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| **Joint Video Experts Team (JVET)**  **of ITU-T SG21 WP3/21 and ISO/IEC JTC 1/SC 29**  38th Meeting, by teleconference, 26 March – 4 April 2025 | Document: JVET-AL\_notes\_d3 |

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| *Title:* | **Meeting Report of the 38th Meeting of the Joint Video Experts Team (JVET), by teleconference, 26 March – 4 April 2025** | | |
| *Status:* | Report document from the chair of JVET | | |
| *Purpose:* | Report | | |
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| *Source:* | Chair of JVET | | |

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# Summary

The Joint Video Experts Team (JVET) of ITU-T WP3/21 and ISO/IEC JTC 1/‌SC 29 held its thirty-eighth meeting during 26 March – 4 April 2025 meeting as an online-only meeting.

For ISO/IEC purposes, JVET is alternatively designated ISO/IEC JTC 1/‌SC 29/‌WG 5, and this was the nineteenth meeting as WG 5. The JVET meeting was held under the chairmanship of 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 2.16 of this document. It is further noted that work items which had originally been conducted by the Joint Collaborative Team on Video Coding (JCT-VC) were continued in JVET as a single joint team, and explorations towards possible future need of standardization in the area of video coding are also conducted by JVET, as negotiated by the parent bodies.

The JVET meeting began at approximately 0500 UTC on Wednesday 26 March 2025. Meeting sessions were held on all days except the weekend days of Saturday and Sunday 29 and 30 March 2025, until the meeting was closed at approximately XXX hours UTC on Friday 4 April 2025. Approximately XXX people attended the JVET meeting, and approximately XXX input documents (not counting crosschecks, reports, and summary documents), 18 AHG reports, 2 EE summary reports, XX BoG report(s), and XX incoming liaison document(s) were discussed. The meeting took place in coordination with a meeting of various SC29 Working Groups and Advisory Groups – where WG 5 is representing the Joint Video Coding Team(s) and their activities from the perspective of the SC 29 parent body, under whose auspices this JVET meeting was held. The subject matter of the JVET meeting activities consisted of work on further development and maintenance of the twin-text video coding technology standards *Advanced Video Coding* (AVC), *High Efficiency Video Coding* (HEVC), *Versatile Video Coding* (VVC)*, Coding-independent Code Points (Video)* (CICP), and *Versatile Supplemental Enhancement Information Messages for Coded Video Bitstreams* (VSEI), as well as related technical reports, reference software and conformance testing packages. Further important goals were reviewing the results of the Exploration Experiment (EE) on Neural Network-based Video Coding, of the EE on Enhanced Compression beyond VVC capability, of other technical input on novel aspects of video coding technology, and to plan next steps for investigation of candidate technology towards further standard development.

As a primary goal, the JVET meeting reviewed the work that had been performed in the interim period since the thirty-seventh JVET meeting in producing the following documents:

a) JVET documents

* JVET-AK1004 Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP
* JVET-AK1006 HEVC additional profiles and SEI messages, also issued as WG 5 CDAM N 336
* JVET-AK1017 Support for additional VSEI messages in AVC (draft 1)
* JVET-AK2005 Additions and corrections for VVC version 4 (Draft 11), also issued as WG 5 preliminary DAM update N 337
* JVET-AK2006 Additional SEI messages for VSEI version 4 (Draft 5), also issued as WG 5 preliminary DAM update N 335
* JVET-AK2010 VTM and HM common test conditions and software reference configurations for SDR 4:2:0 10 bit video
* JVET-AK2019 Description of algorithms version 10 and software version 12 in neural network-based video coding (NNVC)
* JVET-AK2020 Film grain synthesis technology for video applications ed. 2 (Draft 2)
* JVET-AK2023 Exploration experiment on neural network-based video coding (EE1)
* JVET-AK2024 Exploration experiment on enhanced compression beyond VVC capability (EE2)
* JVET-AK2025 Algorithm description of Enhanced Compression Model 16 (ECM 16)
* JVET-AK2026 Testing of video coding technology beyond conditions of exploration experiments
* JVET-AK2030 Optimization of encoders and receiving systems for machine analysis of coded video content (draft 8)
* JVET-AK2032 Technologies under consideration for future extensions of VSEI (version 7)
* JVET-AK2038 Draft white paper on VSEI
* JVET-AK2039 Announcement of JVET AHG17 Meeting, Aachen (Germany), 10-12 March 2025

b) documents produced as WG 5 documents only:

* WG 5 N 338 Request for ISO/IEC 23090-15 Conformance testing for VVC (3rd ed.)
* WG 5 N 340 Request for ISO/IEC 14496-10:202x (11th ed.) Amd.1 Support for additional SEI messages

c) document forwarded by JVET and Q6/21 for ITU-T agreement:

* SG21 TD44R1/Plen H-Series Supplement 21 (ex. H.Sup-FGST) Film grain synthesis technology for video applications

As main results, the JVET produced XX output documents from the current meeting (update):

* JVET-AK1004 Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP
* JVET-AK1006 HEVC additional profiles and SEI messages, also issued as WG 5 CDAM N 336
* JVET-AK1017 Support for additional VSEI messages in AVC (draft 1)
* JVET-AK2005 Additions and corrections for VVC version 4 (Draft 11), also issued as WG 5 preliminary DAM update N 337
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* JVET-AK2020 Film grain synthesis technology for video applications ed. 2 (Draft 2)
* JVET-AK2023 Exploration experiment on neural network-based video coding (EE1)
* JVET-AK2024 Exploration experiment on enhanced compression beyond VVC capability (EE2)
* JVET-AK2025 Algorithm description of Enhanced Compression Model 16 (ECM 16)
* JVET-AK2026 Testing of video coding technology beyond conditions of exploration experiments
* JVET-AK2030 Optimization of encoders and receiving systems for machine analysis of coded video content (draft 8)
* JVET-AK2032 Technologies under consideration for future extensions of VSEI (version 7)
* JVET-AK2038 Draft white paper on VSEI
* JVET-AK2039 Announcement of JVET AHG17 Meeting, Aachen (Germany), 10-12 March 2025

The following X documents were produced as WG 5 documents only, without a corresponding JVET output document or direct repetition of their content in this meeting report:

* WG 5 N 338 Request for ISO/IEC 23090-15 Conformance testing for VVC (3rd ed.)
* WG 5 N 340 Request for ISO/IEC 14496-10:202x (11th ed.) Amd.1 Support for additional SEI messages

For the organization and planning of its future work, the JVET established XX “ad hoc groups” (AHGs) to progress the work on particular subject areas. At this meeting, X Exploration Experiments (EE) were defined. The next eight JVET meetings were planned for 26 June – 4 July 2025 under ISO/IEC JTC 1/‌SC 29 auspices in Daejeon, KR; during 3 – 12 October 2025 under ITU-T SG21 auspices in Geneva, CH; during 14 – 23 January 2026 under ISO/IEC JTC 1/‌SC 29 auspices, to be conducted as teleconference meeting; during 24 April – 1 May 2026 under ISO/IEC JTC 1/‌SC 29 auspices in Santa Eulària, ES; during 7 – 15 July 2026 under ITU-T SG21 auspices in Geneva, CH; during 14 – 23 October 2026 under ISO/IEC JTC 1/‌SC 29 auspices in Hangzhou, CN; during January 2027 under ISO/IEC JTC 1/‌SC 29 auspices, date and location t.b.d.; and during April 2027 under ITU-T SG21 auspices, date and location t.b.d.

The document distribution site <https://jvet-experts.org/> was used for distribution of all documents. It was noted that the previous sites <http://phenix.int-evry.fr/jvet/>, <http://phenix.int-evry.fr/jct/>, and <http://phenix.int-evry.fr/jct3v/> were shut down, but the most recent versions of JCT-VC and JCT-3V documents can now be accessed directly via the JVET site, whereas all uploaded versions are also available from <http://wftp3.itu.int/av-arch/jctvc-site/> and <http://wftp3.itu.int/av-arch/jct3v-site/>, respectively.

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 21 Visual Coding Experts Group (VCEG) and ISO/IEC JTC 1/‌SC 29/‌WG 5. The parent bodies of the JVET are ITU-T WP3/21 and ISO/IEC JTC 1/‌SC 29.

The Joint Video Experts Team (JVET) of ITU-T WP3/21 and ISO/IEC JTC 1/‌SC 29 held its thirty-eighth meeting during 26 March – 4 April 2025 meeting as an online-only meeting.

