constraint\_flag to constrain pps\_cabac\_init\_present\_flag (S0209 #1)
   7. no\_entropy\_coding\_sync\_constraint\_flag to constrain sps\_entropy\_‌coding\_sync\_enabled\_flag (S0230)

J. Boyce was asked to coordinate offline study of these proposals for further discussion during the main meeting. See S0161-v3.

The additional recommendations from the side activity requested at the 19–21 June AHG meeting were discussed in the main JVET meeting at 2240 UTC on 24 June and resulted in the following action:

Decision (cleanup): In response to JVET-S0195, replace one\_subpic\_per\_pic\_constraint\_flag with proposed no\_subpic\_info\_constraint\_flag and its semantics and add no\_idr\_rpl\_constraint\_flag.

[JVET-S0046](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10168) AHG9: General constraint information semantics constraints [R. Yu, M. Pettersson, R. Sjöberg, M. Damghanian, J. Enhorn, Z. Zhang, J. Ström, D. Liu (Ericsson)]

[JVET-S0050](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10172) AHG9: On general constraints information [Z. Deng, Y.-K. Wang, L. Zhang, K. Zhang, K. Fan (Bytedance)]

[JVET-S0054](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10176) AHG9: Clean-ups on general constraint flags [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-S0058](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10180) AHG9: Additional General Constraint Flags [K. Naser, F. Le Leannec, T. Poirier, P. de Lagrange (InterDigital)]

[JVET-S0059](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10181) AHG9: Fixing the Semantics of no\_bdpcm\_constraint\_flag [K. Naser, F. Le Leannec, T. Poirier, P. de Lagrange (InterDigital)]

[JVET-S0060](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10182) AHG9: Fixing the Semantics of no\_chroma\_qp\_offset\_constraint\_flag and no\_sbt\_constraint\_flag [K. Naser, F. Le Leannec, T. Poirier, P. de Lagrange (InterDigital)]

[JVET-S0061](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10183) AHG9: HLS Cleanup of All-Intra Profile [K. Naser, F. Le Leannec, T. Poirier, P. de Lagrange (InterDigital)]

[JVET-S0066](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10188) AHG9: On constraint flags [C. Rosewarne, J. Gan (Canon)]

[JVET-S0067](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10189) AHG9: General constraint information on features using APS [S.-T. Hsiang, O. Chubach, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-S0069](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10191) AHG9: General constraint information on features related to transform skip mode [S.-T. Hsiang, O. Chubach, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

Aspect 1 of this contribution belongs to this category.

[JVET-S0073](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10195) AHG9: Bug-fix of the constraint flag of VVC [M. G. Sarwer, Y. Ye (Alibaba)]

Aspect 1 of this contribution belongs to this category.

[JVET-S0090](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10212) AHG8/AHG9: On single\_layer\_constraint\_flag [K. Abe, T. Nishi, T. Toma, V. Drugeon (Panasonic)]

[JVET-S0091](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10213) AHG8/AHG9: On constraints of still picture [K. Abe, T. Nishi, T. Toma, V. Drugeon (Panasonic)]

Aspect 2 of this contribution belongs to this category.

[JVET-S0092](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10214) On constraint info signalling [J. Samuelsson, S. Deshpande, A. Segall (Sharp)]

[JVET-S0094](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10216) AHG9: Profile-level constraints on chroma format and bit depth constraint flags [K. Sharman, S. Keating, A. Browne (Sony)]

[JVET-S0103](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10225) AHG9: On OLS identification [R. Skupin, Y. Sanchez, K. Suehring, T. Schierl (HHI)]

Aspect 2 of this contribution belongs to this category.

[JVET-S0105](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10227) AHG9: Modification of general constraint information [S. McCarthy, P. Yin, T. Lu, F. Pu, W. Husak, T. Chen (Dolby)]

All aspects other than the aspect on changing the semantics of no\_tsrc\_constraint\_flag belong to this category.

[JVET-S0106](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10228) AHG9: Some cleanups on general constraint flags [G. Laroche, N. Ouedraogo, P. Onno (Canon)]

[JVET-S0111](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10233) AHG9: On GCI syntax structure [Y. He, Y.-J. Chang, N. Hu, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-S0112](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10234) AHG9: On GCI semantic constraints [Y. He, N. Hu, Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-S0113](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10235) AHG9: On new GCI flags [Y. He, Y.-J. Chang, N. Hu, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-S0127](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10249) AHG9: On general constraint info signalling [M. Coban, V. Seregin, Y. He, Y.-J. Chang, M. Karczewicz (Qualcomm)]

[**JVET-S0129**](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10251) **AHG9: cleanup on parameter sets and GCI [L. Li, X. Li, B. Choi, S. Wenger, S. Liu (Tencent)]**

Aspect 3 of this contribution belongs to this category.

[JVET-S0131](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10253) AHG9: On general constraint information syntax [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, X. Wang (Kwai Inc.)]

[**JVET-S0160**](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10282) **AHG9/AHG12/AHG8: Miscellaneous HLS cleanups [Y.-K. Wang, Z. Deng, L. Zhang, K. Zhang (Bytedance)]**

Aspect 7 of this contribution belongs to this category.

[JVET-S0161](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10283) AHG9: Report of side activity on GCI syntax elements [J. Boyce]

[JVET-S0179](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10301) AHG9: On conditional signalling of GCI fields [Y.-K. Wang, L. Zhang, Z. Deng, K. Zhang, K. Fan (Bytedance), J. Samuelsson, S. Deshpande, A. Segall (Sharp), M. Coban, V. Seregin, Y. He, Y.-J. Chang, M. Karczewicz (Qualcomm), Hendry, J. Nam (LGE), S. Wenger, B. Choi (Tencent), M. Zhou (Broadcom)]

[JVET-S0195](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10317) AHG9: On GCI cleanups [Y. He, Y.-J. Chang, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-S0209](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10331) AHG9: On General Constraint Information [M. Pettersson, R. Yu, R. Sjöberg, M. Damghanian, J. Enhorn, J. Ström, D. Liu (Ericsson)]

[JVET-S0230](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10352) AHG9: New GCI flag [T. Ikai (Sharp)]

[JVET-S0238](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10360) AHG9: GCI for RRC [K. Naser, F. Le Leannec, T. Poirier, P. de Lagrange (InterDigital)] [late]

### SPS, PPS, and APS cleanups (9+8 – Closed)

[JVET-S0142](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10264) AHG9: A summary of proposals on SPS, PPS, and APS cleanups [Hendry (LGE)]

This contribution was discussed in the HLS AHG meeting at 2330 UTC on Wednesday 27 May and in the HLS AHG pre-meeting at 2225 UTC on 19 June.

This contribution provides a summary of the 16 proposals on SPS, PPS, and APS cleanups (the agenda item 3.1.4 in JVET-S0137 and JVET-S0237).

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. The following changes are proposed:

1. It is asserted that when extension\_flag in DCI, VPS, SPS, PPS, or APS is equal to 1, it is allowed that no extension\_data\_flag syntax elements be present. The following options for change are proposed (JVET-S0042)
   1. Option 1: When an extension\_flag in DCI, VPS, SPS, PPS, or APS is equal to 1, enforce the presence of at least one extension\_data\_flag syntax element in the syntax.

From the following design in the current spec:

|  |  |
| --- | --- |
| **dci\_extension\_flag** | u(1) |
| if( dci\_extension\_flag ) |  |
| while( more\_rbsp\_data( ) ) |  |
| **dci\_extension\_data\_flag** | u(1) |

To the following:

|  |  |
| --- | --- |
| **dci\_extension\_flag** | u(1) |
| if( dci\_extension\_flag ) { |  |
| do |  |
| **dci\_extension\_data\_flag** | u(1) |
| while( more\_rbsp\_data( ) ) |  |
| } |  |

* 1. Option 2: Relax the semantics so that an extension\_flag in DCI, VPS, SPS, PPS, or APS equal to 1 specifies that specifies extension\_data\_flag syntax elements *may be* present. (Currently, it says these flags *are* present.)
  2. Option 3: Do nothing

It was commented that option 2 seems like just a better editorial expression of the what the current syntax already specifies.

AHG Recommendation (editorial clarification): Option 2.

Note: This should be also considered as an errata report for HEVC semantics clarification.

1. Rearrange some syntax elements in SPS so that the syntax elements of similar coding tools are grouped together.
   1. All of the transform related SPS syntax are placed together (JVET-S0074 aspect 1)
   2. sps\_lmcs\_enabled\_flag is signalled right after signalling of sps\_ccalf\_enabled\_flag (JVET-S0074 aspect 1)
   3. Group the dual tree related syntax elements together in the SPS (JVET-S0132 aspect 1)
   4. Rearrange the partition constraint related syntax elements in the SPS to be consistent with the ordering of the corresponding syntax elements in the picture header (PH). More specifically, group such syntax in the SPS based on whether they are intra or inter related (JVET-S0132 aspect 2)

AHG Recommendation (minor cleanup of logical syntax order): Adopt. It is also desirable to have the constraint flag order match SPS order (to be considered by J. Boyce in further study).

1. Not signalling sps\_max\_sublayers\_minus1 when sps\_ptl\_dpb\_hrd\_params\_present\_flag is equal to 0 (JVET-S0079)
   1. Move the signalling of sps\_max\_sublayers\_minus1 and sps\_reserved\_zero\_4bits immediately before the signalling of profile\_tier\_level( 1, sps\_max\_sublayers\_minus1 )
   2. Condition the presence of the two syntax elements such that they are present only when sps\_ptl\_dpb\_hrd\_params\_present\_flag is equal to 1.

The proponent reported that the sps\_max\_sublayers\_minus1 value is not actually used when sps\_ptl\_dpb\_hrd\_params\_present\_flag is equal to 0.

It was commented that there may be some interaction with other proposals or the extraction process.

It was commented that sps\_max\_sublayers\_minus1 could be useful to know even if not necessary for parsing and the decoding process.

No clear need for action was evident, so no action was recommended.

1. Add a constraint such that when sps\_video\_parameter\_set\_id is greater than 0 and vps\_all\_layers\_same\_num\_sublayers\_flag is equal to 1, the value of sps\_max\_sublayers\_minus1 shall be equal to the value of vps\_max\_sublayers\_minus1 (JVET-S0115 aspect 2).

It was commented that this had been proposed in JVET-R0125 item 2. At that time a concern had been expressed about what would happen if some sublayers are removed and the SPS is rewritten.

It has been intended that it should be allowed to removed sublayers without rewriting the VPS.

AHG Recommendation (bug fix/expression of existing intent): Change the name and semantics of vps\_all\_layers\_same\_num\_sublayers\_flag to only control VPS syntax without requiring the number of sublayers to be the same for all layers.

No action on the proposed change, due to the agreement recorded above.

1. Add new flag sps\_one\_picture\_only\_constraint\_flag and use the flag to skip signalling of some syntax elements in SPS. The skipped syntax elements include inter prediction, RPL, and POC related syntax elements in both SPS and PH (JVET-S0129 aspect 2).

It was commented that this would require PH rewriting when extracting a single picture from the bitstream (e.g., to remove RPL and POC).

Concern was expressed about POC, as we allow sending POC for IDR pictures.

A similar proposal was considered at the previous meeting, for intra-only rather than for single-picture-only. The basic issues seemed similar.

It was commented that it is an encoder choice how to set the values of non-relevant syntax elements if the bitstream will contain only intra pictures or only one picture.

No clear need for action was identified, so no action was recommended.

1. Constrain the value of pps\_alf\_info\_in\_ph\_flag to be equal to 0 when the PH is in the SH (JVET-S0049 aspect 4)

It was asked why we hadn’t already done something like this, since we did something like this for five other similar syntax elements (see the next item for a list). There had been some argument of wanting the ALF info to be early in the header. However, it was commented that the ALF info can be in the SH already.

It was noted that another proposal has this as one of two options for action (see item 9a in the S0143 summary for S0120).

AHG Recommendation (consistency/cleanup): Adopt.

1. When pps\_rect\_slice\_flag is equal to 1 and pps\_num\_slices\_in\_pic\_minus1 is equal to 0, constrain the values of the 6 PPS flags (i.e., pps\_alf\_info\_in\_ph\_flag, pps\_rpl\_info\_in\_ph\_flag, pps\_dbf\_info\_in\_ph\_flag, pps\_sao\_info\_in\_ph\_flag, pps\_wp\_info\_in\_ph\_flag, and pps\_qp\_delta\_info\_in\_ph\_flag) to be all equal to 0 (JVET-S0049 aspect 5).

The motivation / justification of the proposed changes is as follows:

* + To be better aligned with the inference of the value to 0 when pps\_no\_pic\_partition\_flag is equal to 1.
  + For more optimal syntax in the case of pps\_rpl\_info\_in\_ph\_flag or pps\_wp\_info\_in\_ph\_flag.
  + For the case of pps\_alf\_info\_in\_ph\_flag, to enable the use of ALF for the same use case that applies independent parallel encoding of different subpictures as above.

It was commented that this could require SH rewriting if there is an original bitstream and one subpicture is extracted as one picture with one slice. These flags could be in the PPS and would need to be moved to the SH.

It was commented that there is a similar issue for when pps\_no\_pic\_partition\_flag is equal to 1. However, it was commented that this flag could be set to 0.

After offline further study, the proposal was withdrawn in HLS AHG pre-meeting at 2225 UTC on 19 June.

1. Rearrange the syntax elements related to inter slices in the picture parameter set (PPS) in a similar manner as the grouping of the inter-slice related syntax elements in the PH. More specifically, group syntax elements in PPS based on whether they are intra or inter related (JVET-S0132 aspect 3).

It was commented that this change is pretty minor and logical, and this had been tested with software. See also item 2 above.

AHG Recommendation (consistency/cleanup): Adopt.

1. Currently due to existing constraints, only 3 bits out of 5 bits of APS Id are needed in current profiles. The following is proposed: split the u(5)-coded aps\_adaptation\_parameter\_set\_id into u(2)-coded aps\_reserved\_zero\_2bits followed by u(3)-coded aps\_adaptation\_parameter\_set\_id (JVET-S0049 aspect 6).

Currently we signal the APS ID first, followed by the APS type, but the value spaces for different APS types are distinct.

It was commented that in some future profile we might want a larger range of values.

It was concluded that, as proposed, this would really be only an editorial change.

No clear need for action was evident, so no action was recommended.

1. If aps\_chroma\_present\_flag is equal to 0, due to an existing constraint, alf\_luma\_filter\_signal\_flag must be equal to 1. Based on that, it is proposed that when aps\_chroma\_present\_flag is equal to 0, alf\_luma\_filter\_signal\_flag is skipped and inferred to be equal to 1. Otherwise, when alf\_chroma\_filter\_signal\_flag and alf\_cc\_cb\_filter\_signal\_flag are both equal to 0, alf\_cc\_cr\_filter\_signal\_flag is skipped and inferred to be equal to 1 (JVET-S0049 aspect 7).

No clear need for action was evident, so no action was recommended.

1. It is asserted that the memory to store APSs may exceed the max memory used to store the max number of APSs in a PU due to the fact that in a PU, prefix and suffix APS NAL units with particular APS identifier and type can have different contents. The following two constraints are proposed (JVET-S0122)
   1. In a PU, for an APS type, a signalled suffix APS shall not have the same identifier as a referenced APS.

It was commented that this topic had been raised the previous meeting.

It was commented that this depends on whether the decoding process is applied after receiving the VCL NAL units or after also receiving the suffix APS NAL units. If the picture is decoded before parsing the suffix APS NAL units, the memory of the prior APS content can be re-used in the on-chip memory.

No clear need for action was evident, so no action was recommended.

* 1. Any two suffix (prefix resp.) APS NAL units with particular APS identifier and type signalled in a PU cannot have the same APS identifier

This would disallow repetition. It was commented that such repetition is not really a problem.

No clear need for action was evident, so no action was recommended.

Review of the above items in this category completed ~0120 UTC 28 May.

Discussion resumed here in the HLS AHG pre-meeting at 2225 UTC on 19 June.

1. Allow inferring some SPS syntax elements from SPS in the reference layer. It is asserted that in HEVC such mechanism is allowed (i.e., for scaling list data structure). If we allow this mechanism, the following syntax elements are proposed to be inferred from SPS in direct reference layer (JVET-S0166):
   1. RPLs of the current SPS from the SPS referred to by the direct reference layer.
   2. Subpicture information of the current SPS from the SPS referred to by the direct reference layer

Mechanism detail: for each category of syntax elements that can be inferred, add a new flag to specify whether the syntax elements are inferred or not. If inferred, signal additional syntax element to specify the index of the direct reference layer.

Concern was expressed about introducing such a prediction across layers at this late stage.

A benefit of coding efficiency could be argued, but did not seem like an important consideration.

The proponent said the proposal might help encoders avoid conformance problems.

It was noted that SPS sharing is allowed. This would be a form of partial SPS sharing.

No action was recommended on this, to be conservative about considering late changes.

1. It is asserted that the current semantics of sps\_sublayer\_dpb\_params\_flag and vps\_sublayer\_dpb\_params\_present\_flag are inaccurate. It currently says that it control the presence of max\_dec\_pic\_buffering\_minus1[ i ], max\_num\_reorder\_pics[ i ], and max\_latency\_increase\_plus1[ i ] syntax elements. However, it actually controls the presence of those syntax elements for temporal sub-layers that are not the highest. It is proposed to change the semantics to be more accurate (JVET-S0169 aspect 1). (added or changed in **bold**)

sps\_sublayer\_dpb\_params\_flag is used to control the presence of max\_dec\_pic\_buffering\_minus1[ i ], max\_num\_reorder\_pics[ i ], and max\_latency\_increase\_plus1[ i ] syntax elements in the dpb\_parameters( ) syntax strucure in the SPS **for i in range from 0 to sps\_max\_sublayers\_minus1 − 1, inclusive, when sps\_max\_sublayers\_minus1 is larger than 0.** When not present, the value of sps\_sublayer\_dpb\_params\_flag is inferred to be equal to 0.

vps\_sublayer\_dpb\_params\_present\_flagis used to control the presence of max\_dec\_pic\_buffering\_minus1[ **j** ], max\_num\_reorder\_pics[ **j** ], and max\_latency\_increase\_plus1[ **j** ] syntax elements in the dpb\_parameters( ) syntax strucure in the VPS **for j in range from 0 to vps\_dpb\_max\_tid[ i ] − 1, inclusive, when vps\_dpb\_max\_tid[ i ] in VPS is larger than 0**. When not present, vps\_sub\_dpb\_params\_info\_present\_flag is inferred to be equal to 0.

*It is noted that j instead of i is used for specifying the range of syntax element array max\_dec\_pic\_buffering\_minus1[ ], max\_num\_reorder\_pics[ ], and max\_latency\_increase\_plus1[ ] in order to avoid confusion of the i in vps\_dpb\_max\_tid[ i ].*

It was commented that this is just editorial and should be considered by the editor.

Editor action item: The editor is asked to consider this potential clarification.

1. Move the two syntax elements (sps\_chroma\_format\_idc and sps\_log2\_ctu\_size\_minus5) to take the place of sps\_reserved\_zero\_4bits. (JVET-S0186 aspect 1)

The reserved bits were said to have been there only for byte alignment.

AHG Recommendation (cleanup): Adopt.

1. Reserve sps\_seq\_parameter\_set\_id value equal to 15 for future extensibility. Additionally, do the same for value 63 of pps\_pic\_parameter\_set\_id. (JVET-S0186 aspect 2)

No clear need for action on this seemed evident.

1. Move the location of decoded picture buffer (DPB) parameters syntax structure and hypothetical reference decoder (HRD) parameters syntax structure to directly follow sps\_ptl\_dpb\_hrd\_params\_present\_flag. (JVET-S0199).

Currently only the signalling of PTL syntax structure directly follows sps\_ptl\_dpb\_hrd\_params\_present\_flag (i.e., early in SPS), the signalling of DPB syntax structure is in the middle of SPS, and HRD syntax structure is near the end of SPS. The proposal would move DPB and HRD syntax structures to early position in the SPS.

It was commented that moving DBP and HRD syntax earlier could put it ahead of other syntax that may be more important to access from the system perspective and that saving some condition checks in the parsing is not so important, so no action was recommended on this.

1. Change the coding of syntax element sps\_log2\_transform\_skip\_max\_size\_minus2 from ue(v) to u(2). (JVET-S0204).

It was asked whether some future profile might want to allow a value greater than 3, and this seemed possible, although it was commented that such a future profile would probably have other, much more significant, changes in it.

In HEVC, RExt added larger TS block sizes without a syntax change for that, and used the same type of coding, although in the PPS rather than SPS.

It was noted that this would increase the number of bits used for coding the value 0.

Since no clear need for action was identified, no action was recommended on this.

1. Add additional conditions for the presence of the six PPS flags pps\_alf\_info\_in\_ph\_flag, pps\_rpl\_info\_in\_ph\_flag, pps\_dbf\_info\_in\_ph\_flag, pps\_sao\_info\_in\_ph\_flag, pps\_wp\_info\_in\_ph\_flag, and pps\_qp\_delta\_info\_in\_ph\_flag, as follows (S0164) (additions in *italic*):

|  |  |
| --- | --- |
| **...** |  |
| if( !pps\_no\_pic\_partition\_flag *&& ( !pps\_rect\_slice\_flag | |  pps\_single\_slice\_per\_subpic\_flag | | pps\_num\_slices\_in\_pic\_minus1 > 0 )* &&  pps\_deblocking\_filter\_override\_enabled\_flag ) |  |
| **pps\_dbf\_info\_in\_ph\_flag** | u(1) |
| if( !pps\_deblocking\_filter\_disabled\_flag ) { |  |

|  |  |
| --- | --- |
| ... |  |
| if( !pps\_no\_pic\_partition\_flag *&& ( !pps\_rect\_slice\_flag | |* *pps\_single\_slice\_per\_subpic\_flag | | pps\_num\_slices\_in\_pic\_minus1 > 0 )* ) { |  |
| **pps\_rpl\_info\_in\_ph\_flag** | u(1) |
| **pps\_sao\_info\_in\_ph\_flag** | u(1) |
| **pps\_alf\_info\_in\_ph\_flag** | u(1) |
| if( ( pps\_weighted\_pred\_flag | | pps\_weighted\_bipred\_flag ) &&  pps\_rpl\_info\_in\_ph\_flag ) |  |
| **pps\_wp\_info\_in\_ph\_flag** | u(1) |
| **pps\_qp\_delta\_info\_in\_ph\_flag** | u(1) |
| } |  |
| … |  |

The contribution was said to be similar in spirit to item 7 above (S0049).

The desire is that when there is only one slice in the picture, to avoid signalling some information in the PPS.