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 the *Versatile Video Coding* (VVC) and *Versatile Supplemental Enhancement Information Messages for Coded Video Bitstreams* (VSEI) standards, as well as associated conformance test sets, reference software, verification testing, and non-normative guidance information. Furthermore, starting from the twentieth meeting, work items which had originally been conducted by the Joint Collaborative Team on Video Coding (JCT-VC) were continued to be conducted in JVET as a single joint team, as negotiated by the parent bodies. This particularly consists of work on:

* *High Efficiency Video Coding* (HEVC) and its extensions, the development of associated conformance test sets, reference software, verification testing, and non-normative guidance information,
* Specification of *Coding-independent Code Points (Video)* (CICP), and associated technical report(s),
* Maintenance and enhancement work on the *Advanced Video Coding* (AVC) standard, associated conformance test sets and reference software.

Furthermore, explorations towards possible future need of standardization in the area of video coding are also conducted by JVET. Currently, the following topics are under investigation:

* Exploration on Neural Network-based Video Coding
* Exploration on Enhanced Compression beyond VVC capability

As requested by the parent bodies, JVET is currently also preparing a call for evidence on video compression with capability beyond existing standards.

This report contains three important annexes, as follows:

* Annex A contains a list of the documents of the JVET meeting
* Annex B contains a list of the meeting participants, as recorded by the teleconferencing tool used for the meeting
* Annex C contains the meeting recommendations of ISO/IEC JTC 1/‌SC 29/‌WG 5 for purposes of results reporting to ISO/IEC.

## 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/2025_03_AL_Virtual/>.

## Primary goals

As a primary goal, the JVET meeting reviewed the work that was performed in the interim period since the thirty-seventh JVET meeting in producing the following output documents:

a) JVET documents

* JVET-AK1004 Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP
* JVET-AK1006 HEVC additional profiles and SEI messages, also issued as WG 5 CDAM N 336
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c) document forwarded by JVET and Q6/21 for ITU-T agreement:

* SG21 TD44R1/Plen H-Series Supplement 21 (ex. H.Sup-FGST) Film grain synthesis technology for video applications

Further important goals were reviewing the results of the EE on Neural Network-based Video Coding, of the EE on Enhanced Compression beyond VVC capability, of other technical input on novel aspects of video coding technology, and planning next steps for investigation of candidate technology towards further standard development.

## Documents and document handling considerations

### General

The document distribution site <https://jvet-experts.org/> was used for distribution of all documents.

Document 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 follow the CEST timezone (local time in Geneva), except as otherwise noted.

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 one of the various software packages but have no normative effect on text are marked by the string “Decision (SW):”.
* Decisions that fix a “bug” in one of the test model descriptions such as VTM, HM, etc. (an error, oversight, or messiness) or in the associated software package are marked by the string “Decision (BF):”.
* Decisions that are merely editorial without effect on the technical content of a 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.
* Other parenthetical comments may be used for describing the impact or motivation of a decision. Some decisions are recorded with the word “agreed” rather than “Decision:”, especially for work items under study, non-normative, editorial and planning matters.

This meeting report is based primarily on notes taken by the JVET chair. 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. Expressions such as “X.XX%” indicate that the desired results were not available at the time the information was recorded.

### Late and incomplete document considerations

The formal deadline for registering and uploading non-administrative contributions had been announced as Wednesday, 19 March 2025. Any documents uploaded after 1159 hours Paris/Geneva time on Thursday 20 March 2025 were considered “officially late”, with 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.

All contribution documents with registration numbers higher than JVET-AL0239 were registered after the “officially late” deadline (and therefore were also uploaded late). However, some documents in the “late” range might include break-out activity reports that were generated during the meeting, or documents which were requested to be produced for the purpose of improving specification text, and are therefore better considered as report documents rather than as late contributions.

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 has been 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 has been 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-AL0XXX (a proposal on …), uploaded 03-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.

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

* JVET-AL0XXX (a study on …), uploaded 03-XX,
* … .

All cross-verification reports at this meeting were registered late, and/or 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 contribution registrations were noted that were later cancelled, withdrawn, never provided, were cross-checks of a withdrawn contribution, or were registered in error: JVET-AL0088, JVET-AL0089, JVET-AL0090, JVET-AL0146, JVET-AL0163, JVET-AL0170, JVET-AL0172, JVET-AL0180, JVET-AL0267, JVET-AL0318, … .

The following cross-verification reports were still missing by the end of the meeting, but were uploaded later: JVET-AL0XXX, … . The following reports had not become available yet three weeks after the end of the meeting: JVET-AL0XXX, … . These were marked as withdrawn by the JVET chair, assuming the registration had become obsolete.