It was commented that if an original bitstream has multiple slices and has this signalling in the PH, then extraction of a single slice could cause a rewriting requirement. The proponent indicated that there is a provision to avoid the rewriting based on the single slice per subpicture flag equal to 1 (at some expense of bits).

No clear need for action was identified, and thus no action was recommended.

1. Enable removal of parameter sets (i.e., PPS and APS) in non-output layer that is not used as reference for decoding of pictures in output layers during extraction process, as follows: (JVET-S0219 aspect 1)

* Modify the semantics of vps\_max\_tid\_il\_ref\_pics\_plus1[ i ][ j ] such that when it is greater than 0 it means for decoding pictures of the i-th layer, no parameter set and picture from the j-th layer with TemporalId greater than vps\_max\_tid\_il\_ref\_pics\_plus1[ i ][ j ] − 1 is used as reference.
* In extraction process, in addition to removing VCL NAL unit, also remove PPS and APS with TemporalId that is greater than or equal to NumSubLayersInLayerInOLS[ targetOlsIdx ][ GeneralLayerIdx[ nuh\_layer\_id ] ].

It was commented that this makes more sense for the APS than the PPS and that APSs are a bigger problem. This would treat APS more similar to PH for the extraction.

“Smart” extractors were discussed, and whether the extraction process model is sufficient.

Several participants saw value in being able to identify and remove useless APS from the bitstream based on this proposal. The change is also small.

AHG Recommendation (cleanup): Adopt APS aspect only.

1. Move the signalling of aps\_params\_type to an earlier position and change the signalling of aps\_adaptation\_parameter\_set\_id from u(5) to u(v). The length of the syntax element depends on the type of the APS. (JVET-S0219 aspect 2)

A participant said this (or swapping the order of the ID and type) may be useful for extensibility, as some future APS type might need more ID values. The fact that the type is before the ID seemed to just be for historical reasons – it was originally proposed that way and never modified.

It was commented that we took no action on something similar previously.

AHG Recommendation (cleanup): Just change the order to put the type before the ID.

1. Move the flag indicating the presence of sh\_cabac\_init\_flag from PPS to SPS. (JVET-S0235)

The location is a carry-over from HEVC.

No action seemed clearly necessary, so no action was recommended on this.

[JVET-S0042](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10164) JVET-S0042 AHG9: On the parameter set extension mechanism [M. M. Hannuksela, K. Kammachi-Sreedhar (Nokia)]

[JVET-S0049](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10171) AHG9/AHG8/AHG12: On parameter sets and picture header [Y.-K. Wang, L. Zhang, Z. Deng, K. Zhang (Bytedance)]

Aspects 4 to 7 of this contribution belong to this category.

[JVET-S0074](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10196) AHG9: On SPS, PH, SH syntax order [M. G. Sarwer, Y. Ye (Alibaba)]

Aspect 1 of this contribution belongs to this category.

[JVET-S0079](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10201) AHG9: On signalling of sps\_max\_sublayers\_minus1 [Hendry (LGE)]

[JVET-S0115](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10237) AHG9: On SPS cleanups [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Aspect 2 of this contribution belongs to this category.

[**JVET-S0129**](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10251) **AHG9: cleanup on parameter sets and GCI [L. Li, X. Li, B. Choi, S. Wenger, S. Liu (Tencent)]**

Aspect 2 of this contribution belongs to this category.

[JVET-S0132](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10254) AHG9: On syntax signaling order in SPS and PPS [H.-J. Jhu, Y.-W. Chen, X. Xiu, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-S0122](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10244) AHG9: On APS memory constraint [N. Hu, V. Seregin, M. Karczewicz (Qualcomm)

[JVET-S0164](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10286) AHG9: On signalling six PPS flags for indicating the presence of syntax in PH/SH [S.-T. Hsiang, L. Chen, O. Chubach, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-S0166](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10288) AHG9: Inferring information of the SPS from the reference layer [S.-T. Hsiang, L. Chen, O. Chubach, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-S0169](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10291) AHG9: Miscellaneous Cleanups for HLS [B. Wang, S. Esenlik, H. Gao, E. Alshina (Huawei)]

Aspect 1 of this contribution belongs to this category.

[JVET-S0186](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10308) AHG9: On SPS Cleanup [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

[JVET-S0199](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10321) AHG9: On syntax grouping in SPS [H.-J. Jhu, Y.-W. Chen, X. Xiu, T.-C. Ma, C.-W. Kuo, X. Wang (Kwai Inc.)]

[JVET-S0204](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10326) AHG9: On signalling of the maximum transform skip size [K. Unno, K. Kawamura (KDDI)]

[JVET-S0219](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10341) AHG8/AHG9: On APS NAL unit clean-up [H. Jang, J. Nam, J. Lim, S. Paluri, Hendry, S. Kim (LGE)]

[JVET-S0235](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10357) AHG9: On pps\_cabac\_init\_flag signalling [M. Coban, V. Seregin, Y. He, Y.-J. Chang, M. Karczewicz (Qualcomm)]

### PH and SH cleanups (10+4 – Closed)

[JVET-S0143](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10265) AHG9: A summary of proposals on picture header and slice header cleanups [Hendry (LGE)]

This topic was discussed in the HLS AHG at 2330 on 28 May, in the HLS AHG pre-meeting at 1900 on 21 June, and in the main JVET meeting at 1900 on 22 June (GJS) and at 1335 on 25 June (GJS),.

This contribution provides a summary of the 13 proposals on picture header and slice header cleanups (the agenda item 3.1.5 in JVET-S0137 and JVET-S0237).

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. The following changes are proposed:

1. Add a constraint such that the value of ph\_inter\_slice\_allowed\_flag is required to be equal to 1 when vps\_independent\_layer\_flag[ GeneralLayerIdx[ nuh\_layer\_id ] ] is equal to 0 (JVET-S0049 aspect 8).

This proposal seemed undesirable, as it would enforce undesirable behaviour on the picture header based on layer-level characteristics.

1. It is asserted there may be issue with the signalling of ph\_no\_output\_of\_prior\_pics\_flag. When ph\_gdr\_or\_irap\_pic\_flag is equal to 0, but the associated picture the associated picture may or may not be an IRAP picture but the ph\_no\_output\_of\_prior\_pics\_flag is not present but there is no inference value for it. The following options are proposed to fix this asserted issue (JVET-S0055 proposal 1, JVET-S0070 proposal 1)
   1. Option 1: Change the current semantics of ph\_gdr\_or\_irap\_pic\_flag to be a two-way (i.e., if ph\_gdr\_or\_irap\_pic\_flag is equal 1 the associated picture is a GDR or an IRAP picture, otherwise, if ph\_gdr\_or\_irap\_pic\_flag is equal to 0, the associated picture is not a GDR nor an IRAP picture) (JVET-S0055 proposal 1 option 1).
   2. Option 2: Apply the following (JVET-S0070 proposal 1):
      1. Replace the current flag ph\_gdr\_or\_irap\_pic\_flag with two new flags: ph\_irap\_pic\_flag and ph\_gdr\_pic\_flag
      2. Semantics of ph\_irap\_pic\_flag and ph\_gdr\_pic\_flag are two-way.
      3. ph\_no\_output\_of\_prior\_pics\_flag is present when at least ph\_irap\_pic\_flag or ph\_gdr\_pic\_flag is equal to 1
   3. Option 3: Add the following inference: when not present, the value of ph\_no\_output\_of\_prior\_pics\_flag is inferred to be equal to 0. (JVET-S0055 proposal 1 option 1)

It was agreed that there is a problem. It was commented that the idea of using one-way semantics was to avoid PH rewriting for BEAM usage. It was commented that a two-flag approach had also been previously discussed.

Moving the no\_output\_of\_prior\_pics\_flag to the slice header was suggested. It had previously been there.

See item 13 for later developments on this issue.

1. Add a constraint such that when aud\_irap\_or\_gdr\_au\_flag is present and the value of aud\_irap\_or\_gdr\_au\_flag is equal to 1, the value of ph\_gdr\_or\_irap\_pic\_flag shall be equal to 1. (JVET-S0055 proposal 2)

It was commented that this interacts with BEAM usage. This is related to item 2 above.

The AHG did not close this topic. In further discussion in the JVET meeting at 1950 on 22 June (GJS), it was agreed that no action was needed on this (similar in spirit to item 16 below).

1. Regarding the signalling of ph\_gdr\_or\_irap\_pic\_flag when pps\_mixed\_nalu\_types\_in\_pic\_flag is equal to 1 (JVET-S0135):
   1. Option 1: add a constraint such that the value of ph\_gdr\_or\_irap\_pic\_flag shall be equal to 0 when pps\_mixed\_nalu\_types\_in\_pic\_flag is equal to 1.
   2. Option 2: condition the presence of ph\_gdr\_or\_irap\_pic\_flag on pps\_mixed\_nalu\_types\_in\_pic\_flag being equal to 0.
   3. Option 3: add a constraint to the definition of GDR picture that pps\_mixed\_nalu\_types\_in\_pic\_flag is equal to 0.

For option 3, the proponent provided the text as a NOTE, instead of a constraint.

This is related to items 2 and 3 above.

The AHG did not close this topic. In further discussion in the JVET meeting at 1950 on 22 June (GJS), it was said that option 2 is not feasible due to the syntax location. It was also commented that the constraint described as option 3 already exists.

Editor action item: The editor is asked to consider adding a NOTE to point out that a GDR picture cannot have pps\_mixed\_nalu\_types\_in\_pic\_flag equal to 1.

1. Change coding of ph\_pic\_parameter\_set\_id from ue(v) to u(6) (JVET-S0076 item b), JVET-S0110 aspect 3)

This would add 5 bits to every picture when only 1 PPS is being used.

No strong need for action was identified, so no action was recommended for this.

1. Rearrange the position of syntax elements in PH and SH.
   1. Move syntax elements related to SAO and de-blocking process to earlier position in PH and in SH (i.e., signal them right after ALF and LMCS related syntax) JVET-S0074 aspect 2)

This suggestion had been discussed at the previous meeting. This would move the APS ID for the scaling list APS to later in the syntax, which is undesirable. No strong need for action was identified, so no action was recommended for this.

* 1. Move ph\_non\_ref\_pic\_flag to earlier position, i.e., before any syntax element whose presence is conditioned on the value of other syntax element(s). Immediately after ph\_gdr\_or\_irap\_pic\_flag (JVET-S0076 item a) )

AHG Recommendation (cleanup): Adopt.

* 1. Move ph\_pic\_parameter\_set\_id to earlier position (i.e., after ph\_non\_ref\_pic\_flag) (JVET-S0076 item c) )

This was withdrawn due to lack of action on item 5.

* 1. Move down the location of syntax elements ph\_inter\_slice\_allowed\_flag and ph\_intra\_slice\_allowed\_flag and condition the presence of ph\_inter\_slice\_allowed\_flag only for picture with no inter-layer prediction and non-irap picture and non-gdr picture when ph\_recovery\_poc\_cnt is equal to 0 (JVET-S0070 proposal 2)

It was commented that this would require some SPS parsing for interpretation. There was discussion over whether this would be of interest to the system level.

It could save one or two bits per picture under some circumstances.

There seemed to be no clear need for action on this, so no action was recommended.

Discussion in the HLS AHG stopped here at 0020 UTC on 29 May.

Discussion in the HLS AHG pre-meeting resumed here at 1900 on 21 June.

1. Condition the presence of ph\_gdr\_pic\_flag such that it may be present only when sps\_gdr\_enabled\_flag is equal to 1 (JVET-S0076 item d)

This proposal is somewhat based on the idea that ph\_gdr\_pic\_flag is not needed/used by the system level, which was not considered necessarily true, so no action was recommended on this item.

1. Change the constraint on the value of sh\_picture\_header\_in\_slice\_header\_flag as follows: the value of sh\_picture\_header\_in\_slice\_header\_flag shall be equal to 0 when sps\_subpic\_info\_present\_flag is equal to 1 *and pps\_no\_pic\_partition\_flag is equal to 0* (JVET-S0120 aspect 1)

The idea is that if there is only one slice in the picture, it should be OK to put the PH in the SH.

This would not be friendly to parallel encoding with merging.

In the discussion, it was said that the only purpose of having sps\_subpic\_info\_present\_flag equal to 1 is to support BEAM usage, and putting the PH in the SH would not be consistent with that purpose. No action was thus recommended on this.

1. Change the constraint on the value of sh\_picture\_header\_in\_slice\_header\_flag as follows: (JVET-S0120 aspect 2 and 3)
   1. Option 1: the value of sh\_picture\_header\_in\_slice\_header\_flag shall be equal to 0 when the value of pps\_rpl\_info\_in\_ph\_flag, pps\_dbf\_info\_in\_ph\_flag, pps\_sao\_info\_in\_ph\_flag, pps\_wp\_info\_in\_ph\_flag, *pps\_alf\_info\_in\_ph\_flag*, or pps\_qp\_delta\_info\_in\_ph\_flag is equal to 1.
   2. Option 2: remove the following constraint: “*the value of sh\_picture\_header\_in\_slice\_header\_flag shall be equal to 0 when The value of pps\_rpl\_info\_in\_ph\_flag, pps\_dbf\_info\_in\_ph\_flag, pps\_sao\_info\_in\_ph\_flag, pps\_wp\_info\_in\_ph\_flag, or pps\_qp\_delta\_info\_in\_ph\_flag is equal to 1”*

This topic was closed; see notes for S0142.

1. Change VTM encoder to signal the override flag (i.e., ph\_partition\_constraints\_override\_flag) as zero when the derived partition constraints for a PH are identical to the ones in the SPS (JVET-S0133 aspect 1)

This aspect is a non-normative software-only encoder modification proposal. The software was attached to the proposal.

Some coding gain was reported under CTC conditions (overall 0.14% in LB, with 0.46% in Class E).

It was commented that this could have just been fixed in response to a bug track report.

AHG Recommendation (non-normative encoder software improvement): Adopt.

1. Change the semantics of the signalled values of partition constraints in PH from values for overriding the corresponding values signalled in SPS to delta values relative to the corresponding values signalled in the SPS (JVET-S0133)

The results reportedly show that the encoder-only change to remove the redundant signalling introduces -0.10% (RA) and -0.06% (LD) BD-rate reduction for class D. On top of the encoder-only change, the proposed syntax modifications introduce -0.18% (RA), -0.19% (LD) BD-rate reduction for class D. In average, the encoder-only change introduces 0.00 (AI), -0.03% (RA) and -0.14% (LDB) BD-rate changes, and when combined with the encoder-only change, the proposed syntax modification introduces 0.00 (AI), -0.03% (RA) and -0.15% (LDB) BD-rate changes under CTC.

The additional average gain from the syntax change across all classes is negligible, although there is a little gain for class D.

It is noted that the results show no impact on AI because the current VTM always disables the override of the partition constraints for intra pictures.

The proposal assumes the SPS-level information is an upper bound or lower bound. The proposal use the upper bound convention for some SEs and the lower bound convention for others, based on which would be more efficient than the CTC.

It was commented that this seems to complicate the design for basically negligible benefit, so no action was recommended.

1. It is asserted that reference rule for the value of ph\_collocated\_from\_l0\_flag when L0 empty and L1 non-empty is missing. Update the current inference rule for ph\_collocated\_from\_l0\_flag as follows: (JVET-S0174 aspect 3) (added/changed in **bold**)

ph\_collocated\_from\_l0\_flag equal to 1 specifies that the collocated picture used for temporal motion vector prediction is derived from reference picture list 0. ph\_collocated\_from\_l0\_flag equal to 0 specifies that the collocated picture used for temporal motion vector prediction is derived from reference picture list 1. When **not present and** ph\_temporal\_mvp\_enabled\_flag and pps\_rpl\_info\_in\_ph\_flag are both equal to 1, **the value of ph\_collocated\_from\_l0\_flag is inferred to be equal to ( num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ]  = =  0 ? 1 : 0 ).**

This is proposed as a bug fix.

It was commented that either of the lists can be empty. However, per the notes for S0140 item 11 in section 6.1.6 that discuss S0096, list 0 could only be empty for an I slice.

The AHG did not reach a conclusion on this item. In further discussion in the JVET meeting at 2015 on 22 June (GJS), the matter was closed as recorded in notes for item 11 of S0140 in section 6.1.6.

1. Further study result for the item 2 above (i.e., harmonization of JVET-S0055 proposal 1 and JVET-S0070 proposal 1). Change IRAP or GDR flag in PH with the following options (JVET-S0193 aspect 1):
   1. Option 1: Change the semantics of ph\_gdr\_or\_irap\_pic\_flag to be two-way.
   2. Option 2: Replace the flag ph\_gdr\_or\_irap\_pic\_flag with two new flags: ph\_irap\_pic\_flag and ph\_gdr\_pic\_flag with two-way semantics.
   3. Option 3: Add the following inference: when not present, the value of ph\_no\_output\_of\_prior\_pics\_flag is inferred to be equal to 1.
   4. Option 4: Move no\_output\_of\_prior\_pics\_flag to the slice header of IRAP and GDR slices (but require it to have the same in all IRAP and GDR slices of the AU).

It was commented that option 1 would be harmful to merging bitstreams that have different IRAP periods. Option 2 has the same issue.

Option 3 would lose the ability to set the flag to 0 in some cases and might require some rewriting to put the flag in.

Option 4 was thus suggested. It was noted that the flag in HEVC is at the slice level.

Putting the no\_output\_of\_prior\_pics\_flag in the AUD was mentioned as a possible option 5.

An option 6 was mentioned of putting the flag in all PHs.

AHG Recommendation (bug fix): Adopt option 4. (It was noted that no inference rule is needed for this case and the text should reflect that.)

1. If option 3 or option 4 from the above item is agreed, change the syntax element ph\_gdr\_or\_irap\_pic\_flag to ph\_irap\_pic\_flag and send a GDR flag in more cases. (JVET-S0193 aspect 1)

It was commented that the detecting a random-access point would be easier without the change. However, detecting an IRAP would be easier with the change, and this is anticipated to be the more common use – e.g. for trick play. Another participant said that the current semantics is difficult to understand.

Since the technical merits seem relatively unimportant, no action was recommended on this aspect.

Discussion in the HLS pre-meeting stopped here at 2100 UTC on 21 June.

Discussion in the JVET main meeting began here at 1900 UTC on 22 June (GJS).

1. Do one of the following (JVET-S0200):
   1. Option 1: Add a constraint such that ph\_inter\_slice\_allowed\_flag shall be equal to 1 when ph\_gdr\_pic\_flag is equal to 1.
   2. Option 2: Condition the presence of ph\_inter\_slice\_allowed\_flag on ph\_gdr\_pic\_flag being equal to 0.

The ph\_gdr\_pic\_flag comes before the ph\_inter\_slice\_allowed\_flag.

A discussed case that would be prohibited was an all-intra picture with a recovery POC distance of 0 (or with some other recovery POC distance). The proponent said this might help make sure the bitstream can be merged. However, it was mentioned that this can be a choice for the encoder. Adaptation to a sudden scene change was another suggested use of all-intra.

It was commented that this seems like an unnecessary restriction, so no action was taken on it.

1. Add a constraint such that when vps\_max\_layers\_minus1 is equal to 0, an AUD is present for the current AU, and aud\_irap\_or\_gdr\_au\_flag is equal to 0, the value of ph\_gdr\_or\_irap\_pic\_flag shall be equal to 0 (JVET-S0160 aspect 4).

It was concluded that this constraint is already imposed by the semantics. It was discussed whether adding a NOTE to observe this would be helpful, but no action seemed necessary.

1. Add a constraint such that when an AUD is present for the current AU and aud\_pic\_type is equal to 0 (i.e., there are only I slices), the value of sh\_slice\_type shall be equal to 2 (JVET-S0160 aspect 2).

No action was deemed necessary on this, as that is the stated meaning of aud\_pic\_type is equal to 0.

1. Add a constraint such that when an AUD is present for the current AU and aud\_pic\_type is equal to 1, the value of sh\_slice\_type shall be equal to 1 or 2 (JVET-S0160 aspect 3).

No action was deemed necessary on this, as that is the stated meaning of aud\_pic\_type is equal to 0.

1. Add the following constraint for CTU size when using ILRP as collocated reference picture as follows (JVET-S0174 aspect 1) (addition in **bold**):

sh\_collocated\_ref\_idx specifies the reference index of the collocated picture used for temporal motion vector prediction.

[…]

Let colPicList be set equal to sh\_collocated\_from\_l0\_flag ? 0 : 1. It is a requirement of bitstream conformance that the picture referred to by sh\_collocated\_ref\_idx shall be the same for all non-I slices of a coded picture and the value of RprConstraintsActiveFlag[ colPicList ][ sh\_collocated\_ref\_idx ] shall be equal to 0 **and the value of sps\_log2\_ctu\_size\_minus5 in the SPS referred to by the picture referred to by sh\_collocated\_ref\_idx shall be equal to or greater than the value of sps\_log2\_ctu\_size\_minus5 in the SPS referred to by the current picture**.

NOTE – The above constraint requires the collocated picture to have the same spatial resolution, the same scaling window offsets **and the same or larger CTU size** as the current picture. [Comment: And the same number of subpictures]

Another variation had been developed during offline study, which would also prohibit the ILRP from having a larger CTU size.

The issue is how the MV data is stored for the reference picture. There would be more flexibility over how the data is stored if it is guaranteed to have the same CTU layout. Unless this is possible to assume, it would make the multilayer case different from single-layer operation, which is not the design intent. It is not possible, in the single-layer case, for a picture (e.g. a RASL picture) to refer to a picture with a different CTU size).

Decision (bug fix/expression of existing intent): Adopt the alternative (more strict) variation.

Discussion of this aspect in the JVET meeting ended at 1945 on 22 June.

In the main JVET meeting at 1335 on 25 June (GJS), the text was confirmed to be adequate.

[JVET-S0049](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10171) AHG9/AHG8/AHG12: On parameter sets and picture header [Y.-K. Wang, L. Zhang, Z. Deng, K. Zhang (Bytedance)]

Aspect 8 of this contribution belongs to this category.

[JVET-S0055](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10177) AHG9: On signaling IRAP and GDR pictures [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-S0070](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10192) AHG9: On flag ph\_gdr\_or\_irap\_pic\_flag [L. Chen, C.-W. Hsu, S.-T. Hsiang, O. Chubach, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-S0074](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10196) AHG9: On SPS, PH, SH syntax order [M. G. Sarwer, Y. Ye (Alibaba)]

Aspect 2 of this contribution belongs to this category.

[JVET-S0076](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10198) AHG9: On syntax elements in the beginning of picture header [Hendry (LGE)]

[JVET-S0110](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10232) AHG9: On HLS Editorial cleanup [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Aspect 3 of this contribution belongs to this category.

[JVET-S0120](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10242) AHG9: Constraints on sh\_picture\_header\_in\_slice\_header\_flag [N. Hu, V. Seregin, Y. He, M. Karczewicz (Qualcomm)]

[JVET-S0133](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10255) AHG9: On partition constraints override in picture header [Y.-W. Chen, X. Xiu, H.-J. Jhu, T.-C. Ma, X. Wang (Kwai Inc.)]

[JVET-S0135](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10257) AHG9: On IRAP and GDR picture signaling in picture header [X. Xiu, Y.-W. Chen, H.-J. Jhu, T.-C. Ma, X. Wang (Kwai)]

[**JVET-S0160**](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10282) **AHG9/AHG12/AHG8: Miscellaneous HLS cleanups [Y.-K. Wang, Z. Deng, L. Zhang, K. Zhang (Bytedance)]**

Aspects 2 to 4 of this contribution belong to this category.

[JVET-S0174](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10296) AHG9: Miscellaneous cleanups [R. Skupin, Y. Sanchez, K. Suehring, T. Schierl (HHI)]

Aspects 1 and 3 of this contribution belong to this category.

[JVET-S0193](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10315) AHG9: Bugfix and Cleanup on ph\_no\_output\_of\_prior\_pics\_flag and ph\_gdr\_or\_irap\_pic\_flag [B. Choi, S. Wenger, S. Liu (Tencent), L. Chen, C.-W. Hsu, S.-T. Hsiang, O. Chubach, Y.-W. Huang, S.-M. Lei(MediaTek)]

[JVET-S0200](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10322) AHG9: On ph\_inter\_slice\_allowed\_flag in GDR picture [H.-J. Jhu, X. Xiu, Y.-W. Chen, T.-C. Ma, C.-W. Kuo, X. Wang (Kwai Inc.)]

### Reference picture lists cleanups (8+2 – Closed)

[JVET-S0140](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10262) AHG9: A summary of proposals on reference picture lists [Y.-K. Wang (Bytedance)]

This contribution was discussed in the HLS AHG meeting at 0500 UTC on Thursday 28 May and in the HLS AHG pre-meeting at 1300 UTC on 20 June.

This contribution provides a summary of the 9 proposals on reference picture lists cleanups (the agenda item 3.1.6 in JVET-S0137 and JVET-S0237).

It is suggested that this summary, in terms of a list of proposed items, is used for the reviewing of these proposals, such that the discussions can be in a more structured and efficient manner. The following changes were proposed:

1. Modify the semantics of strp\_entry\_sign\_flag[ listIdx ][ rplsIdx ][ i ], such that it (S0045)
2. swaps the meaning of positive and negative (consequently swaps the sign assignment of DeltaPocValSt[ listIdx ][ rplsIdx ][ i ] in Equation 155, and change the subtraction to addition when assigning RefPicPocList[ i ][ j ] using DeltaPocValSt[ i ][ RplsIdx[ i ] ][ j ] in Equation 205.

The concept is that in other place in the spec, a sign flag value ‘1’ is associated with a negative value and ‘0’ is associated with a positive value.

1. associates strp\_entry\_sign\_flag[ listIdx ][ rplsIdx ][ i ] with DeltaPocValSt[ listIdx ][ rplsIdx ][ i ] instead of with an "i-th entry in the syntax structure ref\_pic\_list\_struct( listIdx, rplsIdx )".

Both aspects are only editorial. The “bits on the wire” do not change.

Editor action item: The editor is strongly suggested to make the proposed changes as a more precise and natural expression of the intent.

1. When sps\_inter\_layer\_ref\_pics\_present\_flag is equal to 1, sps\_idr\_rpl\_present\_flag is skipped and inferred to be equal to 1. (S0049 aspect 2)

The motivation is to eliminate a combination that is asserted to not make sense.

This is closely related to items 4 and 5.

It was suggested to remove the sps\_idr\_rpl\_present\_flag, as a simplification of the RPL design for IDR pictures. This would require RPL to be present even for all-intra usage, costing about one or two bits per picture to signal an empty RPL.

Another participant said there is not really a problem in the current syntax.

No clear need for action was evident, so no action was recommended.

1. Add a constraint: When vps\_independent\_layer\_flag[ GeneralLayerIdx[ nuh\_layer\_id ] ] is equal to 0, the value of sps\_idr\_rpl\_present\_flag shall be equal to 1. (S0049 aspect 2)

The motivation is to eliminate a combination that is asserted to not make sense.

It was commented that it might be desirable to be able to detect the self-contained nature of such an IDR picture.

No clear need for action was evident, so no action was recommended.

1. Remove sps\_idr\_rpl\_present\_flag (i.e., always signal RPLs for IDR slices, like for non-IDR I slices), and invoke generating unavailable reference picture for IDR pictures: (S0123 approach 1)

See also items 2 and 5. No clear need for action was evident, so no action was recommended.

1. As an alternative to 4), do the following and invoke generating unavailable reference picture for IDR pictures: (S0123 approach 2)
   1. Do one of the following:
2. Change the SH syntax to signal RPL for each IDR slice in a non-independent layer.
3. Require sps\_idr\_rpl\_present\_flag or pps\_rpl\_info\_in\_ph\_flag to be equal to 1 for an IDR slice when the current layer is a non-independent layer.
4. Require sh\_slice\_type to be equal to 2 for IDR slice when sps\_idr\_rpl\_present\_flag and pps\_rpl\_info\_in\_ph\_flag are both equal to 0.
   1. Change the process for deriving empty RPLs when sps\_idr\_rpl\_present\_flag is equal to 0 and nal\_unit\_type is equal to IDR\_W\_RADL or IDR\_N\_LP to involve pps\_rpl\_info\_in\_ph\_flag.

See also items 2 and 4. For the aspect “a”, no clear need for action was evident, so no action was recommended.

However, for the basic concept of needing to generate unavailable reference picture for IDR pictures, it was agreed there is an issue.

It was commented that this may only be relevant/necessary for a merge/extract scenario.

It was noted that some validity checks for entries of the RPL apply even if the picture is not an active entry.

AHG Recommendation (bug fix/expression of existing intent): Invoke the generation of unavailable reference picture for an IDR picture that has RPLs, and change the RPL constraints in clause 8.3.2 accordingly.

For aspect “b” it was agreed that there is a spec bug relating to when the RPL is in the PH.

AHG Recommendation (bug fix/expression of existing intent): Adopt aspect “b”. Editor may consider the exact expression.

1. Add sps\_ref\_layer\_idx\_plus1 under the condition "if( sps\_inter\_layer\_ref\_pics\_present\_flag )" to enable skipping ilrp\_idx[ listIdx ][ rplsIdx ][ i ] in the RPL syntax structures when the layer has only one direct reference layer, as follows: (S0082)
   1. The value of ps\_ref\_layer\_idx\_plus1 shall be equal to

( NumDirectRefLayers[ GeneralLayerIdx[ nuh\_layer\_id ] ] > 1 ) ? 0:  
 DirectRefLayerIdx[ GeneralLayerIdx[ nuh\_layer\_id ] ][ 0 ] + 1

* 1. Consequently, when sps\_ref\_layer\_idx\_plus1 is greater than 0, ilrp\_idx[ listIdx ][ rplsIdx ][ i ] is skipped and inferred to be equal to sps\_ref\_layer\_idx\_plus1 − 1.

It is common for there to be only one direct reference layer. In this case it would be possible to skip the ILRP index signalled in the PH/SH (whichever has the RPL structure, if one of them does).

It was noted that something similar is done in HEVC.

It was commented that this seemed like something we would do if it was proposed a couple of meetings earlier. It would be basically a shortcut for a common use case.

The bit savings for this was not so clear, and software had not been tested.

No clear need for action was evident, so no action was recommended.

1. Change ilrp\_idx[ listIdx ][ rplsIdx ][ i ] to delta\_ilrp\_idx\_minus1[ i ][ RplsIdx ][ i ] as well as the semantics such that the following part of Equation 205 (S0083):

layerIdx = DirectRefLayerIdx[ GeneralLayerIdx[ nuh\_layer\_id ] ][ ilrp\_idx[ i ][ RplsIdx ][ j ] ]  
refPicLayerId = vps\_layer\_id[ layerIdx ]

is proposed to be changed to be as follows:

ilrpIdx = GeneralLayerIdx[ nuh\_layer\_id ] − ( delta\_ilrp\_idx\_minus1[ i ][ RplsIdx ][ j ] + 1 )  
layerIdx = DirectRefLayerIdx[ GeneralLayerIdx[ nuh\_layer\_id ] ][ ilrpIdx ]  
refPicLayerId = vps\_layer\_id[ layerIdx ]

The motivation is partly to make it more possible to be able to share SPSs.

It was commented that some sharing is already enabled since the index is an index into a list of direct reference layers.

Again it was commented that this seemed like something we would do if it was proposed a couple of meetings earlier.

There was a bug noted in the proposed equations, that they should instead be more like this:

ilrpIdx = GeneralLayerIdx[ nuh\_layer\_id ] − ( delta\_ilrp\_idx\_minus1[ i ][ RplsIdx ][ j ] + 1 )  
refPicLayerId = vps\_layer\_id[ ilrpIdx ]

No clear need for action was evident, so no action was recommended.

1. Fix an asserted bug (when sps\_num\_ref\_pic\_lists[ 0 ] is greater than sps\_num\_ref\_pic\_lists[ 1 ], pps\_rpl1\_idx\_present\_flag is equal to 0, and rpl\_idx[ 1 ] is less than sps\_num\_ref\_pic\_lists[ 0 ], the value of rpl\_idx[ 1 ] may be out of range), with either of the following two options: (S0085 aspect 1)
   1. Add a constraint: When sps\_num\_ref\_pic\_lists[ 0 ] is greater than sps\_num\_ref\_pic\_lists[ 1 ], pps\_rpl1\_idx\_present\_flag shall be equal to 1.
   2. Add the following to the semantics of rpl\_idx[ i ]: When pps\_rpl1\_idx\_present\_flag is equal to 0, the syntax element rpl\_idx[ 0 ] shall be in the range of 0 to min(sps\_num\_ref\_pic\_lists[ 0 ], sps\_num\_ref\_pic\_lists[ 1 ]) − 1 and the syntax element rpl\_idx[ 0 ] is represented by Ceil( Log2(min( sps\_num\_ref\_pic\_lists[ 0 ], sps\_num\_ref\_pic\_lists[ 1 ] ) ) ) bits, otherwise (pps\_rpl1\_idx\_present\_flag is equal to 1) the syntax element rpl\_idx[ i ] is represented by Ceil( Log2( sps\_num\_ref\_pic\_lists[ i ] ) ) bits.

It was commented that there is a constraint, on the value range of rpl\_idx[ 1 ], that would be violated by the example for describing of the asserted but. Therefore, the asserted bug is not valid.

It was noted that a value range for a syntax element, unless explicitly said to apply only when the syntax element is present, it applies also to inferred values.

No need for an action was identified. Thus no action was recommended on this.

1. Fix an asserted bug in the syntax condition "if( !pps\_rpl\_info\_in\_ph\_flag | | num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] > 0 )" in the PH syntax (when pps\_rpl\_info\_in\_ph\_flag is equal to 0 the variable RplsIdx[ 1 ] in the context is used undefined), with the following changes: (S0085 aspect 2)
   1. Add ", otherwise rpl\_sps\_flag[ i ] is inferred to be equal to 0" to the end of inference of rpl\_sps\_flag[ i ].
   2. Add "num\_ref\_entries[ listIdx ][ sps\_num\_ref\_pic\_lists[ listIdx ] ] is infered to be equal to 0." to end of the semantics of num\_ref\_entries[ listIdx ][ rplsIdx ].

It was commented that " if( !pps\_rpl\_info\_in\_ph\_flag | | num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] > 0 )" is equivalent to "if( !pps\_rpl\_info\_in\_ph\_flag | | ( pps\_rpl\_info\_in\_ph\_flag && num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] > 0 ) )". Therefore, the asserted bug is not valid.

Generally, a value of a syntax element or variable, when not present, is not inferred/derived when not needed, unless it is referred in a syntax condition or other condition.

It was commented that the text has some issue.

It was initially agreed to add the derivation of the value of RplsIdx[ 1 ] in the PH semantics when pps\_rpl\_info\_in\_ph\_flag is equal to 0. In later discussion, adding an “if” condition was suggested as an alternative.

Editor action item: The editor is asked to rephrase the text to avoid the problem. The suggested method is to add an extra “if” condition with a comment to explain why it is there.

1. Fix an asserted bug that the inference of RplsIdx[ 0 ] is missing, by adding the following inference rule (in addition to the existing inference of RplsIdx[ 1 ]): The value of rpl\_idx[ 0 ] is inferred to be equal to 0 when sps\_num\_ref\_pic\_lists[ 0 ] is equal to 1 and rpl\_sps\_flag[ 0 ] is equal to 1. (S0085 aspect 3, S0096 aspect 3)

AHG Recommendation (bug fix/expression of existing intent): Adopt in spirit; infer a value only when needed. Exact expression to be determined offline by the editor.

1. Additionally check num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] for conditional signalling of ph\_collocated\_from\_l0\_flag and ph\_mvd\_l1\_zero\_flag to reduce the unnecessary signalling, by changing "num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] > 0" in the syntax condition to "num\_ref\_entries[ 0 ][ RplsIdx[ 0 ] ] > 0 && num\_ref\_entries[ 1 ][ RplsIdx[ 1 ] ] > 0". (S0096 aspect 1)

If list 0 is empty, we should not be able to indicate that we are getting the collocated picture from that list.

List 0 could only be empty for an I slice. Usually, for an I slice, if we have a non-empty list, we would make that list 0, but we do not have a constraint that requires that. It was remarked that we might not want to establish such a constraint.

The existing syntax condition seems to have a built-in assumption that list 0 will always be non-empty. This is not a valid assumption.

The initial AHG discussion thought that, as a bug fix/expression of existing intent, this should be adopted.

This was further discussed in the context of discussion of S0174 on 21 June at 1940. The prior understanding seemed to be incorrect. If the RPL is sent in the PH, it is used for all slices, and therefore list 0 can only be empty if the whole picture contains only I slices.

It was suggested to require that ph\_inter\_slice\_allowed\_flag be 0 when the RPL is sent in the PH and list 0 is empty, but it was suggested that this could be unfriendly to merging.

See also the notes for related contribution S0174 in 3.1.5 for S0143 item 12.

The AHG did not reach a conclusion on this topic. Offline study was conducted to determine the appropriate course of action. In further discussion in the JVET meeting at 2009 on 22 June (GJS), it was agreed that the above suggestion is not actually unfriendly to merging.

Decision (sensibility constraint): Require that ph\_inter\_slice\_allowed\_flag be 0 when the RPL is sent in the PH and list 0 is empty.

1. Consider the number of active entries in the reference picture list when inferring the value of sh\_collocated\_ref\_idx so that encoder can have more flexibility to change the number of active entries in slice headers, by changing "sh\_collocated\_ref\_idx is inferred to be equal to ph\_collocated\_ref\_idx" to "sh\_collocated\_ref\_idx is inferred to be equal to min( ph\_collocated\_ref\_idx, NumRefIdxActive[ !sh\_collocated\_from\_l0\_flag ] − 1 )". (S0096 aspect 2)

The issue is not actually a bug, because the problem case is prohibited.

The usefulness of the extra flexibility would be to avoid needing to signal the RPL in the SH by allowing it to be sent in the PH in such a case. However, it was remarked that it is not clear that this would be a common case. No clear need for action was evident, so no action was recommended.

1. Change the constraint that the collocated picture "shall be the same for all slices of a picture" to "shall be the same for all non-I slices of a picture". (S0096 aspect 4).

It was remarked that this seems necessary to resolve the lack of a collocated picture definition for an I slice, and that this is the same way it was done in HEVC.

AHG Recommendation (bug fix/expression of existing intent): Adopt.

The discussion of the above items of this section in the HLS AHG meeting was completed at 0830 UTC on 28 May.

Discussion of the below items in the HLS pre-meeting began at 1300 UTC on 20 June.

1. Add a constraint such that when sps\_idr\_rpl\_present\_flag is equal to 0, pps\_mixed\_nalus\_in\_pic\_flag is equal to 1, and pps\_rpl\_info\_in\_ph\_flag is equal to 0, the value of nal\_unit\_type shall not be equal to IDR\_W\_RADL or IDR\_N\_LP. (S0159 aspect 1)

There was discussion of whether this would be purely editorial (due to existing indirect constraints) and whether it is necessary to specify. A possible violation would be an IDR slice without RPL information mixed with an I slice with a trail NAL unit type in which the RPL is empty, which would not seem to cause a problem in principle (although it would be strange).

No action was recommended on this.

1. Add a constraint such that when vps\_independent\_layer\_flag[ GeneralLayerIdx[ nuh\_layer\_id ] ] is equal to 0, the value of sps\_inter\_layer\_ref\_pics\_present\_flag shall be equal to 1. (S0159 aspect 2)

It was asked whether this constraint would really be needed. It did not seem to really be needed. It was mentioned that since some semantics are “one-way”, an encoder could set flags to indicate that something may happen that would not actually occur in the bitstream, and there seemed to be no clear need to prohibit this. Thus, no action was recommended on this.

1. Add GDR picture with ph\_recovery\_poc\_cnt equal to 0 (in addition to IRAP picture) to the constraint in clause 8.3.2 on RPLs based on the value of vps\_max\_tid\_il\_ref\_pics\_plus1[ ][ ]. (S0159 aspect 3)

The idea of this is to treat GDR picture with ph\_recovery\_poc\_cnt equal to 0 consistently the same as an IRAP picture. This seemed to be just a forgotten, essentially editorial, issue.

AHG Recommendation (editorial BF/expression of existing intent): Adopt as proposed.

1. Mark each ILRP entry, when present, in RefPicList[ 0 ] or RefPicList[ 1 ], of a CLVSS picture as "used for long-term reference". (S0159 aspect 4)

The proponent said that this is an essentially editorial bug fix of the existing intent of the spec.

It was noted that the proposal would put the same text in both an “if” and “otherwise”, so it could just be applied unconditionally.

AHG Recommendation (editorial BF/expression of existing intent): Adopt (with suggested editorial refinement).

1. When num\_ref\_entries[ listIdx ][ rplsIdx ] in the ref\_pic\_list\_struct( listIdx, rplsIdx ) syntax structure is equal to 0, ltrp\_in\_header\_flag[ listIdx ][ rplsIdx ] is skipped and inferred to be equal to 0. (S0182)

In this case, the ltrp\_in\_header\_flag[ listIdx ][ rplsIdx ] has no purpose or meaning.

The inference aspect is not proposing a change, since there is an existing inference specification that would naturally include this case.

AHG Recommendation (cleanup): Adopt.

[JVET-S0045](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10167) AHG9: On the sign of DeltaPocValSt [D. Liu, R. Sjöberg, Z. Zhang, M. Pettersson, M. Damghanian, J. Enhorn, J. Ström, R. Yu(Ericsson)]

[JVET-S0049](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10171) AHG9/AHG8/AHG12: On parameter sets and picture header [Y.-K. Wang, L. Zhang, Z. Deng, K. Zhang (Bytedance)]

Aspect 2 of this contribution belongs to this category.

[JVET-S0082](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10204) AHG8/AHG9: On signaling of inter-layer reference picture layer index [H. Jang, Hendry, S. Paluri, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-S0083](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10205) AHG8/AHG9: On signaling of ILRP layer index using delta value [Hendry, H. Jang, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-S0085](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10207) AHG9: On semantics related to reference picture lists [T. Chujoh, E. Sasaki, T. Ikai (Sharp)]

[JVET-S0096](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10218) AHG9: On RPL syntax and semantics [J. Chen, Y. Ye, R.-L. Liao (Alibaba)]

Aspects 1 to 4 of this contribution belong to this category.

[JVET-S0123](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10245) AHG9: On reference picture list constraints [V. Seregin, Y. He, M. Coban, A. K. Ramasubramonian, M. Karczewicz (Qualcomm)]

[JVET-S0159](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10281) AHG9: Reference picture list (RPL) cleanups [Y.-K. Wang, L. Zhang, Z. Deng (Bytedance)]

[JVET-S0182](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10304) AHG9: On Reference Picture List Sgnalling [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

### Signalling of virtual boundaries (2+5 – Closed)

[JVET-S0047](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10169) AHG9: Signalling of Virtual Boundary Positions [M. Damghanian, R. Sjöberg, M. Pettersson, Z. Zhang, J. Enhorn, J. Ström, R. Yu, D. Liu]

This contribution was discussed in the HLS AHG meeting at 0837 UTC on Thursday 28 May and in the main JVET meeting at 1340 on 25 June (GJS).

At the 18th JVET meeting, it was decided (in JVET-R0266 item 6) to code virtual boundary positions using ue(v) for the sps\_virtual\_boundary\_pos\_x, sps\_virtual\_boundary\_pos\_y, ph\_virtual\_boundary\_pos\_x and ph\_virtual\_boundary\_pos\_y syntax elements instead of fixed length coding using u(13). It is observed that the value of 0 is not allowed for these four syntax elements so this contribution proposes to align the semantics of these four syntax elements with other syntax elements in the specification and use the minus1 mechanism. The following changes to the syntax and semantics are proposed:

* Add “\_minus1” to each of the four syntax elements sps\_virtual\_boundary\_pos\_x, sps\_virtual\_boundary\_pos\_y, ph\_virtual\_boundary\_pos\_x and ph\_virtual\_boundary\_pos\_y.
* Update the corresponding ranges and derivations in the semantics of the four syntax elements accordingly.

AHG Recommendation (cleanup): Adopt.

[JVET-S0065](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10187) AHG9: On Virtual Boundary [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

This contribution was discussed in the HLS AHG meeting at 0840 UTC on Thursday 28 May.

Modifications are proposed related to virtual boundary.

The following changes were proposed:

* Proposal 1: An assertedly missing inference rule is specified for sps\_virtual\_boundaries\_present\_flag to be inferred to be equal to 0 when not present.

AHG Recommendation (bug fix/expression of existing intent): Adopt.

* Proposal 2: An asserted simplification of text is proposed for virtual boundary derivation.

This aspect is only editorial.

Editor action item: The editor is requested to consider improving the expression. It was remarked that there may be some issues with the text that was proposed.

The following topics were discussed in the HLS pre-meeting at 1340 UTC on 20 June.