“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 be counted as a late contribution if the update was after the document deadline). At the current meeting, this situation did apply to documents JVET-AL0183, and JVET-AL0195 which were initially empty of results and were flagged as late in the list above, based on the time of the first reasonable document upload.

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.

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 may have been some expression of annoyance and remarks on the difficulty of dealing with late contributions and late revisions.

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.). Any such 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 may have also 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-AK1000, the Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP JVET-AK1004, the HEVC additional profiles and SEI messages (draft 2) JVET-AK1006, the Support for additional SEI messages in AVC (draft 1) JVET-AK1017, the Additions and corrections for VVC version 4 (Draft 11) JVET-AK2005, the Additional SEI messages for VSEI version 4 (Draft 5) JVET-AK2006, the VTM and HM common test conditions and software reference configurations for SDR 4:2:0 10 bit video JVET-AK2010, the Description of algorithms version 10 and software version 12 in neural network-based video coding (NNVC) JVET-AK2019, the Film grain synthesis technology for video applications ed. 2 (Draft 2) JVET-AK2020 (not delivered yet by beginning of the 38th meeting), the Description of the EE on Neural Network-based Video Coding JVET-AK2023, the Description of the EE on Enhanced Compression beyond VVC capability JVET-AK2024, the Algorithm description of Enhanced Compression Model 16 (ECM 16) JVET-AK2025, the Testing of video coding technology beyond conditions of exploration experiments JVET-AK2026, the Optimization of encoders and receiving systems for machine analysis of coded video content (draft 8, for future updates) [JVET-AK2030](https://jvet-experts.org/doc_end_user/current_document.php?id=12584), the Technologies under consideration for future extensions of VSEI (version 7) JVET-AK2032, the Draft white paper on VSEI JVET-AK2038, and the Announcement of JVET AHG17 Meeting in Aachen, DE, 10-12 March 2025 JVET-AK2039, had been completed and those which were available were approved. In a few cases, the corresponding WG 5 N-numbered documents had not yet been uploaded, and this was requested to be done as soon as possible. The software implementations of VTM versions 23.7 and 23.8, ECM versions 16.0 and 16.1, and NNVC version 12.0 were also approved.

Only minor editorial issues were found in the meeting report JVET-AK1000; no need to produce an update was identified (see section 2.14 for details).

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 WP3/21 or ISO/IEC JTC 1/‌SC 29/‌WG 5 (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 through the ISO Meetings website for ISO/IEC experts, and through the Q6/21 rapporteur for ITU-T experts. The password for meeting access had been sent to registered participants via these channels. Links to the Zoom sessions (without the necessary password) were available in the posted meeting logistics information and the calendar of meeting sessions in the JVET web site.

The following rules were established for those participating remotely via Zoom teleconference meeting:

* 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. The online queue will be interleaved with the room queue, though it may not always be guaranteed that the sequence perfectly follows the sequence by which hand raising occurred.
* Stay muted unless you have something to say. People are muted by default when they join and 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).
* Identify who you are and your affiliation when you begin speaking. The same applies for speakers in the room to let online participants know who is speaking.
* Use your full name and company/organization and country affiliation in your joining information, since the participation list of Zoom would also be used to compile the online part of attendance records.
* Turn on the chat window and watch for chair communication and side commentary there as well as by audio.
* Generally, do not use video for the teleconferencing calls in order to avoid overloading internet connections; enable only voice and screen sharing.
* Extensive use of screen sharing is encouraged, to enable participants to view the presented material and the meeting notes. At times, multiple sources of screen sharing may be enabled, so it may be necessary for participants to understand that this is happening and to understand how to select which shared screen they want to see.

## Agenda

The agenda for the meeting, for the further development and maintenance of the twin-text video coding technology standards *Advanced Video Coding* (AVC), *High Efficiency Video Coding* (HEVC), *Versatile Video Coding* (VVC)*, Coding-independent Code Points (Video)* (CICP), and *Versatile Supplemental Enhancement Information Messages for Coded Video Bitstreams* (VSEI), as well as related technical reports, software and conformance packages, was as follows:

* Opening remarks and review of meeting logistics and communication practices
* Roll call of participants
* Approval of the agenda
* Code of conduct policy reminder
* IPR policy reminder and declarations
* Contribution document allocation
* Review of results of the previous meeting
* Review of target dates
* Reports of ad hoc group (AHG) activities
* Report of exploration experiment on neural-network-based video coding (EE1)
* Report of exploration experiment on enhanced compression beyond VVC capability (EE2)
* Consideration of contributions on high-level syntax
* Consideration of contributions and communications on project guidance
* Consideration of video coding technology contributions
* Consideration of contributions on conformance and reference software development
* Consideration of contributions on software development in exploration activities
* Consideration of contributions on coding-independent code points for video signal type identification
* Consideration of contributions on film grain synthesis technology
* Consideration of contributions on gaming content compression
* Consideration of contributions on generative face video compression
* Consideration of contributions on optimization of encoders and receiving systems for machine analysis of coded video content
* Consideration of contributions on testing video coding technology beyond common testing conditions, and preparation of a call for evidence towards future video coding standardization
* Consideration of contributions on aspects of ultra-low latency and packet loss resilience in the context of video compression
* Consideration of contributions on errata relating to standards in the domain of JVET
* Consideration of contributions on technical reports relating to standards and exploration study activities in the domain of JVET
* Consideration of contributions providing non-normative guidance relating to standards and exploration study activities in the domain of JVET
* Consideration of information contributions
* Consideration of future work items
* Coordination of visual quality testing
* Liaisons, coordination activities with other organizations
* Review of project editor and liaison assignments
* 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, future meeting planning, other planning issues
* Other business as appropriate for consideration
* Closing

The agenda was approved as suggested.

* The plans for the times of meeting sessions were established as follows, in UTC (which for this meeting was 1 hour behind the time in Geneva and Paris – 2 hours from Sunday 30 March; 7 hours ahead of the time in Los Angeles, 8 hours behind the time in Beijing, 9 hours behind the time in Seoul and Tokyo, etc.). No session was scheduled to last longer than 2 hrs.
  + 0500–0700 1st “morning” session [break after 2 hours]
  + 0720–0920 2nd “morning” session
  + [“midday” break – nearly 4 hours]
  + 1300–1500 1st “afternoon” session [break after 2 hours]
  + 1520–1720+1 2nd “afternoon” session

It was also pointed out that the session times had been changed from meeting to meeting, such that different time zones of the world might be treated approximately equally fairly either in one meeting or another. For the current meeting, the same UTC session times were used as in the 27th JVET meeting (which had been the tenth meeting conducted as an online-only meeting, whereas the current one is the thirteenth).

## ISO and IEC Code of Conduct reminders

Participants were reminded of the ISO and IEC Codes of Conduct, found at

<https://www.iso.org/publication/PUB100011.html>.

<https://www.iec.ch/basecamp/iec-code-conduct-technical-work>

These include points relating to:

* Behave ethically
* Promote and enable all voices to be heard
* Engage constructively in ISO and IEC activities
* Respect others (in meetings, when writing, on social media)
* Declare actual and potential conflicts of interest and manage them appropriately
* Protect confidential information
* Protect ISO and IEC assets
* Avoid and prevent any form of bribery or corruption
* Uphold the consensus process
* When disputes arise, escalate, resolve and uphold agreed resolution

Participants were also reminded of the UN Codes of Conduct, applying to work under ITU-T, found at <https://www.un.org/management/sites/www.un.org.management/files/un-system-model-code-conduct.pdf>

## IPR policy reminder

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

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

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

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

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

* <http://www.itu.int/ITU-T/ipr/index.html> (common patent policy for ITU-T, ITU-R, ISO, and IEC, and guidelines and forms for formal reporting to the parent bodies)
* <http://ftp3.itu.int/av-arch/jvet-site> (JVET contribution templates)
* <http://www.itu.int/ITU-T/dbase/patent/index.html> (ITU-T IPR database)

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 and ECM software implementation packages use 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](https://dms.mpeg.expert/doc_end_user/documents/89_London/wg11/w10791.zip) of the 89th meeting of ISO/IEC JTC 1/‌SC 29/‌WG 11 of June/July 2009. Both ITU and ISO/IEC will be identified in the <OWNER> and <ORGANIZATION> tags in the header. This software header is also used in the process of designing the VTM and ECM software, and for evaluating proposals for technology to be potentially included in these designs. 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. The SADL and NNVC packages for neural network-based video coding use the same licensing terms.

Software packages that had been developed in prior work of the JVT, the JCT-VC and the JCT-3V have similar considerations and are maintained according to the past practice in that work.