[JVET-S0165](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10287) AHG9: Cleanup on signalling virtual boundaries [S.-T. Hsiang, L. Chen, O. Chubach, Y.-W. Huang, S.-M. Lei (MediaTek)]

In this contribution following high-level syntax cleanups are proposed, related to signalling information on virtual boundaries:

1. Proposal 1: The presence of sps\_virtual\_boundaries\_present\_flag is conditioned on sps\_res\_change\_in\_clvs\_allowed\_flag.
2. Proposal 2: The presence of virtual boundaries is further conditioned on sps\_subpic\_info\_present\_flag.
   1. Proposal 2a: The presence of ph\_virtual\_boundaries\_present\_flag is further conditioned on sps\_subpic\_info\_present\_flag
   2. Proposal 2b: The presence of sps\_virtual\_boundaries\_present\_flag is further conditioned on sps\_subpic\_info\_present\_flag

This is a proposal for syntax conditioning to enforce existing constraints that disable the combination of virtual boundaries with resolution changes and subpictures.

It was commented that it would be hypothetically possible to make these tools work together (e.g. in some future revision), although that is prohibited, and that we ordinarily do not use syntax conditioning in such cases. In some prior contributions (see JVET-Q0417), these features were proposed to work together. Thus, no action was recommended on this.

[JVET-S0171](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10293) AHG9: Cleanup on virtual boundaries for SAO [S.-Y. Lin, Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek)]

This contribution proposes editorial changes for disabling SAO filtering operations across virtual boundaries by moving the specification text to the condition of edge offset mode to make it clearer.

This does not propose technical modifications.

Editor action item: The editor is requested to consider the proposed improvements.

[JVET-S0184](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10306) AHG9: On Virtual Boundary Signalling [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

Modification is proposed related to a virtual boundary constraint.

It is proposed to specify a conformance constraint regarding virtual boundary signalling when subpictures are present, directly on related SPS syntax elements, to disallow the combination of subpictures and the signalling of virtual boundaries in the PH.

After offline study, this was further discussed in the main JVET meeting at 1340 on 25 June (GJS).

Decision (sensibility constraint/expression of existing intent): Adopt.

[JVET-S0211](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10333) AHG9: Extensibility for the number of virtual boundaries [M. Damghanian, M. Pettersson, R. Sjöberg, J. Enhorn, J. Ström, R. Yu, D. Liu (Ericsson)]

This contribution proposes to signal the number of virtual boundaries using ue(v) instead of the current signalling using u(2) for the four syntax elements sps\_num\_ver\_virtual\_boundaries, sps\_num\_hor\_virtual\_boundaries, ph\_num\_ver\_virtual\_boundaries and ph\_num\_hor\_virtual\_boundaries. The motivation for the proposed change was reported to be future extensibility. The value range of the four syntax elements are proposed to be kept as 0 to 3, inclusive, for version 1 of VVC.

The current “hard coding” of the constraint seemed only to try to prohibit violation, but forecloses future uses. It was commented that we generally do not use syntax solely to enforce constraints that could be violated in a reasonable future use.

AHG Recommendation (extensibility cleanup): Adopt (while retaining the current value range).

[JVET-S0221](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10343) AHG9: On virtual boundaries [Y.-J. Chang, M. Coban, V. Seregin, N. Hu, M. Karczewicz (Qualcomm)]

The current specification allows a virtual boundary to be located at the picture boundary when the picture resolution is 8xH or Wx8, but it is disallowed for other picture resolutions. This contribution proposes to disallow virtual boundaries located at picture boundary for all picture resolutions. Two approaches, signalling constraint or semantics restriction, are proposed as follows:

1. Add explicit checking on the signalling of syntax elements as follows:
   1. Condition sps\_virtual\_boundaries\_enabled\_flag on (sps\_pic\_width\_max\_in\_luma\_samples > 8 | | sps\_pic\_height\_max\_in\_luma\_samples > 8), and infer sps\_virtual\_boundaries\_enabled\_flag to be equal to 0 when not present.
   2. Condition sps\_num\_ver\_virtual\_boundaries on (sps\_pic\_width\_max\_in\_luma\_samples > 8).
   3. Condition sps\_num\_hor\_virtual\_boundaries on (sps\_pic\_height\_max\_in\_luma\_samples > 8).
   4. Condition ph\_num\_ver\_virtual\_boundaries on (pps\_pic\_width\_in\_luma\_samples > 8).
   5. Condition ph\_num\_hor\_virtual\_boundaries on (pps\_pic\_height\_in\_luma\_samples > 8).
2. Or add bitstream conformance constraints as follows:
   1. It is a requirement of bitstream conformance that when the value of sps\_pic\_width\_max\_in\_luma\_samples is equal to or smaller than 8, the value of sps\_num\_ver\_virtual\_boundaries shall be equal to 0.
   2. It is a requirement of bitstream conformance that when the value of sps\_pic\_height\_max\_in\_luma\_samples is equal to or smaller than 8, the value of sps\_num\_hor\_virtual\_boundaries shall be equal to 0.
   3. It is a requirement of bitstream conformance that when the value of pps\_pic\_width\_in\_luma\_samples is equal to or smaller than 8, the value of ph\_num\_ver\_virtual\_boundaries shall be equal to 0.
   4. It is a requirement of bitstream conformance that when the value of pps\_pic\_height\_in\_luma\_samples is equal to or smaller than 8, the value of ph\_num\_hor\_virtual\_boundaries shall be equal to 0.

In the current draft spec, there is a case where a syntax element has a specified range from 0 to −1 under certain conditions.

The proponent said that subpicture layout has a similar syntax treatment as approach #1.

AHG Recommendation (spec bug fix/expression of existing intent): Adopt approach 2 (or editorial equivalent). It also seems desirable to make sure the range constraint never specifies a non-valid range even in disallowed cases.

[JVET-S0256](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10395) AHG2: An integration of virtual boundaries adoptions of S0171, S0211 and S0221 [[M. Pettersson (Ericsson)](mailto:martin.m.pettersson@ericsson.com)] [late]

This was discussed in the main JVET meeting at 1345 on 25 June (GJS).

This was editorial input to express an integrated combination of adoptions. One aspect that was noted was to use range expressions in the semantics rather than to express constraints separately.

The editor used this text when incorporating the combination.

### Hypothetical reference decoder (HRD) (12+15)

See also JVET-S0098 aspects c and d in section 3.3.

[JVET-S0141](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10263) AHG9: A Summary of Proposals Related to HRD [S. Deshpande (Sharp)]

This contribution was discussed in the HLS AHG meeting at 0850 UTC on Thursday 28 May, in the HLS AHG pre-meeting at 1530 on 20 June and in the JVET meeting at 1935–2320 on 23 June (GJS), 1640 on 24 June (GJS), and 1900 on 25 June (GJS).

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).

Following proposals listed in JVET-S0137-v2 section 3.1.8 are covered in this summary: JVET-S0064, JVET-S0075 (aspect 2), JVET-S0097, JVET-S0080, JVET-S0086, JVET-S0099, JVET-S0101, JVET-S0102, JVET-S0117, JVET-S0118. Additionally JVET-S0049 Item 1 is covered.

Additionally the 14 new proposals listed below in this Section starting from JVET-S0154 are also covered in this summary.

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. The following changes were proposed:

**Related to HRD signalling and operation:**

1. Conditionally signal bp\_sublayer\_dpb\_output\_offsets\_present\_flag (and bp\_dpb\_output\_tid\_offset[ i ]) only when bp\_max\_sublayers\_minus1 is greater than 0 and infer it as 0 otherwise?
   1. Alternatively, add following constraint: when bp\_max\_sublayers\_minus1 is equal to 0, bp\_sublayer\_dpb\_output\_offsets\_present\_flag shall be equal to 0. (JVET-S0064)

See also items 20 and 21 for rationale.

AHG Recommendation (cleanup): Adopt the conditional signalling.

1. When sps\_video\_paramater\_set\_id is equal to 0:

AHG Recommendation (bug fix/expression of existing intent): Adopt inferences a, b, c, e, f, and g.i.

* 1. Infer TotalNumOlss to be equal to 1 (JVET-S0075, JVET-S0097)
  2. Infer NumLayersInOls[ 0 ] to be equal to 1 (JVET-S0075, JVET-S0097)
  3. Infer vps\_layer\_id[ 0 ] to be equal to the single value of nuh\_layer\_id of all the VCL NAL units. (JVET-S0097)
  4. Require that parameter sets referred to shall have same nuh\_layer\_id value (JVET-S0075)

It was commented that this aspect is not necessary since the extraction process indirectly requires this.

Also, sharing of PSs is only allowed only if all layers are present in the OLS, which would be violated unless the requirement is true.

Editor action item: The editor is asked to consider adding some explanation to point out that this is the case. Item e below may help to make this clear.

* 1. Infer LayerIdInOls[ 0 ][ 0 ] to be equal to the single value of nuh\_layer\_id of all the VCL NAL units. (JVET-S0097)
  2. Infer NumSubLayersInLayerInOLS[ 0 ][ 0 ] to be equal to sps\_max\_sublayers\_minus1 + 1. (JVET-S0097)
  3. Modify the inference rule for vps\_max\_sub\_layers\_minus1 and range of values for sps\_max\_sublayers\_minus1 by adding quoted text and not inferring vps\_max\_layers\_minus1 to be equal to 6? (JVET-S0097)
     1. “When sps\_video\_parameter\_set\_id is greater than 0,” the value of sps\_max\_sublayers\_minus1 shall be in the range of 0 to vps\_max\_sublayers\_minus1, inclusive. “When sps\_video\_parameter\_set\_id is equal to 0, the value of sps\_max\_sublayers\_minus1 shall be in the range of 0 to 6, inclusive, and vps\_max\_sublayers\_minus1 is inferred to be equal to sps\_max\_sublayers\_minus1.”

or

* + 1. Modify only the inference for vps\_max\_sub\_layers\_minus1 (JVET-S0049 Item 1, JVET-S0097) as: When sps\_video\_parameter\_set\_id is equal to 0, the value of vps\_max\_sublayers\_minus1 is inferred to be equal to“sps\_max\_sublayers\_minus1” (instead of 6).

It was commented that option ii has a circularity issue in the semantics of sps\_max\_sublayers\_minus1, so option i is preferred.

1. Modify the semantics of bp\_max\_sublayers\_minus1 to change the range of values from 0 to vps\_max\_sublayers\_minus1 to instead require it to be equal to maxSubLayers (given as input to the ols\_hrd\_parameters() syntax structure)? (JVET-S0097)

It was commented that this has a relationship to S0100.

See the notes for S0100 in section 3.3.

1. Modify the additional bumping process for DPB by doing following? (JVET-S0080)
   1. Move the process for setting the value of PicLatencyCount from within additional bumping process to within the output and removal of pictures from the DPB (i.e., sub clause C.5.2.2) after the invocation of bumping process.

It was commented that no action is needed on this due to the recommended action for PictureOutputFlag for S0077.

* 1. Remove the additional bumping process or removal of the output of pictures in the additional bumping process.

This aspect was deferred for further study by the HLS AHG.

This was further discussed in the JVET meeting at 1640 on 24 June (GJS). The contributor said they had concluded that there was a problem with the contribution as proposed, so the request for its consideration was withdrawn.

Discussion in the HLS AHG meeting stopped here at ~0220 on 28 May.

Discussion continued here in the HLS AHG pre-meeting at 1530 on 20 June.

1. Fix an asserted bug in Equation C.10 (also applicable to HEVC)? (JVET-S0101)

AHG Recommendation (bug fix/expression of existing intent): Adopt (also applicable to HEVC).

1. Add a constraint on the sum of InitialCpbRemovalDelay and InitialCpbRemovalOffset as follows? (JVET-S0101)

When bp\_concatenation\_flag is equal to 0, the sum of InitCpbRemovalDelay[ Htid ][ ScIdx ] and InitCpbRemovalDelayOffset[ Htid ][ ScIdx ] shall be the same as in the previous buffering period.

In the discussion, it was commented that we need to consider the possibility of splicing without the use of bp\_concatenation\_flag equal to 1. It was commented that this constraint could be a very serious imposition for such a splicing operation, and would be unlikely to be fulfilled in practice.

No action was recommended on this.

1. Include PH and AUD NAL units into the bitstream subject to HRD conformance checking using either of the following alternative options? (JVET-S0118)
   1. Include PH NAL unit and AUD in Type I bitstream
   2. Include PH NAL unit and AUD in Type II bitstream

Currently, Type I includes VCL (i.e., slices) and filler data NAL units only. Everything goes in Type II (possibly needing editorial clarification, but this is clearly what is specified).

Since PH is sometimes in the SH, it will be in Type I when it is not in a separate NAL unit.

When rewriting / BEAMing, we do not ordinarily expect PH content to be rewritten.

AHG Recommendation (consistency cleanup): Include PH NAL unit in Type I (but keep AUD in Type II as it was).

**Related to general and subpicture sub-bitstream extraction processes:**

Review of this group of contributions was deferred in the AHG, and the next topic discussed in the AHG was item 12. Discussion of these was held in the main JVET meeting at 1900 on 25 June (GJS).

1. Perform the asserted bug-fixes for the general sub-bitstream extraction process for determining which AUD NAL units of the input bitstream are kept in the output sub-bitstream as follows? (JVET-S0086)
   1. Add AUD\_NUT among the NAL unit types that are kept in the output sub-bitstream regardless of its nuh\_layer\_id value.
   2. Add removal of an AUD NAL unit for which all VCL NAL units of an AU are removed by the sub-bitstream extraction.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Make the following changes related to the general sub-bitstream extraction process? (JVET-S0102)
   1. Add a constraint that the SEI payload of the BP/PT/DUI/SLI SEI messages for any two OLSs with the same layer set are the same.

Decision (sensibility constraint): Adopt (clarified as per above).

* 1. Modification regarding AUs that become IRAP or GDR AU after extraction by doing one of the two options:
     1. Option 1: Add AUD writing to the extraction process for AUs that become IRAP AUs or GDR AUs.
     2. Option 2: Mandate AUDs to be placed in AUs that contain only IRAP or GDR pictures for the layers of an OLS that contains more than one layer, and add rewriting of aud\_irap\_or\_gdr\_au\_flag to extraction process.

Item 46) is related. One difference is whether AUD would need to be present in single-layer bitstreams.

The description of option 2 was refined in the group discussion.

It was commented that this requirement is already imposed indirectly by the fact that an extracted bitstream is required to be a conforming bitstream.

Editor action item: The editor is strongly suggested to add a NOTE (or editorial equivalent) to point out that the presence of AUDs for such AUs is indirectly required.

Decision (bug fix): Specify that when an AUD is present and the AU of the output bitstream becomes an IRAP or GDR AU, to set aud\_irap\_or\_gdr\_au\_flag equal to 1.

Editor action item: The editor is suggested to consider removing “au\_” from the name of aud\_irap\_or\_gdr\_au\_flag, since it seems redundant.

* 1. Place PT SEI messages in individual SEI NAL units when general\_same\_pic\_timing\_in\_all\_ols\_flag is equal to 1.

Item 37) is related – see the notes for JVET-S0178-v3 aspect 7.

* 1. Require that the scalable-nested and non-scalable-nested BP SEI messages in a CVS have the same values for the five syntax elements which specify lengths of various u(v) syntax elements.

Decision (consistenty cleanup): Adopt.

1. Modify the subpicture sub-bitstream extraction process regarding handling of scalable-nested SEI messages by performing following? (JVET-S0099)
   1. Removal of scalable-nested SEI messages for non-target subpictures

Item 66) is related.

* 1. Removal before replacing non-scalable-nested SEI messages

Item 72) is related.

Revisit after discussing scalable nesting SEI messages and SLI.

1. Modify the subpicture sub-bitstream extraction process by performing the following? (JVET-S0117)
   1. Remove rewriting of PPS conformance window syntax elements since pps\_conformance\_window\_flag is asserted to be equal to 0.
   2. Remove subpicture ID mapping in PPS by removing the syntax elements pps\_subpic\_id[ j ] in all the referenced PPS NAL units, for each j that is not equal to subpicIdx. (Note that the current text already addresses the SPS issue in an earlier version of the contribution.)

If the extracted subpicture is not the first subpicture and the original encoder did not explicitly provide the mapping information, then the mapping needs to be provided in the rewritten SPS.

* 1. Rewrite virtual boundary syntax elements in SPS (when they are present).

Decision (bug fixes): Adopt (all three aspects as described and refined above).

Discussion of these in the main JVET meeting ended at 2030 on 25 June (GJS).

**New submissions (for the June 10th submission deadline)**

Discussion in the AHG pre-meeting began here at 1635 on 20 June.

(Convention for text changes proposed: “quoted text” is proposed to be removed and text inside delimiters < > is proposed to be added by proposals)

**Related to HRD signalling and operation:**

1. Change HRD operation description from being picture-specific to be AU-specific as follows? (JVET-S0157 item 1)
   1. In clauses C.2.3, D.3.2, and D.4.2, rename prevNonDiscardablePic to prevNonDiscardableAu, firstPicInPrevBuffPeriod to firstAuInPrevBuffPeriod, notDiscardablePic to notDiscardableAu, and change their descriptions from being picture-specific to AU-specific.
   2. In clause D.3.2, change the description of the semantics of bp\_concatenation\_flag and bp\_cpb\_removal\_delay\_delta\_minus1 from being picture-specific to be AU-specific.
   3. In clause D.3.2, change the description of the condition for the constraint requiring bp\_alt\_cpb\_params\_present\_flag to be equal to 0 from being picture-specific to be AU-specific.
   4. In clause D.4.2, change the descriptions of BpResetFlag, CpbRemovalDelayMsb[ i ], CpbRemovalDelayVal[ i ] and the constraint requiring pt\_cpb\_alt\_timing\_info\_present\_flag to be equal to 0 from being picture-specific to be AU-specific.
   5. In clause D.4.2, change the description of the semantics of pt\_dpb\_output\_delay, pt\_dpb\_output\_du\_delay, and pt\_display\_elemental\_periods\_minus1 from being picture-specific to be AU-specific.
   6. In clause D.5.2 (DU information SEI message semantics), change the description of the semantics of dui\_dpb\_output\_du\_delay from being picture-specific to be AU-specific.

It was commented that the design intent should already be clear that the HRD is intended to operate on an AU basis. These changes are intended just as editorial expression of this existing design intent.

AHG Recommendation (editorial BF/expression of existing intent): Adopt.

1. In clause D.3.2, modify the constraint related to bp\_alt\_cpb\_params\_present\_flag as follows: (JVET-S0157 item 2):

When <the associated AU is not an IRAP or GDR AU> “the associated picture is neither a CRA picture nor an IDR picture”, the value of bp\_alt\_cpb\_params\_present\_flag shall be equal to 0.

The idea of this is to treat GDR picture with ph\_recovery\_poc\_cnt equal to 0 consistently the same as an IRAP picture. This seemed to be just a forgotten, essentially editorial, issue.

AHG Recommendation (editorial BF/expression of existing intent): Adopt as proposed.

1. In clause D.4.2, in the constraint related to requiring pt\_cpb\_alt\_timing\_info\_present\_flag to be equal to 0, add that the RASL pictures in the constraint are RASL pictures that do not have mixed NAL unit types as follows? (JVET-S0157 item 4).

When <all pictures in the associated AU are RASL pictures with pps\_mixed\_nalu\_types\_in\_pic\_flag equal to 0> “the associated picture is a RASL picture”, the value of pt\_cpb\_alt\_timing\_info\_present\_flag shall be equal to 0.

AHG Recommendation (editorial BF/expression of existing intent): Adopt as proposed.

1. In clause D.5.2, in the semantics of pt\_display\_elemental\_periods\_minus1, change fixed\_pic\_rate\_within\_cvs\_flag[ TemporalId ] (3 instances) to fixed\_pic\_rate\_within\_cvs\_flag[ Htid ]? (JVET-S0153 item 5)

AHG Recommendation (editorial BF/expression of existing intent): Adopt as proposed.

1. Modify constraints as follows: (JVET-S0175 aspect 3)?

When “fixed\_pic\_rate\_within\_cvs\_flag[ TemporalId ] is equal to 0 or sps\_field\_seq\_flag is equal to 1, the value of” <any of the following applies> pt\_display\_elemental\_periods\_minus1 shall be equal to 0.<:

– sps\_field\_seq\_flag is equal to 1 for the output layers in the OLS.

– <sps\_field\_seq\_flag is equal to 0 for all output layers of the bitstream and there is not frame-field information SEI message present or display\_fields\_from\_frame\_flag is equal to 0 if a frame-field SEI message is associated with the AU and fixed\_pic\_rate\_within\_cvs\_flag[ TemporalId ] is equal to 0.>

It was noted that the frame-field SEI message is in the SEI message specification, and it contains the display\_fields\_from\_frame\_flag. It was said that the expressed constraint on pt\_display\_elemental\_periods\_minus1 is wrong in both specs.

AHG Recommendation (editorial bug fix/expression of existing intent): Replace the constraint above with “When sps\_field\_seq\_flag is equal to 1, the value of pt\_display\_elemental\_periods\_minus1 shall be equal to 0” and to say this (or equivalent) in both specs.

1. Change the condition for fixed picture rate across CVSs, by removing the max\_dec\_pic\_buffering\_minus1 (asserted not to be needed) and adding BP SEI message syntax related to concatenation\_flag. (JVET-S0175 aspect 1, 2)

AHG Recommendation (bug fix/expression of existing intent): Adopt first aspect. (This also affects HEVC in one place.)

The second aspect would impose an extra burden that is not currently imposed when the general flag is set equal to 0. It was also commented that it may not consider picture decoding time appropriately.

No action was recommended on the second aspect.

Discussion in the HLS AHG pre-meeting stopped here with the remaining items open.

Discussion resumed here in the JVET meeting at 1935 on 23 June (GJS).

1. Make either of the following changes (JVET-S0175 aspects 4 and 5)?
   1. Add a gating flag for pt\_display\_elemental\_periods\_minus1, so that its presence can be controlled and change the derivation of elementalOutputPeriod as follows and change D.9.6 accordingly?

– If a PT SEI message is present for picture n <and pt\_display\_elemental\_periods\_present\_flag equal to 1>, elementalOutputPeriods is equal to the value of pt\_display\_elemental\_periods\_minus1 + 1.

–< Otherwise, if external means are provided to set the value of elementalOutputPeriods, elementalOutputPeriods is set equal to the value provided via external means.

– Otherwise , if frame-field information SEI messages are present for at least one of the output pictures in the AU of picture n, the value of elementalOutputPeriods is set to the lowest value of display\_elemental\_periods\_minus1 + 1 among all present frame-field information SEI messages.>

– Otherwise, elementalOutputPeriods is equal to 1.

* 1. An alternative option to a), with the key difference being that herein the main VVC specification does not depend on the frame-field information SEI message that is specified in the SEI specification.

The current text says that when the PT SEI message is not present, elementalOutputPeriods is always set to 1.

It was commented that presence of PT SEI messages could either be in the bitstream or equivalently by external means but the manner of their presence doesn’t need to be discussed everywhere that the syntax elements are discussed – e.g., since we don’t do that for SPS or PPS – that if they are present they are simply considered present, however they got there. See AVC in the first section of Annex C.

It was asked why the text has a discussion of PT SEI messages not being present at all. AVC considers that some information might not be present “in the bitstream”, but doesn’t seem to consider the idea of them not being present at all. Revisit that question.

For Item 5, we have pt\_display\_elemental\_periods\_minus1 in the PT SEI message (with OLS scope), constrained to match the display\_elemental\_periods\_minus1 in the frame-field SEI message (which is layer-specific).

A problem was identified in the definition of DisplayElementalPeriods in the proposal. This was drafted as an input to the SEI spec, not an output of it. The main spec can just refer to pt\_display\_elemental\_periods\_minus1 + 1. The SEI message spec does not need that variable.

It was commented that there may be a problem with 4-bit length of the syntax element in the frame-field information SEI message, if it is intended to be used for temporal sublayering timing. Revisit that.

The HRD is OLS specific. It was commented that we need only one elementalOutputPeriods is needed per OLS.

It was commented that perhaps the frame-field information SEI message should not be used in the example use case.

PT SEI message is for HRD.

FFI SEI message is for display.

Skipping the sytnax element in the PT SEI message?

Suggestion for revisit: Establish the modified constraint, but not modify the syntax of the PT SEI message.

1. Enable decoder operation without HRD timing SEI messages when fixed picture rate is signalled? (JVET-S0175 aspect 6). This is related to S0109 in section 3.1.2.

This relates to the question of HRD operation without any BP and PT SEI messages present if there is a fixed elemental period. Revisit (also considering S0109).

1. Conditionally signal bp\_sublayer\_initial\_cpb\_removal\_delay\_present\_flag, only when bp\_max\_sublayers\_minus1 is greater than 0 and infer it to 0 otherwise? (JVET-S0181 proposal 1, JVET S0157 item 3)

It was commented that a similar conditioning was proposed in S0064 and was recommended for adoption. See also item 21 for rationale.

Decision (cleanup): Adopt the conditional signalling.

1. Move the signalling of bp\_max\_sublayers\_minus1 to be before the signalling of bp\_cpb\_removal\_delay\_deltas\_present\_flag and conditionally signal bp\_cpb\_removal\_delay\_deltas\_present\_flag and bp\_num\_cpb\_removal\_delay\_deltas\_minus1 and bp\_cpb\_removal\_delay\_delta\_val[ i ] syntax elements, only when bp\_max\_sublayers\_minus1 is greater than 0 and infer bp\_cpb\_removal\_delay\_deltas\_present\_flag equal to 0 otherwise? (JVET-S0181 proposal 2)?

It was commented that generally we should not be signalling things about temporal sublayers if there are no temporal sublayers.

Decision (cleanup): Adopt the conditional signalling.

1. Move the syntax element pt\_cpb\_removal\_delay\_minus1[ bp\_max\_sublayers\_minus1 ]  to locate it near the other CPB removal delay syntax elements, in particular other pt\_cpb\_removal\_delay\_minus1[ i ] syntax elements (and pt\_cpb\_removal\_delay\_delta\_idx[ i ] syntax elements) for i in the range of TemporalId to bp\_max\_sub\_layers\_minus1 − 1, inclusive? (JVET-S0185 proposal 1)

Decision (cleanup): Put pt\_cpb\_removal\_delay\_minus1[ bp\_max\_sublayers\_minus1 ] first, followed by similar information for sub-layers, followed by pt\_dpb\_output\_delay, followed by the rest of the syntax in the current order.

1. Move the signalling of syntax element bp\_alt\_cpb\_params\_present\_flag to locate it near the syntax element bp\_use\_alt\_cpb\_params\_flag where it is used? (JVET-S0185 proposal 2)

Decision (cleanup): Adopt this aspect.

1. Modify the output and removal of picture from DPB as follows? (JVET-S0198)

C.5.2.2 Output and removal of pictures from the DPB

…

– Otherwise (the current AU is not a CVSS AU or the current AU is a CVSS AU that is not AU 0 but the current picture is not the first picture of the current AU), all picture storage buffers containing a picture which are marked as "not needed for output" and "unused for reference" are emptied (without output). For each picture storage buffer that is emptied, the DPB fullness is decremented by one. “When one or more of the following conditions are true, t”<T>he "bumping" process specified in clause C.5.2.4 is invoked repeatedly “while further decrementing the DPB fullness by one for each additional picture storage buffer that is emptied,” until <the number of pictures in the DPB is less than max\_dec\_pic\_buffering\_minus1[ Htid ] + 1>. “none of the following conditions are true:

* The number of pictures in the DPB that are marked as "needed for output" is greater than max\_num\_reorder\_pics[ Htid ].
* max\_latency\_increase\_plus1[ Htid ] is not equal to 0 and there is at least one picture in the DPB that is marked as "needed for output" for which the associated variable PicLatencyCount is greater than or equal to MaxLatencyPictures[ Htid ].
* The number of pictures in the DPB is greater than or equal to max\_dec\_pic\_buffering\_minus1[ Htid ] + 1.”

…

The intent of this is only editorial. The intent is clear.

It is certainly not intended for the fullness to be decremented twice when one picture is removed.

The other parts of this are just trying to remove conditions that are asserted to be redundant.

Decision (bug fix/expression of existing intent): Adopt.

1. In clause 8.1.1, add the derivation of the variables DuHrdPreferredFlag and DecodingUnitHrdFlag, similarly as in HEVC. (S0248 aspect 2 late)

Decision (bug fix/expression of existing intent): Adopt.

1. In clauses C.2.2 and C.2.3, change the local variable decodingUnitParamsFlag to be a global variable DecodingUnitParamsFlag, to address the issue that decodingUnitParamsFlag was used in clause C.2.2 without being defied/initialized. (S0248 aspect 3 late)

Editorial action item: Apply variable name convention.

1. In clause C.3.2, change the condition on when to remove decoded pictures neither needed for referecne nor needed for output such that it is applied to all pictures except for the first picture of AU 0. (S0248 aspect 4 late)

Decision (bug fix/expression of existing intent): Adopt.

1. In clause C.5.2.2, change "Otherwise (the current AU is not a CVSS AU or the current AU is a CVSS AU that is not AU 0 but the current picture is not the first picture of the current AU)" to either of the following, as the condition in the parentheses is assertedly incorrect.
   1. "Otherwise (the current AU is not a CVSS AU, <the current AU is CVSS AU 0,> or the current AU is a CVSS AU that is not AU 0 but the current picture is not the first picture of the current AU)" (S0223)
   2. "Otherwise" (S0248 aspect 5 late)

Decision (editorial bug fix): Adopt approach b.

1. In clause C.5.2.3, remove "AU n containing " from the first sentence, i.e., "The processes specified in this clause happen instantaneously when the last DU of AU n containing the current picture is removed from the CPB." (S0223, S0248 aspect 6 late)

Decision (bug fix/expression of existing intent): Adopt.

1. In clause D.3.2, add the following constraint to disallow the combination of alternative timing for the CRA/DRAP case and the decoding unit HRD mode: When bp\_alt\_cpb\_params\_present\_flag is equal to 1, the value of bp\_du\_hrd\_params\_present\_flag shall be equal to 0. (S0248 aspect 7 late)

Decision (bug fix/expression of existing intent): Adopt.

Discussion in JVET stopped here at 2320 on 23 June.

Discussion in JVET resumed here at 1650 on 24 June.

**Related to sub-bitstream extraction**

**General SEI semantics and constraints:**

1. Fix an asserted missing integration of an agreement (from JVET-Q0394) that specifies that non-scalable-nested HRD-related SEI messages apply to the OLSs that include the same set of layers as the entire bitstream (instead of only to the 0th OLS)? (JVET-S0178 aspect 1)
   1. Consequently, add a constraint such that when there is no OLS that includes the set of layers that is the same as the entire bitstream, there shall be no non-scalable-nested SEI message with payloadType equal to 0 (BP), 1 (PT), 130 (DUI), or 203 (SLI)? (JVET-S0178 aspect 1.a)
   2. And remove the constraint requiring the value of nuh\_layer\_id for an SEI NAL unit containing non-scalable-nested HRD-related SEI messages to be equal to vps\_layer\_id[ 0 ], such that the value of nuh\_layer\_id for such SEI NAL units is unconstrained, same as for the nuh\_layer\_id for DCI, VPS, AUD, and EOS NAL units? (JVET-S0178 aspect 1.b)

Decision (editorial bug fix/expression of existing intent): Adopt (S0178-v3 aspects 1, 1.a, 1.b).

1. Remove the payloadType value 203 (SLI, subpicture level information) from the VclAssociatedSeiList? (JVET-S0178-v3 aspect 2)

Decision (editorial bug fix/expression of existing intent): Adopt (S0178-v3 aspect 2).

1. Add the clarification (that was recently added to the HEVC specification as an corrigendum item) on the value ranges of tone\_map\_id, frame\_packing\_arrangement\_id, knee\_function\_id, and colour\_remap\_id, including potential collisions of the interpretation for values of these syntax elements? (JVET-S0178-v3 aspect 3)

This is purely editorial.

Editor action item: The editor is asked to attend to this issue (S0178-v3 aspect 3).

1. Add a constraint such that when general\_same\_pic\_timing\_in\_all\_ols\_flag is equal to 1, there shall be no SEI NAL units that contain a scalable-nested SEI message with payloadType equal to 1 (PT) ? (JVET-S0178-v3 aspect 4)

Decision (editorial bug fix/expression of existing intent): Adopt (S0178-v3 aspect 4).

1. Modify an existing constraint, to add the SLI SEI message, such that when an SEI NAL unit contains a non-scalable-nested SEI message with payloadType equal to 0 (BP), 1 (PT), 130 (DUI), or 203 (SLI), the SEI NAL unit shall not contain any other SEI message with payloadType not equal to 0, 1, 130, or 203? (JVET-S0178-v3 aspect 5)

Decision (editorial bug fix/expression of existing intent): Adopt (S0178-v3 aspect 5).

1. Modify an existing constraint, to add the SLI SEI message, that when an SEI NAL unit contains a scalable-nested SEI message with payloadType equal to 0 (BP), 1 (PT), 130 (DUI), or 203 (SLI), the SEI NAL unit shall not contain any other SEI message with payloadType not equal to 0, 1, 130, 203, or 133 (scalable nesting) ? (JVET-S0178-v3 aspect 6)

Decision (editorial bug fix/expression of existing intent): Adopt (S0178-v3 aspect 6).

1. Add a constraint such that when an SEI NAL unit contains an SEI message with payloadType equal to 3 (filler payload), the SEI NAL unit shall not contain any other SEI message with payloadType not equal to 3? (JVET-S0178-v3 aspect 7)

Item 9).c) above is a similar issue for PT SEI messages in individual SEI NAL units when general\_same\_pic\_timing\_in\_all\_ols\_flag is equal to 1.

Decision (editorial bug fix/expression of existing intent): Adopt (S0178-v3 aspect 7) and S0102 aspect 3.

1. Add a constraint such that when an SLI SEI message and a BP SEI message that apply to a particular OLS are present within an AU, the SLI SEI messages shall precede the BP SEI message in decoding order? (JVET-S0178-v3 aspect 8)

Decision (editorial bug fix/expression of existing intent): Adopt (S0178-v3 aspect 8).

Discussion in the main JVET meeting stopped here at 1720 on 24 June.

Discussion in the main JVET meeting resumed here at 2030 on 25 June (GJS).

**Scalable nesting SEI message:**

1. Modify semantics of sn\_num\_subpics\_minus1 (based on following options)? (Adding blue text in angle brackets and removing red text in quotes)
   1. Clarify the association of scalable-nested SEI messages for subpictures to either layers or OLS as follows? (JVET-S0173 item 2)

**sn\_num\_subpics\_minus1** plus 1 specifies the number of subpictures to which the scalable-nested SEI messages apply. <When sn\_ols\_flag is equal to 0,> the value of sn\_num\_subpics\_minus1 shall be less than or equal to the value of sps\_num\_subpics\_minus1 in the SPS referred to by the pictures <of the indicated layer. Otherwise, when sn\_ols\_flag is equal to 1, the value of sn\_num\_subpics\_minus1 shall be less than or equal to the value of sps\_num\_subpics\_minus1 in the SPS referred to by the pictures of the highest layer in the OLS with sps\_num\_subpics\_minus1 greater than 0.>

* 1. Specify the semantics of sn\_num\_subpics\_minus1 and sn\_subpic\_idx[ i ] in a way such that the syntax elements are about the subpictures of the layers with multiple subpictures per picture? (JVET-S0177 aspect 7)

<Among the layers in the OLSs (when sn\_ols\_flag is equal to 1) to which the scalable-nested SEI messages apply, or among the layers (when sn\_ols\_flag is equal to 0) to which the scalable-nested SEI messages apply, those for which the referenced SPSs have sps\_num\_subpics\_minus1 greater than 0 are referred to as the multiSubpicLayers.>

**sn\_num\_subpics\_minus1** plus 1 specifies the number of subpictures <in each picture in the multiSubpicLayers> “to which the scalable-nested SEI messages apply”. The value of sn\_num\_subpics\_minus1 shall be less than or equal to the value of sps\_num\_subpics\_minus1 in the SPS<s> referred to by the pictures in the <multiSubpicLayers> “CLVS**”**.

Revisit after offline work to harmonize the text expressions in “a” and “b”.

1. Change sn\_subpic\_id[ i ] to sn\_subpic\_idx[ i ] and remove sn\_subpic\_id\_len\_minus1 or change the semantics of sn\_subpic\_id\_len\_minus1 as follows?
   1. Per JVET-S0177 aspect 1

**sn\_subpic\_id<x>**[ i ] “indicates” <specifies the subpicture index of> the i-th subpicture “ID associated with the scalable-nested SEI messages” <in each picture in the multiSubpicLayers. The value of sn\_subpic\_idx[ i ] shall be less than or equal to the value of sps\_num\_subpics\_minus1 in the SPSs referred to by the pictures in the multiSubpicLayers.> “The length of the sn\_subpic\_id[ i ] syntax element is sn\_subpic\_id\_len\_minus1 + 1 bits.” <The scalable-nested SEI messages also apply to the single subpicure in each picture in the layers that are not in the multiSubpicLayers but are among the layers in the OLSs (when sn\_ols\_flag is equal to 1) to which the scalable-nested SEI messages apply or among the layers (when sn\_ols\_flag is equal to 0) to which the scalable-nested SEI messages apply.>

**“sn\_subpic\_id\_len\_minus1** plus 1 specifies the number of bits used to represent the syntax element sn\_subpic\_id[ i ]. The value of sn\_subpic\_id\_len\_minus1 shall be in the range of 0 to 15, inclusive.

It is a requirement of bitstream conformance that the value of sn\_subpic\_id\_len\_minus1 shall be the same for all scalable nesting SEI messages that are present in a CLVS.”

* 1. Or change semantics of sn\_subpic\_id\_len\_minus1 by changing CLVS to CVS (JVET-S0173 item 2):

**sn\_subpic\_id\_len\_minus1** plus 1 specifies the number of bits used to represent the syntax element sn\_subpic\_id[ i ]. The value of sn\_subpic\_id\_len\_minus1 shall be in the range of 0 to 15, inclusive.

It is a requirement of bitstream conformance that the value of sn\_subpic\_id\_len\_minus1 shall be the same for all scalable nesting SEI messages that are present in a C“L”VS.

It was commented that the “id” is a position-independent identifier and that using that can prevent some need for rewriting.

Decision (editorial bug fix): Adopt approach “b”.

1. Disallow containing of filler payload SEI messages in a scalable nesting SEI message? (JVET-S0177 aspect 2)

It was commented that if we do not do this, the extraction process would need to be made more complicated in order to deal with nested filler data.

Decision (bug fix of extraction process): Adopt.

1. Constrain that, when a scalable nesting SEI message contains one or more subpicture level information (SLI) SEI messages, the value of sn\_ols\_flag shall be equal to 1, and the value of sn\_subpic\_flag shall be equal to 0? (JVET-S0177 aspect 3)

This is said to be because the SLI SEI message is HRD related, so it needs to have similar constraints as for BP/PT/DUI SEI messages in regard to the sn\_ols\_flag.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Modify an existing constraint, to include the SLI message, such that when a scalable nesting SEI message contains a BP, PT, DUI, or SLI SEI message, the scalable nesting SEI message shall not contain any other SEI message with payloadType not equal to 0 (BP), 1 (PT), 130 (DUI), or 203 (SLI)? (JVET-S0177 aspect 4)

This is similar in spirit to item 42.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Modify an existing constraint, to include recently added SEI messages, such that when a scalable nesting SEI message contains an SEI message that has payloadType not equal to 132 (decoded picture hash), the SEI NAL unit containing the scalable nesting SEI message shall have nal\_unit\_type equal to PREFIX\_SEI\_NUT? (JVET-S0177 aspect 5)

Typically we have planned for SEI messages to be prefixes except decoded picture hashes, filler payload and scalable nesting.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Add a constraint such that when a scalable nesting SEI message contains an SEI message that has payloadType equal to 132 (decoded picture hash), the SEI NAL unit containing the scalable nesting SEI message shall have nal\_unit\_type equal to SUFFIX\_SEI\_NUT? (JVET-S0177 aspect 6)

This is similar in spirit to item 44.

Decision (editorial bug fix/expression of existing intent): Adopt.

**General sub-bitstream extraction:**

1. Handling of AUD in sub-bitstream extraction process (JVET-S0102 item 5, JVET-S0225)
   1. Restrict aud\_irap\_or\_gdr\_au\_flag to a one-way constraint in single-layer bitstreams as follows? (JVET-S0102 item 5).

aud\_irap\_or\_gdr\_au\_flag equal to 1 specifies that the AU containing the AU delimiter is an IRAP or GDR AU. aud\_irap\_or\_gdr\_au\_flag equal to 0 specifies that the AU containing the AU delimiter is not an IRAP or GDR AU <when NumLayersInOls[ TargetOlsIdx ] is greater than 1>.

* 1. And/or modify sub-bitstream extraction process using either one of the following two options: (JVET-S0225)
     1. Option 1: Add AUD or rewrite aud\_irap\_or\_gdr\_au\_flag of the existing AUD when the associated extracted AU is an IRAP AU or GDR AU as follows:

<When an AU is an IRAP AU or GDR AU and no associated AUD, add an AUD NAL unit of type AUD\_NUT before the first VCL NAL unit of the AU with aud\_irap\_or\_gdr\_au\_flag equal to 1. Otherwise for any existing AUD, set aud\_irap\_or\_gdr\_au\_flag equal to 1 for  an IRAP AU or GDR AU.>

* + 1. Option 2: Add AUD or rewrite aud\_irap\_or\_gdr\_au\_flag of the existing AUD when the associated AU is an IRAP AU or GDR AU and the target OLS has multi-layers; and either remove the existing AUD or rewrite aud\_irap\_or\_gdr\_au\_flag of the existing AUD when the associated AU is an IRAP AU or GDR AU and the target OLS contains only single layer as follows:

– <When the targte OLS contains more than one layer,

* For each AU that is an IRAP AU or GDR AU with no associated AUD, add a NAL unit of type AUD\_NUT before the first VCL NAL unit of the AU with aud\_irap\_or\_gdr\_au\_flag equal to 1.
* Otherwise for any existing AUD, set aud\_irap\_or\_gdr\_au\_flag equal to 1 for an IRAP AU or GDR AU.

– Otherwise (the target OLS contains only one layer), remove the associated AUD from outBitstream for each AU, or for any existing AUD, set aud\_irap\_or\_gdr\_au\_flag equal to 1 for an IRAP AU or GDR AU.>

Item 9).b) is related. See the notes for that item. No further action was determined to be needed for either aspect of this item.

1. In the general sub-bitstream extraction process, specify the conditions under which an output sub-bitstream is required to be a conforming bitstream such that the value of tIdTarget is specified to be in the range of 0 to vps\_ptl\_max\_tid[ vps\_ols\_ptl\_idx[ targetOlsIdx ] ], inclusive (instead of 0 to 6 inclusive)? (JVET-S0158 aspect 1)

This seemed purely editorial and obvious upon study.

Editor action item: The editor is suggested to include this change.

1. Specify the general sub-bitstream extraction process such that it would remove, from the output bitstream outBitstream, SEI NAL units that contain a scalable nesting SEI message with sn\_ols\_flag equal to 0 while the applicable layers as indicted in the scalable nesting SEI message does not include any layer in the target OLS? (JVET-S0158 aspect 2)

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Make the following changes to the 4th step in the general sub-bitstream extraction process? (JVET-S0158 aspect 3)
   1. Remove the redundant condition "nuh\_layer\_id is equal to LayerIdInOls[ targetOlsIdx ][ j ] for a value of j in the range of 0 to NumLayersInOls[ targetOlsIdx ] − 1 inclusive". (This is asserted to be editorial.)?

Editor action item: The editor is suggested to remove the redundant expression.

* 1. When removing from the output bitstream the VCL NAL units, instead of removing the associated SEI NAL units containing SEI messages other than the BP, PT, DUI and SLI SEI messages, remove all SEI NAL units that contain SEI messages that become not applicable to any picture or subpicture remaining in the final output bitstream? (Since this is not easy to do, another option is not to remove SEI NAL units in this step.)

It was commented that the TID should be sufficient to identify the relevant pictures, so SEI NAL units associated with an AU with a particular TID should only apply to VCL NAL units with TID greater than or equal to that value of TID.

Revisit after checking whether we have clear specification of extraction of SEI messages/NAL units associated with an AU.

1. Make the following changes to the last step in the general sub-bitstream extraction process? (JVET-S0158 aspect 4)
   1. Change the condition as follows?

When the list LayerIdInOls[ targetOlsIdx ] does not include all values of nuh\_layer\_id in all <VCL> NAL units in the bitstream <inBitstream>.

* 1. When at least one layer is removed by the extraction process, also remove all SEI NAL units that contain a non-scalable-nested SLI SEI message (same as for BP, PT, and DUI SEI messsages)?
  2. Insert SEI NAL units to directly contain those SEI messages that were scalable-nested HRD-related SEI messages that apply to the output bitstream, and remove their original container SEI NAL units from the output bitstream. When the target OLS includes only one layer, apply the same for scalable-nested non-HRD-related SEI messages?