## Communication practices

The documents for the meeting can be found at <https://jvet-experts.org/>. The site contains links for creating a user account for document uploading and for contacting an administrator – e.g., to update the email address associated with an account, and experts were reminded to keep this information up to date. It was reminded to send a notice to the chairs in cases of changes to document titles, authors, etc.

It was noted that also the most recent versions of JCT-VC and JCT-3V documents can be accessed directly via the JVET site. A mirror for JCT-VC, JCT-3V and JVET document access (including all versions with original upload dates) has also been provided via the ITU ftp site, providing a “documents” subfolder in the directory of each respective meeting.

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 on the JVET email list was 1292 (as of 25 March 2025). All discussions (including those on AVC, HEVC, VVC, CICP, etc.) shall be conducted on the JVET reflector rather than any of the old reflectors (including JVT, JCT-VC, and JCT-3V) which are retained for archiving purposes.

It is further emphasized that the document JVET-AJ1012 gives valuable hints about communication practices as well as other IT resources used in JVET, such as software, conformance, and test materials.

## Terminology

* **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)
* **ARMC**: Adaptive re-ordering of merge candidates
* **ARSS**: Adaptive reference sample smoothing
* **ATM**: AVC-based multiview and 3D test model
* **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
* **BT**: Binary tree
* **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
* **CCCM**: Cross-component convolutional model
* **CCP**: Cross-component prediction
* **CCSAO**:Cross-component SAO
* **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
* **CPB**: Coded picture buffer
* **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
* **DCI**: Decoder capability information
* **DCT**: Discrete cosine transform (sometimes used loosely to refer to other transforms with conceptually similar characteristics)
* **DCTIF**: DCT-derived interpolation filter
* **DF**: Deblocking filter
* **DIMD**: Decoder intra mode derivation
* **DMVR**: Decoder motion vector refinement
* **DoCR**: Disposition of comments report
* **DPB**: Decoded picture buffer
* **DPCM**: Differential pulse-code modulation
* **DPS**: Decoding parameter sets
* **DRC**: Dynamic resolution conversion (synonymous with ARC, and a form of RPR)
* **DT**: Decoding time
* **DQ**: Dependent quantization
* **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)
* **ECM**: Enhanced compression model – a software codebase for future video coding exploration
* **ECV**: Extended Colour Volume (up to WCG)
* **EIP**: Extrapolation based intra prediction
* **EL**: Enhancement layer
* **EOS**: End of (coded video) sequence
* **ET**: Encoding time
* **FRUC**: Frame rate up conversion (pattern matched motion vector derivation)
* **GCI**: General constraints information
* **GDR**: Gradual decoding refresh
* **GFV**: Generative face video
* **GLM**: Gradient linear model
* **GOP**: Group of pictures (somewhat ambiguous)
* **GPM**: Geometry partitioning mode
* **GRA**: Gradual random access
* **HBD**: High bit depth
* **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 conforms to the HEVC standard design (possibly with under-development extensions) – now also used especially in reference to the (non-normative) encoder algorithms (see WD and TM)
* **HMVP**: History based motion vector prediction
* **HOP**: High-complexity operating point for neural network-based filter.
* **HRD**: Hypothetical reference decoder
* **HTM**: HEVC-based multiview and 3D test model (developed by JCT-3V)
* **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)
* **ILRP**: Inter-layer reference picture
* **IPCM**: Intra pulse-code modulation (similar in spirit to IPCM in AVC and HEVC)
* **IRAP**: Intra random access picture
* **ISP**: Intra subblock partitioning
* **JCCR**: Joint coding of chroma residuals
* **JCT-3V**: Joint collaborative team on 3D video (for AVC and HEVC)
* **JCT-VC**: Joint collaborative team on video coding (for HEVC)
* **JEM**: Joint exploration model – a software codebase previously used for 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
* **JVET**: Joint video experts team (initially for VVC, later expanded)
* **JVT**: Joint video team (for AVC)
* **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”)
* **LOP**: Low-complexity operating point for neural network-based filter.
* **LP** or **LDP**: Low delay P – the variant of the LD conditions that uses P frames
* **LUT**: Look-up table
* **LTRP**: Long-term reference picture
* **MANE**: Media-aware network element
* **MC**: Motion compensation
* **MCP**: Motion compensated prediction
* **MCTF**: Motion compensated temporal pre-filtering
* **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 (an alliance of working groups and advisory groups 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
* **NNPF**: Neural network post filter
* **NNVC**: Neural network-based video coding (experimental software package)
* **NSQT**: Non-square quadtree
* **NSPT**: Non-separable primary transform
* **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)
* **ONNX**: Open Neural Network Exchange – a format used to convert code from common neural network software packages into SADL code
* **operation point**: A temporal subset of an OLS
* **PDPC**: Position-dependent (intra) prediction combination
* **PERP**: Padded equirectangular projection (a 360° projection format)
* **PH**: Picture header
* **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
* **PTL**: Profile/tier/level combination
* **QM**: Quantization matrix
* **QP**: Quantization parameter (sometimes conflated with quantization step size)
* **QT**: Quadtree
* **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 (type of picture)
* **RASL**: Random-access skipped leading (type of picture)
* **R-D**: Rate-distortion
* **RDO**: Rate-distortion optimization
* **RDOQ**: Rate-distortion optimized quantization
* **RDPCM**: Residual DPCM
* **ROI**: Region of interest
* **ROT**: Rotation operation for low-frequency transform coefficients
* **RPL**: Reference picture list
* **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
* **SADL**: Small adhoc deep learning librar
* **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
* **SDH**: Sign data hiding
* **SDT**: Signal-dependent transform
* **SE**: Syntax element
* **SEI**: Supplemental enhancement information
* **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
* **SPO**: SEI processing order
* **SPS**: Sequence parameter set
* **SR**: Super-resolution
* **STMVP**: Spatial-temporal motion vector prediction
* **STRP**: Short-term reference picture
* **STSA**: Step-wise temporal sublayer access
* **TBA/TBD/TBP**: To be announced/determined/presented/public
* **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
* **TIMD**: Template-based intra mode derivation
* **TM**: Template matching
* **TMVP**: Temporal motion vector prediction
* **TS**: Transform skip
* **TSRC**: Transform skip residual coding
* **TT**: Ternary tree
* **UGC**: User-generated content
* **UWP**: Unequal weight prediction
* **VCEG**: Visual coding experts group (ITU-T Q.6/21, the relevant rapporteur group in ITU-T WP3/21, which is one of the two parent bodies of the JVET)
* **VCM**: Video coding for machines
* **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
* **VQA**: Visual quality assessment
* **VT**: Verification testing
* **VTM**: VVC Test Model
* **VUI**: Video usability information
* **VVC**: Versatile Video Coding
* **WCG**: Wide colour gamut
* **WG**: Working group, a group of technical experts (usually used to refer to the WGs of ISO/IEC JTC 1/SC 29).
* **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.