Decision (editorial bug fix/expression of existing intent): Adopt (all three subitems).

**Subpicture level information (SLI) SEI message:**

1. Clarify the scope of Subpicture Level Information (SLI) SEI to be CVS instead of CLVS? (JVET-S0173 item 1)

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Include all layers of the OLS in MinCr related constraint for subpictures by making the following changes? (JVET-S0173 item 3):

* The sum of the NumBytesInNalUnit variables for AU 0 corresponding to the j-th subpicture shall be less than or equal to FormatCapabilityFactor \* ( Max(“SubpicSizeY[ j ]”<AuSizeMaxInSamplesY[ 0 ]>, fR \* MaxLumaSr <) >\* OlsRefLevelFraction[ i ][ j ] ÷ 256 “)” + MaxLumaSr \* ( AuCpbRemovalTime[ 0 ] − AuNominalRemovalTime[ 0 ] ) \* OlsRefLevelFraction[ i ][ j ] ) ÷ ( 256 \* MinCr ), where MaxLumaSr and FormatCapabilityFactor are the values specified in Table A.2 and Table A.3, respectively, that apply to AU 0, at level sli\_ref\_level\_idc[ i ], and MinCr and AuSizeMaxInSamplesY[ 0 ] are derived as indicated in A.4.2.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Modify the inference rule for sli\_ref\_level\_fraction\_minus1[ i ][ j ]? (JVET-S0173 item 5):

When not present, the value of sli\_ref\_level\_fraction\_minus1[ i ][ j ] is inferred to be equal to <Max( 256,> Ceil( 256 \* SubpicSizeY[ j ] ÷ PicSizeInSamplesY \* MaxLumaPs( general\_level\_idc ) ÷ MaxLumaPs( sli\_ref\_level\_idc[ i ] ) <)>− 1.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Resolve editorial notes related to subpictures as follows? (JVET-S0173 item 6):
   1. Refer to minCR and fR derivation in A.4.2.
   2. Replace PicSizeInSamplesY with PicSizeMaxInSamplesY and clarify that the picture size of the highest layer with subpictures in the OLS is taken.

Decision (editorial bug fix/expression of existing intent): Adopt (and also start the minCR and fR variable names with capital letters since they are referred to in multiple clauses).

1. Replace sps\_num\_subpics\_minus1 with sli\_num\_subpics\_minus1 in semantics of sli\_num\_ref\_levels\_minus1? (JVET-S0173 item 7)

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Modify alignment constraint of intendent subpictures by adding sps\_subpic\_treated\_as\_pic\_flag[ i ] syntax element to the clause as follows? (JVET-S0173 item 4):

– All the SPSs referred to by the layers in targetLayerSet shall have the same value of sps\_num\_subpics\_minus1 and <sps\_log2\_ctu\_size\_minus5 and> shall have the same values of sps\_subpic\_ctu\_top\_left\_x[ j ], sps\_subpic\_ctu\_top\_left\_y[ j ], sps\_subpic\_width\_minus1[ j ], sps\_subpic\_height\_minus1[ j ], and sps\_subpic\_treated\_as\_pic\_flag[ j ], respectively, for each value of j in the range of 0 to sps\_num\_subpics\_minus1, inclusive.

It was noted that these syntax elements are signalled in units of CTUs, so it doesn’t achieve the subpicture layout alignment constraint if they have different CTU sizes.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Add sli\_max\_sublayers\_minus1, sli\_sublayer\_info\_present\_flag, and a loop for sublayers for the signalled fractions and reference level indicators, to support levels for sublayers? (JVET-S0176 item 1)

It was noted that scalable nesting has support for sublayers.

It was asked whether sublayers are supported in HEVC temporal MCTS SEI messages, and the syntax of that SEI messages does not directly support that, but that functionality is supported by scalable nesting.

Decision (cleanup/consistency): Adopt.

1. Allow SLI SEI messages to be available either in the bitstream or provided through an external means not specified in this Specification? (JVET-S0176 item 2)

This is another consistency correction to treat SLI SEI messages similarly as BP/PT/DUI SEI messages.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Change the persistency scope for SLI SEI from one CVS to one or more CVSs, to be consistent with VPSs and SPSs wherein level information are or may be signalled? (JVET-S0176 item 3)

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Change the definition of subpicture sequence to cover the case when there is one or more layers with single subpicture per picture? (JVET-S0176 item 4)

This is to properly cover the case where there are multiple subpictures in an enhancement layer with other reference layers that are not split into multiple subpictures.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Require that, when an SLI SEI message is present for a CVS, the value of sps\_num\_subpics\_minus1 shall be the same for all the SPSs referenced by the pictures in the layers with multiple subpictures per picture. (JVET-S0176 item 5)?

This is similar in spirit to the previous item.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Specify the semantics of sli\_num\_subpics\_minus1 in a way such that the syntax element is about the subpictures of the layers with multiple subpictures per picture? (JVET-S0176 item 6)

This is similar in spirit to the previous item.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Make variable derivations subpicture sequence specific as follows: Add an array index, which identifies a subpicture sequence, to both the variables SubpicLevelIdc and SubpicLevelIdx, as well as to the arrays SubpicCpbSizeVcl, SubpicCpbSizeNal, SubpicBitRateVcl, and SubpicBitRateNal in the last set of constraints in the semantics of the SLI SEI message? (JVET-S0176 item 7)

This is said to be just something that was previously overlooked.

Decision (editorial bug fix/expression of existing intent): Adopt.

**Subpicture sub-bitstream extraction:**

1. Modify the specification of subpicture sequences, which when extracted, are required to be a conforming bitstream? (JVET-S0154 aspect 1)?

Across all layers, for the extraction of subpictures, it should select the subpictures in the same position for the layers that are split into multiple subpictures, and it should select the entire pictures for the layers that are not split into subpictures.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Remove VCL NAL units and their associated filler data NAL units and associated filler payload SEI messages, etc., regardless of whether there is an external means for replacing of the parameter sets? (JVET-S0154 aspect 2)

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Remove SEI NAL units containing scalable-nested SEI messages that do not apply to the output bitstream from the output bitstream? (JVET-S0154 aspect 3, also proposed in item 10.a)

A similar action was taken for the general extraction process in item 48; this is for the subpicture extraction process.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Specify the subpicture index for identifying the subpicture sequence as the subpicture index of the to-be-extracted subpictures in the layers with multiple subpictures per picture, not the layers with only one subpicture per picture? (JVET-S0154 aspect 4)

This is similar to items 60–62 in spirit.

Decision (editorial bug fix/expression of existing intent): Adopt.

1. Rewrite both general\_level\_idc and sublayer\_level\_idc[ k ] for k in the range of 0 to tIdTarget − 1, inclusive, in the referenced VPSs, when present, and in the referenced SPSs, when NumLayersInOls[ targetOLsIdx ] is equal to 1? (JVET-S0154 aspect 5)

Revisit after offline study.

1. Rewrite cpb\_size\_value\_minus1[ k ][ j ] and bit\_rate\_value\_minus1[ k ][ j ] for all values of k in the range of 0 to tIdTarget, inclusive, in the referenced VPSs, when present, and in the referenced SPSs, when NumLayersInOls[ targetOLsIdx ] is equal to 1? (JVET-S0154 aspect 6)

Revisit after offline study.

1. Specify the calculation and rewriting of the scaling window offset parameters as part of the subpicture sub-bitstream extraction process?
   1. As per JVET-S0154 aspect 7?
   2. As per JVET-S0189?

The two proposed approaches have the same intention, intended to be the same except editorial differences.

Decision (editorial bug fix/expression of existing intent): Adopt option “a”.

1. Rewrite cbr\_flag[ tIdTarget ][ j ] in the referenced VPSs, when present, and in the referenced SPSs, when NumLayersInOls[ targetOLsIdx ] is equal to 1? (JVET-S0154 aspect 8)

Revisit after offline study.

1. Insert SEI NAL units to directly contain those SEI messages that were scalable-nested HRD-related SEI messages that apply to the output bitstream, and remove their original container SEI NAL units from the output bitstream. When the target OLS includes only one layer, apply the same for scalable-nested non-HRD-related SEI messages? (JVET-S0154 aspect 9)

A similar action was taken for the general extraction process in item 50; this is for the subpicture extraction process.

Item 10.b is a subset of this proposal.

Decision (editorial bug fix/expression of existing intent): Adopt.

Discussion of the above items in the main JVET meeting stopped at 1620 on 25 June.

[JVET-S0049](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10171) AHG9/AHG8/AHG12: On parameter sets and picture header [Y.-K. Wang, L. Zhang, Z. Deng, K. Zhang (Bytedance)]

Aspect 1 of this contribution belongs to this category.

[JVET-S0064](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10186) AHG9: On Buffering Period Message Signalling [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

[JVET-S0075](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10197) AHG9: On constraints and inference values when VPS is not present [Hendry, S. Paluri, S. Kim (LGE)]

Aspect 2 of this contribution belongs to this category.

[JVET-S0097](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10219) AHG8/AHG9: Clarifications to HRD specification for single-layer and multi-layers bitstreams [V. Drugeon, T. Nishi, K. Abe, T. Toma (Panasonic)]

[JVET-S0080](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10202) AHG9: On additional bumping process in the DPB [S. Paluri, Hendry, S. Kim (LGE)]

[JVET-S0086](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10208) AHG9: On AUD NAL units in the sub-bitstream extraction process [M. M. Hannuksela (Nokia)

[JVET-S0099](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10221) AHG12: SEI message handling in subpicture extraction [R. Skupin, Y. Sanchez, K. Suehring (HHI), V. Drugeon (Panasonic)]

[JVET-S0101](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10223) AHG9: On HRD [Y. Sanchez, R. Skupin, K. Suehring, T. Schierl (HHI)]

[JVET-S0102](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10224) AHG9: On OLS extraction [R. Skupin, Y. Sanchez, K. Suehring, T. Schierl (HHI)]

[JVET-S0117](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10239) AHG12: On Subpicture sub-bitstream exaction [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-S0118](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10240) AHG9: On HRD bitstream [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-S0154](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10276) AHG9/AHG8/AHG12: On the subpicture sub-bitstream extraction process [Y.-K. Wang, Z. Deng, K. Zhang, L. Zhang (Bytedance)]

[JVET-S0157](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10279) AHG9: HRD and related cleanups [Y.-K. Wang, Z. Deng (Bytedance)]

[JVET-S0158](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10280) AHG9/AHG8: On the general sub-bitstream extraction process [Y.-K. Wang, Z. Deng (Bytedance)]

[JVET-S0173](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10295) AHG9/AHG12: Subpicture related cleanups [R. Skupin, Y. Sanchez, K. Suehring, T. Schierl (HHI)]

[JVET-S0175](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10297) AHG9: Cleanup of picture rate info and HRD operation without timing SEI messages [Y. Sanchez, R. Skupin, K. Suehring, T. Schierl (HHI)]

[JVET-S0176](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10298) AHG9: On the subpicture level information SEI message [Y.-K. Wang, Z. Deng (Bytedance)]

[JVET-S0177](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10299) AHG9: On the scalable nesting SEI message [Y.-K. Wang, Z. Deng (Bytedance)]

[JVET-S0178](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10300) AHG9: General SEI semantics and constraints [Y.-K. Wang, Z. Deng (Bytedance)]

[JVET-S0181](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10303) AHG9: On Buffering Period [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

[JVET-S0185](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10307) AHG9: On HRD Cleanups [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

[JVET-S0189](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10311) AHG9/AHG8/AHG12: On subpicture bitstream extraction process [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-S0198](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10320) AHG9: On removal of picture from DPB process [S. Paluri, Hendry, S. Kim (LGE)]

[JVET-S0223](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10345) AHG9: On picture bumping process [V. Seregin, Y. He, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-S0225](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10347) AHG 9: On AUD for sub-bitstream extraction [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

S0102-v2 item 5 is related.

[JVET-S0248](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10387) AHG9: HRD text cleanups [Y.-K. Wang (Bytedance), Y. Sanchez, R. Skupin (HHI), S. Deshpande (Sharp), V. Seregin (Qualcomm), Hendry (LGE), J. Chen (Alibaba)] [late]

Aspects 2 to 7 this contribution belong to this category.

### DCI, VUI, and SEI (3+3 – Revisit compositing SEI messages)

[JVET-S0172](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10294) AHG9: On generalized cubemap projection SEI message [Y.-H. Lee, J.-L. Lin, Y.-J. Chen, C.-C. Ju (MediaTek)]

This contribution was discussed in the HLS AHG pre-meeting at 1900 on 20 June.

This proposes the following modifications and constraints related to the generalized cubemap projection SEI message:

1. Add a condition check of gcmp\_guard\_band\_flag when deriving gcmpGuardBandSamples to prevent from accessing an uninitialized variable.
2. Add constraints on gcmp\_face\_index[ i ] and gcmp\_face\_rotation[ i ] for the hemisphere cubemap projection to guarantee that the four half faces are the ones connecting to the full face and can represent 180°×180° omnidirectional image/video. (The “if” part of the “otherwise” should be removed.)
3. Include an offset the remapping of sample locations on the half faces of the hemisphere cubemap projection.

AHG Recommendation (bug fix and sensibility constraints): Adopt.

It was asked whether each half-height / half-width is required to be an integer multiple of 2 in the 4:2:0 / 4:2:2 cases, to avoid half-chroma samples.

Offline work by the proponent was requested to establish this constraint.

This was further discussed in the main JVET meeting at 1430 on 25 June (GJS).

A -v2 version of the contribution was provided that includes the requested constraint. It was commented that although the spirit of the constraint is clear in the provided text, it may be better to derive specific variables and constrain their values rather than to use verbal expressions such as “the width of each face”.

Editor action item: The contributor and editor were asked to consider the above suggestion in the text finalization.

[JVET-S0051](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10173) AHG9: Digital signature SEI message [J. Xu, Y.-K. Wang, L. Zhang, K. Zhang (Bytedance)]

This was discussed at 2135 on 26 June (GJS).

This document proposes a digital signature SEI message. The purpose of this SEI message is to provide a mechanism to protect a video from tampering.

Digital signature provides a trusted mechanism to tell whether the data has been tampered with or not. It has been widely adopted in video communications, file protection, domain verification, etc.

To provide such a protection for video data, the contribution proposes to add a digital signature SEI message into the text. The described use cases include but are not limited to

* Secure video conference
* Telemedicine
* Copyright protection
* Source verification

This could apply also to HEVC and AVC, and is a check on a hash of the decoded picture content (or regions thereof).

The proposed hash operation is defined using pseudo-code, similarly to md5.

Comments from the discussion:

* Operation in the sample domain rather than in the compressed domain may involve a lot of data
  + The proponent noted that the purpose is verification of authenticity rather than content protection, and the checking may not be mandatory
  + The encoder could indicate application only to a region, thereby reducing the data load.
* Embedding information in the bitstream rather than carrying it in the system.
* Some participants said this seemed like a somewhat naïve approach and that various other methods have been developed that seem better.
* It was commented that it is likely to be preferred to have content verification that is *prior* to the decoding rather than decoding the video and then check it after the fact.
* It was asked how to determine the length of the signature. The proponent said this would be defined by the hash type and digital signature type.
* The syntax of the component identification signalling was discussed.
* The proposal operates as a function of the decoded picture size rather than the output picture size. This aspect was questioned.
* It was asked why not to also list the hash types that are used for the decoded picture hash SEI message. The proponent said this was because the other hash types may be more appropriate for debugging than for authentication purposes.
* It was asked where the decoder would get the key and why this was not included in the syntax. It was commented that the syntax seems incomplete (unverifiable) without a key or somewhere to get the key. The key is intended to be public, so sending the key should not be a problem. It was commented that verifying the source of the key (e.g., from a registry of keys) would also be another important aspect.
  + The proponent said the value of a key that is provided in the bitstream could simply be altered.

It was commented that this seems to be getting rather distant from video coding and a substantially different type of expertise should be involved in such a design – that this is more of a system-level functionality and expertise.

* proposal sends a DS type, hash type. It was asked why both are needed. The proponent said this was because some specifications are structured in this manner, with multiple hash types defined in the same family.
* Region definition has an interaction with BEAM applications. The operation for subpictures was considered by the proponents. Extraction involves discarding of certain SEI messages.
* It was commented that this is in among the SEI messages that relate to post-decoding operations, and was noted that many SEI messages somewhat share this characteristic.

Further study was encouraged, and should involve the question of why this should be done in the sample domain in important use cases, and should involve security experts.

[JVET-S0107](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10229) AHG9/AHG12: Recommended multi-layer composite picture SEI messages [J. Boyce (Intel)]

This was discussed at 2135 on 26 June (GJS).

There is a large amount of similarity in spirit with S0213.

Two SEI messages are proposed which describe recommended composite pictures of decoded pictures from multiple layers. The layer composite SEI message is sent for each layer and contains parameters for the current layer’s decoded picture. The recommended composite layers info SEI message applies to multiple layers, and includes parameters for each output layer set (OLS).

The proposed SEI messages provide similar functionality as described in contribution JVET-R0307.

JVET-S0108 is related.

Two SEI messages are proposed which describe recommended composite pictures of decoded pictures from multiple layers. The layer composite SEI message is sent for each layer and contains parameters for the current layer’s decoded picture. The recommended composite layers info SEI message applies to multiple layers, and includes parameters for each output layer set (OLS). A composition process is defined which uses the syntax elements from both SEI messages.

The layer composite position info SEI message applies to the decoded picture of the current layer (with the same value of nuh\_layer\_id as the SEI message). It includes syntax elements to indicate the following:

* top left vertical and horizontal position of the decoded layer picture within a composite picture, in units
* height and width of the decoded layer picture within a composite picture, in units

The recommended composite layers info SEI message contains parameters for a recommended composite pictures for each OLS, which apply to multiple layers.

A design goal is to be able to use multiple OLSs to produce different multi-layer composites.

The design concept is that there is a “master layout” and rectangular groups of these are identified by the SEI message.

This is basically using multiple layers and an SEI message to achieve something like the subpicture functionality.

° wrap-around was not considered, but could perhaps be accomplished with a semantic change.

It was asked if there is something that can be done with this that cannot be done with subpictures.

This could allow “gaps” – empty rectangles in the layout.

The layers can be sent in any order, without any availability rule.

The width and height of the rectangle in the layers would not need to be CTU-aligned.

Each rectangle is a conformance cropping window output. A generalization would allow an output rectangle that is not aligned with the boundaries of the conformance cropping windows of the constituent pictures (this would add some overhead).

The constituent pictures would all be in the same AU.

The composite would not need to be rewritten if extraction is performed.

It was commented that we may need some way to identify that certain not-yet-specified SEI messages should be retained during extraction, sort of like a VPS, regardless of their layer ID and OLS. It was said that it is possible to nest SEI messages in a way that indicates that they apply to all OLSs.

Scaling (either upscaling or downscaling) could be indicated.

Multiple layouts for the same set of pictures was not considered, but the proponent said that using an ID to select among layouts would be a way to support this.

See notes on S0108 on future course of action.

[JVET-S0108](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10230) AHG8/AHG9: Refinement of proposed positioning information SEI message of output independent layers [E. Thomas (TNO)]

This contribution was obsoleted by S0213.

[JVET-S0213](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10335) AHG8/AHG9: Refinement of proposed positioning information SEI message of output independent layers with example bitstreams [E. Thomas (TNO)]

This was discussed at 2300 on 26 June (GJS).

There is a large amount of similarity in spirit with S0107 and follows up on prior contributions JVET-R0307 and R0308 (and updates S0108).

It is asserted that the contribution aims at supporting use cases where a multi-layer bitstream with independent layers can be used. Multi-party video conferencing is considered to be a scenario where multiple participant views can be encoded as independent layers of a single multi-layer bitstream.

This contribution proposed the definition of a SEI message to signal the positioning information of each output layer for a given output layer set into a final output picture. Based on the discussion related to JVET-R0307 at JVET #18, the following changes are introduced in this contribution:

* All the layers in an OLS are connected to the same 4-connected graph, i.e. no orphan layer.
* The process creating the final output picture clarifies that cropped decoded pictures are used and not decoded pictures.
* An informative algorithm describes how to calculate the position of each cropped decoded picture in the final output picture

JVET- S0214 provides the updated software implementation in VTM based on JVET-R0308 corresponding to the presented syntax and operations in the present contribution.

Lastly, example bitstreams with different arrangements are provided in the present contribution.

Like S0213, this indicates a master layout. It differs by defining the layout using neighbour indicators to the “north, south, east and west”. Left boundary and top boundary alignment rules are provided to build a connection map.

It does not include scaling relationships. All pictures have the same sample aspect ratio.

Each rectangle is a full cropping window output picture. Some forms of empty rectangles are supported, as are partial spanning relationships. All pictures are from the same AU of the same OLS.

For some discussed hypothetical layouts, the proponent said there could be a “layer” defined that has no picture in the AU. Or the encoder could, e.g., code flat pictures to fill the regions.

This proposes only one SEI message.

The proponent said this may not be intended to support fully rich application compositing layout, but rather to just identify where identified areas are, so that a later compositor could apply more general mappings.

There was a discussion of what to do if the frame rate is different in different layers (e.g. filling in by repeating prior pictures in output order or by filling in with blank regions).

It was commented that this assumes a compositor functionality that follows the decoding process, and that such a compositor would likely operate based on (x,y) coordinates. A translation of the coordinate systems would be needed. S0107 was said to be more of an (x,y) system, with a scaling of the coordinates by some constant factor.

In terms of features, this does not have the scaling or overlapped rectangle position support proposed in S0107.

Rotation was mentioned as a potential additional functionality that could be considered.

The hypothetical combination with region-wise packing was mentioned as a possibility.

Revisit for determining future course of action. TuC output? Discuss in joint meeting.

[JVET-S0214](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10336) AHG8/AHG9: Updates on the implementation of multi-layer decoding and output independent layer arrangement in VTM [E. Thomas (TNO)]

This contribution contained software to demonstrate the functionality proposed in S0213, and was discussed together with that contribution. The software is available in the JVET gitlab repository under the proponent’s namespace. The contribution provides a link for how to obtain the software.

### HLS editorial inputs (4+3)

These contributions were discussed in the main JVET meeting during 1435–1650 on 25 June (GJS).

[JVET-S0068](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10190) AHG9: Editorial improvements on high-level syntax [S.-T. Hsiang, O. Chubach, L. Chen, Y.-W. Huang, S.-M. Lei (MediaTek)]

This contribution proposes the following editorial improvements on high-level syntax:

1. Remove a redundant check for signalling the syntax element sh\_sign\_data\_hiding\_used\_flag.
2. Remove a redundant check for deriving the variable signHidden.
3. Rename the syntax element sps\_internal\_bit\_depth\_minus\_input\_bit\_depth as sps\_min\_qp\_prime\_ts\_idc.