## Standards, TRs, supplements and technical papers approval and publication status

* MPEG-2 | H.262 (the video coding specification is common text)
  + ITU-T H.262 V3 was approved in 2012-02; Amd.1 was approved in 2013-03 and was not published separately; it was instead incorporated directly into the V3 text and published 2013-09
  + ISO/IEC 13818-2:2013 (Ed. 3) FDIS ballot closed 2012-05-08; FDAM 1 ballot closed 2013-04-12 and was not published separately; it was instead incorporated directly into the V3 text and published 2013-10
  + Conformance testing (not joint with ITU-T)
    - ISO/IEC 13818-4:2004 (Ed. 2) FDIS closed 2004-08-22, published 2004-12-12; it specifies conformance testing for Part 1 (Systems), Part 2 (Video), Part 3 (Audio), and Part 7 (AAC)
    - ISO/IEC 13818-4:2004/Amd 3:2009 Level for 1080@50p/60p conformance testing
    - Cor 1:2007, Cor 2:2009, Cor 3:2012, Cor 4:2011 may also have video relevance
  + Reference software (not joint with ITU-T)
    - ISO/IEC TR 13818-5:2005 (Ed. 2) FDIS closed 2005-07-24, published 2005-10; it specifies reference software for Part 1 (Systems), Part 2 (Video), Part 3 (Audio), Part 7 (AAC) and Part 11 (IPMP)
* AVC (twin text)
  + ITU-T H.264 V14 was Consented at 22nd meeting on 2021-04-30 (with annotated regions, shutter interval, and miscellaneous corrections), approved 2021-08-22, published 2021-10-13
  + ISO/IEC 14496-10:2020 (Ed. 9) FDIS ballot closed 2020-11-27, published 2020-12-15
  + ISO/IEC 14496-10:2022 (Ed. 10), had