It was noted that a ticket #1133 had been filed to report that an outcome of the January meeting had accidentally not been reflected in the text – that “In the PH, don’t send the sign data hiding flag if the dependent quantization flag is 1.”

Decision (editorial and software bug fix): Ticket #1133 is confirmed; this January outcome on SPS signalling of SDH and DQ should be reflected in the text – the signalling dependency in the SPS between SDH and DQ is to be removed. (This invalidates aspect #1.)

For the third aspect, it was suggested that the syntax element name sps\_min\_qp\_prime\_ts\_idc should not the “\_idc” suffix, since “\_idc” is not typically used to send integer numbers.

Editor action item: The second and third aspects seem valid and the editor is strongly suggested to include them in the text.

[JVET-S0096](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10218) AHG9: On RPL syntax and semantics [J. Chen, Y. Ye, R.-L. Liao (Alibaba)]

Aspect 5 of this contribution belongs to this category.

This is a correction of the semantics of sh\_num\_ref\_idx\_active\_override\_flag.

Decision (editorial bug fix): Adopt (probably using the second suggested variation of the expression).

[JVET-S0110](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10232) AHG9: On HLS Editorial cleanup [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Aspect 2 of this contribution belongs to this category.

This aspect proposes to remove "non-IDR" from a NOTE reference picture list definition note

Decision (editorial bug fix): Adopt (either variation, or editorial equivalent).

[JVET-S0119](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10241) AHG9: Expression of existing intent for VPS/SPS/PPS syntax elements [N. Hu, V. Seregin, Y. He, M. Karczewicz (Qualcomm)]

This contribution proposes asserted fixes to the semantics of some VPS, SPS and PPS syntax elements to express the existing intent.

It was commented that perhaps “can”, “could” or “might” would be better than “may”. In this context, there may not be a difference.

Decision (editorial bug fix): Adopt.

[JVET-S0192](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10314) AHG9: On reference picture list with generating unavailable reference picture [B. Choi, S. Wenger, S. Liu (Tencent)]

Aspects 2 and 3 of this contribution belong to this category.

Aspect 2: Modify the following sentence to clarify the intention,

“For each LTRP entry in RefPicList[ 0 ] or RefPicList[ 1 ], when the picture is an STRP with the same nuh\_layer\_id as the current picture, the picture is marked as "used for long-term reference".”  
 as  
“For each LTRP entry in RefPicList[ 0 ] or RefPicList[ 1 ], when the picture is currently marked as "used for short-term reference" with the same nuh\_layer\_id as the current picture, the picture is marked as "used for long-term reference".”

It was commented that a change for aspect 2 is not strictly necessary, because an STRP is a picture that is marked as used for ST reference and an LTRP is a picture that is marked as used for LT reference. However, the first suggested rephrasing may be an improvement of editorial clarity. The second suggested rephrasing is not correct.

Editor action item: The first rephrasing proposed for aspect 2 is suggested to be considered by the editor.

Aspect 3: Add the following note to the decoding process for reference picture list construction, to inform that the bitstream conformance check of the reference picture list should be performed after generating unavailable pictures.

“NOTE 5 – When the bitstream conformance is checked with the following constraints, the conformance check should be done after invoking decoding process for generating unavailable reference pictures specified in 8.3.4.”

Editor action item: The editor is suggested to add such a NOTE, but using “is to be” rather than “should be”.

[JVET-S0194](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10316) AHG9: On editorial cleanups [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

This contribution proposes following editorial changes:

1. Remove a redundant PPS conformance window constraint that says  
   “When pps\_pic\_width\_in\_luma\_samples is equal to sps\_pic\_width\_max\_in\_luma\_samples and pps\_pic\_height\_in\_luma\_samples is equal to sps\_pic\_height\_max\_in\_luma\_samples, it is a requirement of bitstream conformance that pps\_conf\_win\_left\_offset, pps\_conf\_win\_right\_offset, pps\_conf\_win\_top\_offset, and pps\_conf\_win\_bottom\_offset, are equal to sps\_conf\_win\_left\_offset, sps\_conf\_win\_right\_offset, sps\_conf\_win\_top\_offset, and sps\_conf\_win\_bottom\_offset, respectively.”
2. Relocate ph\_gdr\_pic\_flag and ph\_inter\_slice\_allowed\_flag semantic constraints.

It was remarked that this change seemed undesirable as proposed, since it would express a constraint on a syntax element at a location in the document that is not discussing that syntax element.

Editor action item: The editor is suggested to remove the redundant condition expression identified in aspect 1.

[JVET-S0208](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10330) AHG9: Proposed fixes to HLS [M. Pettersson, R. Yu, R. Sjöberg, M. Damghanian, J. Enhorn, J. Ström, D. Liu (Ericsson)]

This contribution proposes the following eight fixes to HLS:

1. Remove the extra\_sh\_bits\_struct() and extra\_ph\_bits\_struct() structures and put their content directly in the SPS. The two structures are only used once in the VVC specification. The change was claimed to be editorial and was asserted to simplify the specification text.
2. Place the check whether pps\_cu\_chroma\_qp\_offset\_list\_enabled\_flag is 1 within the same if-clause in the PPS syntax where pps\_cu\_chroma\_qp\_offset\_list\_enabled\_flag is signalled. This is asserted to be a simple editorial improvement.
3. Modify the semantics of sh\_alf\_enabled\_flag such that sh\_alf\_enabled\_flag equal to 0 specifies that adaptive loop filter is disabled and not applied *to any* colour component in a slice. Currently sh\_alf\_enabled\_flag equal to 0 specifies that adaptive loop filter is disabled and not applied *for all* colour components in a slice.

The “not applied” language was removed in a previous discussion. Using “disabled for all” seems correct, so no further change was needed for this aspect.

1. Modify the definition of "parameter" to also include VPS and APS:

**parameter**: A syntax element of a *video parameter set (VPS),* sequence parameter set (SPS)*,* picture parameter set (PPS) *or adaptation parameter set (APS),* or the second word of the defined term quantization parameter.

This is an editorial bug fix, not just an improvement of phrasing.

Decision (editorial bug fix): Fix this problem. The suggested way to correct this error is to just remove the definition of “parameter”. It was also suggested to only use the word when referring to things in the VPS, SPS, PPS, APS (not using it for DCI, PTL, GCI syntax elements), or to QPs, or to affine model parameters, or to Rice code parameters, although the final determination of when to use the word is a matter of editorial discretion.

1. Replace the single occurrence of “prediction unit partition” in the VVC specification with “coding block”. The proponents believe this single occurrence of “prediction unit” is a remnant from text copied from HEVC and that this is reported in ticket #1040.

This was also reported in ticket #1040.

Decision (editorial bug fix): Remove the (single) use of the term “prediction unit partition”.

1. Modify the derivation process for the variable TotalNumOlss by removing the unnecessary text in italics below:

*if( vps\_max\_layers\_minus1 = = 0 )  
 TotalNumOlss = 1*  
*else* if( olsModeIdc == 4 | | olsModeIdc = = 0 | | olsModeIdc = = 1 )  
 TotalNumOlss = vps\_max\_layers\_minus1 + 1   
else *if( vps\_ols\_mode\_idc = = 2 )*  
 TotalNumOlss = vps\_num\_output\_layer\_sets\_minus1 + 1

1. Prefix all syntax elements in the dpb\_parameters(), general\_hrd\_parameters(), ols\_hrd\_parameters(), and sublayer\_hrd\_parameters() structures with "hrd\_".
2. Make sure all syntax elements for the SEI messages in the “SEI for coded bitstreams” specification have a prefix descriptive to the name of the SEI message. In particular, a suggestion is to prefix all syntax elements in the film grain characteristics SEI message with “film\_grain\_”, all syntax elements in the frame packing arrangement SEI message with “frame\_packing\_”, all syntax elements in the mastering display colour volume SEI message with “mdcv\_”, all syntax elements in the content light level info SEI message with “clli\_”, all syntax elements in the region-wise packing SEI message with “rwp\_”, and all syntax elements in the frame-field information SEI message with “ffi\_”.

Editor action item (and software to match): The editor is requested to consider items 1, 2, 6, 7, and 8 in the editing work, but prefixing syntax elements of dpb\_parameters() with “dpb\_” rather than “hrd\_” and using “fg\_” and “fp\_” for film grain and frame packing syntax elements.

Discussion of these items ended in the JVET meeting at 1650 on 25 June.

## AHG12: High-level parallelism and coded picture regions (7+5 – Closed)

[JVET-S0145](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10267) AHG12: A summary of proposals on tile, slices, and subpictures [Y.-K. Wang (Bytedance)]

This contribution was discussed in the HLS AHG meeting at 0050 UTC on Friday 29 May, in the HLS AHG pre-meeting at 1945 on 20 June, and in the main JVET meeting at 1400 on 25 June (GJS).

This contribution provides a summary of the 11 proposals on subpictures, slices, and tiles (the agenda item 3.2 in JVET-S0137 and JVET-S0237).

It is suggested that this summary, in terms of a list of proposed items, is used for the reviewing of these proposals, such that the discussions can be in a more structured and efficient manner.

**On tiles and slices**

1. Allow the value of pps\_no\_pic\_partition\_flag to be different for different PPSs that are referred to by coded pictures within a CLVS. (S0049 aspect 3, S0095 aspect 4)
   1. Alternatively, move pps\_no\_pic\_partition\_flag from the PPS to the SPS (and rename it to sps\_no\_pic\_partition\_flag). (S0095 aspect 4)

It was said that it is not clear why this constraint is in the draft and that the constraint does not seem logical. We have different flags regarding slices and tiles.

AHG Recommendation (cleanup): Remove the constraint.

1. Do either of the following to reduce the current two options for signalling of a tile containing exactly one rectangular slice to one option only: (S0095 aspect 1)
   1. Replace pps\_num\_exp\_slices\_in\_tile[ i ] with pps\_num\_exp\_slices\_in\_tile\_minus1[ i ].
   2. Change the upper limit of pps\_exp\_slice\_height\_in\_ctus\_minus1[ i ][ j ] from RowHeight[ SliceTopLeftTileIdx[ i ] / NumTileColumns ] − 1 to RowHeight[ SliceTopLeftTileIdx[ i ] / NumTileColumns ] − 2.

There isn’t really a bug or problem, but there are two ways to signal the same thing.

Approach “a” would have a bit cost penalty.

No clear need for action was evident, so no action was recommended on this.

1. For a more precise value range, change the upper limit of pps\_exp\_slice\_height\_in\_ctus\_minus1[ i ][ j ] from RowHeight[ SliceTopLeftTileIdx[ i ] / NumTileColumns ] − 1 to RowHeight[ SliceTopLeftTileIdx[ i ] / NumTileColumns ] − pps\_num\_exp\_slices\_in\_tile[ i ]. (S0095 aspect 2)

This is purely editorial.

Editor action item: The editor may wish to consider whether this would improve clarity.

1. Change the syntax condition for pps\_rect\_slice\_flag from "if( NumTilesInPic > 1 )" to "if( NumTilesInPic > 3 )", because when the number of tiles in a picture is less than 4, the shape of each slice has to be rectangular. (S0095 aspect 3)

It was commented that this seems somewhat similar in spirit to item 2. This would force the encoder to decide the slice layout at the PPS level in advance when there are fewer than 4 tiles per picture. It was commented that this imposition would be undesirable, so no action was recommended on this.

1. Change the semantics of pps\_rect\_slice\_flag to cover the case that rectangular slice is smaller than the tile. (S0095 aspect 5)

This is a correction of an error in the current semantics expression.

AHG Recommendation (editorial bug fix): Adopt.

1. The inference condition of pps\_single\_slice\_per\_subpic\_flag is changed from "When not present" to "When the value of pps\_no\_pic\_partition\_flag is equal to 1" so that pps\_single\_slice\_per\_subpic\_flag is inferred only when it is needed. (S0095 aspect 6)

This is purely editorial. (It makes no technical difference whether we make this change or not.)

Editor action item: The editor may wish to consider whether this would be an editorial improvement.

Discussion in the HLS AHG meeting stopped here at 0120 UTC on 29 May.

Discussion in the HLS AHG pre-meeting began here at 1945 on 20 June.

1. When pps\_pic\_width\_in\_luma\_samples is less than or equal to CtbSizeY, pps\_num\_exp\_tile\_columns\_minus1 and pps\_tile\_column\_width\_minus1[ i ] are skipped and inferred. (S0116 aspect 1)
   1. Alternatively, when the condition is true, the values of pps\_num\_exp\_tile\_columns\_minus1 and pps\_tile\_column\_width\_minus1[ i ] are both constrained to be equal to 0. (S0116 aspect 1)

It was commented that for subpicture position and width / height, there is a syntax condition check to optimize for the single-CTU case. In that case it was necessary to prevent a syntax problem.

It was commented that we generally avoid optimizing syntax for such corner cases.

It was asked whether the constraint is already indirectly required, and the answer was yes, so no action was recommended for this.

1. When pps\_pic\_height\_in\_luma\_samples is less than or equal to CtbSizeY, pps\_num\_exp\_tile\_row\_minus1 and pps\_tile\_row\_height\_minus1[ i ] are skipped and inferred. (S0116 aspect 1)
   1. Alternatively, when the condition is true, the values pps\_num\_exp\_tile\_row\_minus1 and pps\_tile\_row\_height\_minus1[ i ] are both constrained to be equal to 0. (S0116 aspect 1)

See item 7; this is basically the same issue.

1. When NumTilesInPic is equal to 1 and either pps\_pic\_width\_in\_luma\_samples or pps\_pic\_height\_in\_luma\_samples is less than or equal to CtbSizeY, pps\_tile\_idx\_delta\_present\_flag is skipped and inferred to be equal to 0. (S0116 aspect 2)

This raises similar issues as items 7 and 8. It was commented that a sufficient indirect constraint is already expressed.

**On subpictures**

1. Add a shortcut for signalling of subpictures layout, as follows: (S0071)
   1. Add sps\_subpic\_same\_res\_flag, equal to 1 specifies that all subpictures have the same width and height, respectively.
   2. When sps\_subpic\_same\_res\_flag is equal to 1, sps\_subpic\_width\_minus1[ i ] and sps\_subpic\_height\_minus1[ i ] are only signalled when i is equal to 0, and sps\_subpic\_ctu\_top\_left\_x[ i ] and sps\_subpic\_ctu\_top\_left\_y[ i ] are skipped for all i values.

Item 17) is related.

The proponent indicated that a uniform grid would be a typical use case.

A cross-check is in S0247. It was reported that in one OMAF example, 1500 bits could be saved in the SPS. Two other participants said they had closely checked the text and software.

A concern was expressed about adding a special case at this late stage, potentially introducing some problem.

It was asked how this handles the case where the width/height is not divisible by the expressed uniform subpicture width/height. Such a case is disallowed in the proposed shortcut mode. It was noted that in the uniform tile width/height syntax shortcut case, that issue is handled differently, by creating “leftover” areas.

It was commented that various other shortcuts had been proposed before and was suggested that it is too late to introduce a new one.

A participant commented that the use case would be common and said there is not really a need for “leftover” consideration, as this would not be expected in the use of the scheme.

It was commented that the need for repetition in the syntax is rather annoying from the encoder perspective to need to repeat the same data over and over, and that the use case would actually be common.

It was commented that at this meeting we have resisted other temptations to introduce new shortcuts.

This was further discussed in the main JVET meeting at 1400 on 25 June (GJS). Several participants had further considered the proposal offline and expressed support, as this would be a very typical use and is straightforward way to avoid a lot of unnecessary repetition in the syntax.

Decision (syntax shortcut for typical special case): Adopt.

1. When sps\_pic\_width\_max\_in\_luma\_samples and sps\_pic\_height\_max\_in\_luma\_samples are both less than or equal to CtbSizeY, sps\_num\_subpics\_minus1 is skipped and inferred to be equal to 0. (S0115 aspect 1)

This raises similar issues as items 7 and 8. It was commented that a sufficient constraint is already expressed and special handling in the syntax is not necessary.

1. Merge the three sets of constraints on the combination of subpictures and scalability, in the semantics of sps\_subpic\_treated\_as\_pic\_flag[ i ], the semantics of pps\_subpic\_id[ i ], and in the end of clause 8.3.2, respectively, to be placed in the end of clause 8.3.2, as follows (removal of those constraints from the semantics of sps\_subpic\_treated\_as\_pic\_flag[ i ] and the semantics of pps\_subpic\_id[ i ] not shown below): (S0125)

* When sps\_num\_subpics\_minus1 is greater than 0 and the current subpicture with subpicture index subpicIdx has sps\_subpic\_treated\_as\_pic\_flag[ subpicIdx ] equal to 1, it is a requirement of bitstream conformance that exactly one and not both of the following two conditions shall be true:
* The picture referred to by each active entry in RefPicList[ 0 ] or RefPicList[ 1 ] and the current picture have the same value for each of the following:
  + pps\_pic\_width\_in\_luma\_samples
  + pps\_pic\_height\_in\_luma\_samples
  + sps\_num\_subpics\_minus1
  + sps\_subpic\_ctu\_top\_left\_x[ i ], sps\_subpic\_ctu\_top\_left\_y[ i ], sps\_subpic\_width\_minus1[ i ], sps\_subpic\_height\_minus1[ i ], sps\_subpic\_treated\_as\_pic\_flag[ i ], respectively, for each value of i in the range of 0 to sps\_num\_subpics\_minus1, inclusive
  + SubpicIdVal[ subpicIdx ]
* The picture referred to by each active entry in RefPicList[ 0 ] or RefPicList[ 1 ] is an ILRP for which the value of sps\_num\_subpics\_minus1 is equal to 0.

Some constraints in the current text are expressed the same regardless of whether the subpictures are treated as pictures or not. The proponent said it was not clear that this was intentional.

It was commented that there is an important bug fix in the proposal, when the dependent layer has independent subpictures and the reference layer has non-independent subpictures. This should be disallowed and was not in the current text.

However, a different issue is having non-independent subpictures in an enhancement layer with independent subpictures in the reference layer. This is currently disallowed (intended but not fully expressed in the January 2020 Brussels output), and would be allowed in the proposal, although it is not supported by the specified extraction process. It was said that this characteristic of the proposal is undesirable, so it was agreed to disallow this case.

Modified text was requested and was provided in S0258. This was further discussed in the main JVET meeting at 1410 on 25 June (GJS).

In the last bullet, the expression needs to apply for each value of i in the range of 0 to sps\_num\_subpics\_minus1, inclusive.

Decision (bug fix/expression of existing intent): Adopt as expressed in S0258 (or editorial equivalent).

**New submissions (for the June 10th submission deadline)**

1. Add the following constraint to the semantics of sps\_subpic\_treated\_as\_pic\_flag[ ] (S0190 aspect 1):

When sps\_num\_subpics\_minus1 is equal to 0, for each CLVS of a current layer referring to the SPS, let 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, it is a requirement of bitstream conformance that all of the following conditions are true for the targetLayerSet that consists of all the layers that have the current layer as a reference layer:

– All the SPSs referred to by the layers in targetLayerSet shall have the same value of sps\_num\_subpics\_minus1 and shall have the same values of sps\_subpic\_ctu\_top\_left\_x[ j ], sps\_subpic\_ctu\_top\_left\_y[ j ], sps\_subpic\_width\_minus1[ j ], sps\_subpic\_height\_minus1[ j ], and sps\_subpic\_treated\_as\_pic\_flag[ j ], respectively, for each value of j in the range of 0 to sps\_num\_subpics\_minus1, inclusive.

– For each AU in targetAuSet, all pictures of the layers in targetLayerSet shall have the same value of SubpicIdVal[ j ] for each value of j in the range of 0 to sps\_num\_subpics\_minus1, inclusive.

It is proposed that all reference layers need to have the same subpicture layout. There seemed to be a problem with the proposed expression of this concept, so the proposed text was edited above to reflect this intent. It was commented that it is not clear that such a constraint needs to be imposed. No action was recommended unless offline study determines otherwise.

1. Add a constraint: When the value of sps\_subpic\_info\_present\_flag of the current layer is equal to 1, the value of sps\_res\_change\_in\_clvs\_allowed\_flag of the reference layers of the current layer shall be equal to 0. (S0190 aspect 2).

In the discussed case, the size of the pictures in the reference layer could change from AU to AU. It was commented that this is not necessarily a problem, as we already have resampling invoked between the base layer and enhancement layer, and changing the resampling ratio from AU to AU should not be a problem. No action was recommended unless offline study determines otherwise.

1. Infer the value of pps\_loop\_filter\_across\_tiles\_enabled\_flag to be equal to 0 (instead of 1) when not present, for consistency with the inferences of sps\_loop\_filter\_across\_subpic\_enabled\_flag[ i ] and pps\_loop\_filter\_across\_slices\_enabled\_flag. (S0160 aspect 1)

It was commented that this is purely editorial, since the flag is only inferred when there is only one tile in the picture. And since the tile boundary is also a picture boundary in that case, no loop filtering is applied for that boundary anyway.

Editor action item: The editor is asked to consider this suggested consistency improvement.

1. Add a subpicture merging software, which includes the following setup, into the VTM source code package: (S0162)

* Encoding several bitstreams, each with one subpicture per picture, using the VTM encoder.
* Merging selected encoded bitstreams into a bitstream with multiple subpictures, using provided subpicture merging software.
* Decoding a bitstream having multiple subpictures, using the VTM decoder.

The contribution was greatly appreciated for demonstration and experimentation with merging functionality. Software was provided with the contribution, but the understanding was that the merging part was the only change – the encoder and decoder were merely a copy of the existing VTM software. It was agreed to add the merging software into the VTM software package.

It was commented that the type of encoding that is done in this experiment does not show the full potential of VVC for an application, as it disables several tools that are useful.

Having more functionality added in future work is highly desirable.

It was commented that this software will need to be tested and maintained as the rest of the VTM package evolves.

1. Add a flag, sps\_raster\_scan\_order\_subpics\_flag, to the SPS, the value equal to 1 specifies that subpictures are ordered in raster scan order in each picture in the CLVS, and when this flag is equal to 1, derive the top-left CTU positions of the subpictures instead of signalling them. (S0206)

Item 10) is related.

We have a similar scheme for rectangular slices. Software was provided, and it had been cross-checked, as reported in S0250.

Relative to item 10, this would save roughly half of the bits in that special case.

It was noted that this is only an SPS-level issue, where bits are not so precious.

It was commented that other schemes for SPS-level savings were not adopted.

It was commented that the derivation process seems nontrivial.

Due to the expressed concerns and late stage of the project, no action was recommended on this.

1. Specify that the value of sps\_num\_subpics\_minus1 shall be less than MaxSlicesPerPicture. (S0236 aspect 1)

It was noted that this is purely editorial.

Editor action item: The editor is strongly suggested to consider this change (MaxSlicesPerAu rather than MaxSlicesPerPicture).

1. When pps\_subpic\_id\_mapping\_present\_flag is equal to 1, skip pps\_rect\_slice\_flag and infer it to be equal to 1. (S0236 aspect 2)

It was asked whether it would be possible to define subpicture mapping to be compatible with rectangular slices. Yes, this would be possible. However, it was reported that we already have an assumption of this constraint that is built into other parts of the syntax.

It was commented that this is too trivial a refinement to consider at this stage, so no action was recommended for this.

[JVET-S0049](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10171) AHG9/AHG8/AHG12: On parameter sets and picture header [Y.-K. Wang, L. Zhang, Z. Deng, K. Zhang (Bytedance)]

Aspect 3 of this contribution belongs to this category.

[JVET-S0071](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10193) AHG12: Cleanup of subpicture layout signalling [M. Katsumata, M. Hirabayashi, T. Suzuki (Sony)]

[JVET-S0247](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10386) Crosscheck of JVET-S0071 (AHG12: Cleanup of subpicture layout signalling) [R. Sjöberg, D. Liu, M. Damghanian (Ericsson)] [late]

[JVET-S0095](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10217) AHG12: On tile and slice partitioning related syntax and semantics [J. Chen, Y. Ye, R.-L. Liao (Alibaba)]

[JVET-S0115](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10237) AHG9: On SPS cleanups [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

Aspect 1 of this contribution belongs to this category.

[JVET-S0116](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10238) AHG9: On PPS cleanups [Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[**JVET-S0125**](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10247) **AHG9: On sub-picture constraints [V. Seregin, Y. He, Y.-J. Chang, M. Coban, M. Karczewicz (Qualcomm)]**

[JVET-S0190](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10312) AHG8/AHG9/AHG12: On reference picture resampling with scalability [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-S0160](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10282) AHG9/AHG12/AHG8: Miscellaneous HLS cleanups [Y.-K. Wang, Z. Deng, L. Zhang, K. Zhang (Bytedance)]

Aspect 1 of this contribution belongs to this category.

[JVET-S0162](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10284) AHG3/AHG12: Subpicture merging software [A. Hallapuro, M. M. Hannuksela (Nokia)]

[JVET-S0206](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10328) AHG12: Raster scan order subpictures [M. Damghanian, D. Liu, R. Sjöberg, M. Pettersson, J. Enhorn, J. Ström, R. Yu (Ericsson)]

[JVET-S0250](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10389) Crosscheck of JVET-S0206 (Raster scan order subpictures) [S. Paluri, Hendry (LGE)] [late]

[JVET-S0236](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10358) AHG9/AHG12: High-level syntax cleanups on subpictures [S.-T. Hsiang, L. Chen, O. Chubach, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-S0258](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10397) AHG9: On sub-picture constraints [[V. Seregin](mailto:vseregin@qti.qualcomm.com), Y. He, Y.-J. Chang, M. Coban, M. Karczewicz (Qualcomm), [Y.-K. Wang (Bytedance)](mailto:yekui.wang@bytedance.com), [R. Skupin (HHI)](mailto:firstname.lastname@hhi.fraunhofer.de)] [late]

This was discussed in the main JVET meeting at 1410 on 25 June (GJS). It provides text reflecting the discussion of item 12 of S0145 as requested during the discussion. See the notes for that item.

## AHG8: Layered coding and resolution adaptivity (8+5 – Closed)

### General (1+0)

[JVET-S0147](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10269) AHG8: A summary of proposals on scalability and RPR [Y.-K. Wang (Bytedance)]

When discussed in AHG pre-meeting?

This contribution was further discussed in the JVET meeting at 2030 on 22 June (GJS).

This contribution provides a summary of the 12 proposals on scalability and RPR (the agenda item 3.3 in JVET-S0137 and JVET-S0237).

It is suggested that this summary, in terms of a list of proposed items, is used for the reviewing of these proposals, such that the discussions can be in a more structured and efficient manner.

The following changes were proposed:

**On scalability**

1. When vps\_max\_layers\_minus1 is equal to 0, vps\_num\_ptls\_minus1 is skipped and inferred to be equal to 0. (S0063)

It was commented that this may not be strictly necessary but seems like a very small nice little cleanup and that since we are skipping nearby syntax elements under this condition.

AHG Recommendation (cleanup/consistency): Adopt.

1. Fix an asserted bug, that the specification allows to extract sublayers with TemporalId higher than the vps\_ptl\_max\_tid[ 0 ] + 1 for an OLS, by setting NumSubLayersInLayerInOLS[ i ][ k ] to be equal to vps\_ptl\_max\_tid[ i ] + 1, instead of vps\_max\_sublayers\_minus1 + 1, for output layers in Equation 40. (S0100 aspect 1)

AHG Recommendation (bug fix/expression of existing intent): Adopt.

1. Add the following constraint to disallow certain indirect reference layers when the value of vps\_max\_tid\_il\_ref\_pics\_plus1[ i ][ j ] is 0 for all the direct reference layers: (S0100 aspect 2)

For any two layers k and j within an OLS i, with k > j, when both NumSubLayersInLayerInOLS[ i ][ j ] and NumSubLayersInLayerInOLS[ i ][ k ] are equal to 0, j is a (direct or indirect) reference layer of k and there is a picture in layer k that is an IRAP picture or a GDR picture with ph\_recovery\_poc\_cnt equal to 0 in an AU, the picture in layer j shall also be an IRAP picture or a GDR picture with ph\_recovery\_poc\_cnt equal to 0, respectively.

It was commented that a similar constraint is already enforced by the requirement that the extracted bitstream shall be a conforming bitstream. The proposed constraint is a bit tighter than the indirect existing constraint.

Editor action item: The editor is requested to consider adding some NOTE/explanation for this aspect.

1. Do one of the following, with option b being preferred: (S0100 aspect 3)
   1. The values of vps\_ptl\_max\_tid[ i ], vps\_dpb\_max\_tid[ i ] and vps\_hrd\_max\_tid[ i ] shall be the same.
   2. (later modified) The values of vps\_dpb\_max\_tid[ vps\_ols\_dpb\_params\_idx[ j ] ] and vps\_hrd\_max\_tid[ vps\_ols\_hrd\_idx[ j ] ] shall be greater than or equal to vps\_ptl\_max\_tid[ vps\_ols\_ptl\_idx[ i ] ] for the j-th multi-layer OLS with j in the range from 0 to NumMultiLayerOlss − 1 and i as the index of the j-th multi-layer OLS among all OLSs.
   3. Infer the DPB and HRD parameters for sublayers from vps\_ols\_dpb\_max\_tid[ dpbIdx ] and vps\_hrd\_max\_tid[ hrdIdx ] up to vps\_ptl\_max\_tid[ ptlIdx ].

The idea is to have a relationship of these three values for any particular OLS.

It was said that that S0097 aspect 3 is related (see section 6.1.8).

A participant commented that approach “a” is too restrictive, and indeed that approach “b” is preferred. Another participant considered approach “a” to be better.

Approach “b” would allow to send less unnecessary syntax for HRD and DPB parameters for the various OLSs than approach “a”.

It was asked whether S0097 aspect 3 would take care of the issue by itself.

The AHG did not reach a conclusion on this and S0097 aspect 3. After offline study, this was further discussed in the JVET meeting at 2030 on 22 June (GJS), and approach b above, as modified, was suggested.

Decision (bug fix / cleanup to avoid a need for inference): Adopt option b as expressed above.

1. When not present, the value of vps\_max\_tid\_ref\_present\_flag[ i ] is inferred to be equal to 0. (S0129 aspect 1)

The contributor said this is not needed after review of the text and withdrew this aspect.

1. When vps\_all\_independent\_layers\_flag is equal to 1 and vps\_each\_layer\_is\_an\_ols\_flag is equal to 1, the value of vps\_ols\_mode\_idc is inferred to be equal to 0. (also in S0129 aspect 1)

It was noted that this is purely editorial, as the value that is inferred has no effect; this is just a matter of editorial completeness – wanting to always have some value if something is checked in a condition.

It was commented that inferring the value 0 might be confusing or incorrect, since 0 ordinarily has a semantic interpretation that is not intended here. Inferring the value 3 was suggested. Alternatively, adding an extra “if” with a comment seemed better.

Editor action item: The editor is asked to rephrase the text to avoid the problem. The suggested method is to add an extra “if” condition with a comment to explain why it is there.

**On RPR**

1. Change the value ranges of the scaling window offsets such that the scaling window width and height can be up to 16 times the picture width and height, respectively. (S0048 aspect 1)

The purpose of the change is to allow extraction of a small subpicture from a large picture while keeping the scaling window unchanged, and in the multilayer case to avoid incorrect decoding results.

It was asked whether this might have a memory bandwidth impact and concluded that it does not.

However, it was commented that there could be a bit width impact on some variables.

This is closely related to item 8 below.

The HLS AHG did not reach a conclusion on this topic. It was further discussed in the JVET meeting at 2045 on 22 June (GJS).

A revision resulting from further study had been uploaded to further constrain the range of values of the four scaling window offsets.

Decision (bug fix): Adopt as modified.

1. Change the conformance specification for subpicture sequences for the case where higher layers of an OLS contain multiple subpictures while lower layers of OLS do not use subpicture partitioning, as follows: (JVET-S0098)
   1. Support extraction of subpictures that have reference layers with only one subpicture.

This is closely related to item 7 above.

The HLS AHG did not reach a conclusion on this topic. After further study, the issue was resolved as noted above for item 7.

* 1. Change the derivation of RprConstraintsActive[ i ][ j ] to incorporate the number of subpictures in reference picture and current picture, and set RprConstraintsActive[ i ][ j ] to 1 if the two values differ.

This is to fix a clear problem in the text.

AHG Recommendation (bug fix/expression of existing intent): Adopt this aspect.

* 1. Signal a new syntax element non\_subpic\_layers\_fraction[ i ] that specifies the fraction of the bitstream level limits associated with layers in the bitstream that have sps\_num\_subpics\_minus1 equal to 0, for each i.

The current derivation is asserted to not be sensible for cases where different layers have different subpicture layouts.

AHG Recommendation (bug fix): Adopt this aspect.

* 1. Handle accumulated levels for subpicture sets by using one of the following options:
     1. Option 1: Remove the accumulation and adjust equation D.11 to use a single subpicture.
     2. Option 2: Modify equation D.10 (and D.11).

AHG Recommendation (bug fix): Adopt option 1.

1. Change the semantics of the sps\_ref\_pic\_resampling\_enabled\_flag
2. to be aligned with the derivation of the RprConstraintsActive variable, which would be set equal to 1 when one or more of the following 6 parameters differ between the current picture and the reference picture: 1) picture width, 2) picture height, 3) scaling window left offset, 4) scaling window right offset, 5) scaling window top offset, and 6) scaling window bottom offset. (S0048 aspect 2)
3. such that when sps\_ref\_pic\_resampling\_enabled\_flag equal to 1, a slice may refer to a reference picture with a different spatial resolution or a different scaling window. (S0057 aspect 1)

This is editorial – a matter of accurately describing the semantics.

Approach “a” refers to PPS content in SPS semantics, which was suggested to not be appropriate. However, it is more explicit regarding what is involved, and this was suggested to be helpful.

The phrase “spatial resolution” in approach “b” was questioned.

Editor action item: The editor is requested to clarify the semantics as appropriate.

1. Add pps\_res\_change\_in\_clvs\_allowed\_flag, and when pps\_res\_change\_in\_clvs\_allowed\_flag is equal to 0, skip pps\_pic\_width\_in\_luma\_samples and pps\_pic\_height\_in\_luma\_samples and infer their values to be equal to sps\_pic\_width\_max\_in\_luma\_samples and sps\_pic\_height\_max\_in\_luma\_samples, respectively. (S0057 aspect 2)

It was commented that this could introduce a parsing dependency problem for the tile configuration in the PPS. The proposal had not been tested with an implementation. Thus, no action was recommended for this.

1. Add either of the following constraints (S0126):
2. When sps\_res\_change\_in\_clvs\_allowed\_flag is equal to 0, all pictures in the CLVS shall have the same values of pps\_scaling\_win\_left\_offset, pps\_scaling\_win\_right\_offset, pps\_scaling\_win\_top\_offset, and pps\_scaling\_win\_bottom\_offset, respectively.
3. When sps\_res\_change\_in\_clvs\_allowed\_flag is equal to 0, a current picture in the CLVS and a reference picture having the same nuh\_layer\_id shall have the same values of pps\_scaling\_win\_left\_offset, pps\_scaling\_win\_right\_offset, pps\_scaling\_win\_top\_offset, and pps\_scaling\_win\_bottom\_offset, respectively.

It was commented that this constraint would limit some use cases and that a similar constraint had previously been considered and agreed to be undesirable (see JVET-R0058 versions 1-3 aspect 2.c).

No clear problem was agreed to exist, so no action was recommended on this.

**New submissions (for the June 10th submission deadline)**

Discussion continued here in the JVET meeting at 2055 on 22 June (GJS).

1. Change Equation 37 as follows, considering that a reference layer can only be a lower layer: (S0169 aspect 2) (additions in **bold and bigger fonts**, removals in *italic and smaller fonts*)

for( i = 0; i <= vps\_max\_layers\_minus1; i++ ) {  
 for( j = 0; j **< i**  *<= vps\_max\_layers\_minus1*; j++ ) {  
 dependencyFlag[ i ][ j ] = vps\_direct\_ref\_layer\_flag[ i ][ j ]  
 for( k = **j+1** *0* ; k < i; k++ )  
 if( vps\_direct\_ref\_layer\_flag[ i ][ k ] && dependencyFlag[ k ][ j ] )  
 dependencyFlag[ i ][ j ] = 1  
 }  
 LayerUsedAsRefLayerFlag[ i ] = 0  
}  
for( i = 0; i <= vps\_max\_layers\_minus1; i++ ) {  
 for( j = 0, d = 0, r = 0; j **< i**  *<= vps\_max\_layers\_minus1*; j++ ) { (37)  
 if( vps\_direct\_ref\_layer\_flag[ i ][ j ] ) {  
 DirectRefLayerIdx[ i ][ d++ ] = j  
 LayerUsedAsRefLayerFlag[ j ] = 1  
 }  
 if( dependencyFlag[ i ][ j ] )  
 RefLayerIdx[ i ][ r++ ] = j  
 }  
 NumDirectRefLayers[ i ] = d  
 NumRefLayers[ i ] = r  
}

This is intended to be purely editorial.

Some fear was expressed in whether this modification might have some bug in it unless it is well tested; it had not been tested.

The current expression is from HEVC; we’re pretty confident that it works.

No action was taken on this.

1. Do either of the following, considering that assertedly vps\_num\_output\_layer\_sets\_minus1 is signalled when vps\_max\_layers\_minus1 is greater than 0 (and when vps\_ols\_mode\_idc is equal to 2) and in this case there are at least two OLSs: (S0183 aspect 1)
   1. Change vps\_num\_output\_layer\_sets\_minus1 to vps\_num\_output\_layer\_sets\_minus2.
   2. Add a constraint: The value of vps\_num\_output\_layer\_sets\_minus1 shall be greater than 0.

Decision (cleanup to specify a coding that is sensible for the value range): Adopt approach “a”.

1. Add a flag for each multi-layer OLS (except the first one) to indicate whether the OLS DPB picture width, height, chroma format, and bit depth values are the same as the values for the previous multi-layer OLS, and if the flag is equal to 1, these fields are skipped and inferred. (S0183 aspect 2)

This is a syntax shortcut for the VPS. Multiview is an example case. Item 16 is an alternative approach.

This is not a bug fix, just a proposed avoidance of unnecessary repetition.

No action seemed necessary on this, so no action was taken.

1. Change to code the vps\_ols\_dpb\_pic\_width[ i ] and vps\_ols\_dpb\_pic\_height[ i ] in units of 8 luma samples, considering that assertedly the decoded picture width and height in a CLVS are constrained to be an integer multiple of Max( 8, MinCbSizeY ). (S0212 aspect 1)

It was commented that we should also do this for SPS and PPS picture width and height, as the way it is currently done is simply wasteful.

It was asked whether we might be able to (and interested in) create some future profile in which the multiple-of-8 constraint is relaxed.

It was commented that we should at least limit the scope of the discussion to just the VPS topic, as we have used the existing coding in HEVC. There was some reluctance to apply the idea to one but not the other.

In AVC it was in units of macroblocks (16×16).

No action seemed necessary on this, so no action was taken.

1. Instead of signalling a set of width, height, chroma format, and bit depth of a DPB picture storage buffer for each multi-layer OLS in the VPS, signal these DPB parameters in the dpb\_parameters( ) syntax strucures, each of which (per the existing VVC text) can be shared by two or more OLSs. (S0160 aspect 10 late)

Item 14 above is similar in spirit. This moves syntax into an existing mechanism rather than adding a new mechanism. It was discussed whether the max picture format is more or less naturally shared as max reordering, max latency and max DPB size.

No action seemed necessary on this, so no action was taken.

1. Specify that the ue(v)-coded vps\_ols\_dpb\_bitdepth\_minus8[ i ] shall be in the range of 0 to 8, inclusive, considering that the value range is currently missing. (S0212 aspect 2)

This is purely editorial, just to try to have a specified value range for every syntax element (except picture width and height, apparently).

Editor action item: It is suggested to specify a value range of 0 to 2 for bitdepth\_minus8.

1. In Equation 41, replace vps\_ptl\_max\_tid[ 0 ] with vps\_ptl\_max\_tid[ vps\_ols\_ptl\_idx[ 0 ] ] and vps\_ptl\_max\_tid[ i ] with vps\_ptl\_max\_tid[ vps\_ols\_ptl\_idx[ i ] ] (for all the instances). (S0248 aspect 1 late)

Decision (editorial bug fix/expression of existing intent): Adopt.

### Scalability cleanups (3+5)

[JVET-S0063](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10185) AHG9: On VPS Signalling [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

[JVET-S0100](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10222) AHG9: On OLS and sublayers [Y. Sanchez, R. Skupin, K. Suehring, T. Schierl (HHI), Y. He, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-S0129](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10251) AHG9: cleanup on parameter sets and GCI [L. Li, X. Li, B. Choi, S. Wenger, S. Liu (Tencent)]

Aspect 1 of this contribution belongs to this category.

[**JVET-S0160**](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10282) **AHG9/AHG12/AHG8: Miscellaneous HLS cleanups [Y.-K. Wang, Z. Deng, L. Zhang, K. Zhang (Bytedance)]**

Aspect 10 of this contribution belongs to this category.

[JVET-S0169](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10291) AHG9: Miscellaneous Cleanups for HLS [B. Wang, S. Esenlik, H. Gao, E. Alshina (Huawei)]

Aspect 2 of this contribution belongs to this category.

[JVET-S0183](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10305) AHG9: On VPS Information Signalling [S. Deshpande, J. Samuelsson, A. Segall, P. Cowan (Sharp)]

[JVET-S0212](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10334) AHG9: Modifications on VPS OLS DPB related parameters [R. Yu, M. Pettersson, R. Sjöberg, M. Damghanian, J. Enhorn, J. Ström, D. Liu (Ericsson)]

[JVET-S0248](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10387) AHG9: HRD text cleanups [Y.-K. Wang (Bytedance), Y. Sanchez, R. Skupin (HHI), S. Deshpande (Sharp), V. Seregin (Qualcomm), Hendry (LGE), J. Chen (Alibaba)] [late]

Aspect 1 of this contribution belongs to this category.

### Reference picture resampling (RPR) cleanups (4+0)

[JVET-S0048](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10170) AHG9/AHG8: On reference picture resampling [Y.-K. Wang, Z. Deng, K. Zhang, L. Zhang (Bytedance)]

[JVET-S0098](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10220) AHG9/12: On subpicture conformance [R. Skupin, Y. Sanchez, K. Suehring, T. Schierl (HHI)]

[JVET-S0057](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10179) AHG8/AHG9: On signaling reference picture resampling [B. Choi, S. Wenger, S. Liu (Tencent)]

[JVET-S0126](http://phenix.int-evry.fr/jvet/doc_end_user/current_document.php?id=10248) AHG8: On scaling window constraint [Y.-J. Chang, V. Seregin, Y. He, A. K. Ramasubramonian, M. Coban, M. Karczewicz (Qualcomm)]

# Complexity analysis (0)

# Encoder optimization (0)

# Metrics and evaluation criteria (0)

# Withdrawn (1)

Section kept for future use.

JVET-S0220 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 XXday XX June 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:

Track A:

Track B:

## Joint meeting XXday XX June XXXX-XXXX

Profiles and tools in profiles were discussed (see section 4.9).

* S0187 profile without scalability and subpicture support

NB ballot comments were also noted. [add detail]

TR on BD-PSNR

*Future work*

See section 4.5 for technical work on the coding of content with bit depths beyond what is supported in VVC v1.

See S0091 aspect 1 and S0202 aspect 2 regarding scalability support in still picture profiles, esp. to consider whether such a profile should be specified in a *future* version of VVC. The “progressive refinement SEI message” and multiview, multi-camera, multiexposure, multi-focal-length usage were mentioned as related.

Some additional types of scalability, such as ROI scalability, could potentially be studied in future work.

TR v3 on codepoint usage.

2–4 SEI messages proposed, as recorded in section 6.1.9.

## Closing plenary meeting Wednesday XX June 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:

The status of work was discussed

* CTC on chroma QP offsets 4.x – further study was requested
  + …
* Open input reviews and revisits
  + …
* Project development discussion (section 4.1)
  + …
* 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.]

# 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 (update with expectation of lower work load?):

* 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 (better Fri/Sat?) prior to such meetings and closing it at lunchtime on the last day of the WG 11 meeting – a total of 9.5 meeting days).

In cases where an exceptionally high workload is expected for a meeting, an earlier starting date may be defined.

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

* Wed. 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.
* Wed. 7 – Fri. 16 July 2021, 23rd meeting under WG 11 auspices in Prague, CZ.

The agreed document deadline for the 20th JVET meeting was planned to be XXday XX Oct. 2020.

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 19h JVET meeting was closed at approximately XXXX hours UTC on Wednesday 1 July 2020.

# Annex A to JVET report: List of documents

# Annex B to JVET report: List of meeting participants

The participants of the nineteenth meeting of the JVET, according to an attendance sheet circulated during the meeting sessions (approximately XXX people in total), were as follows: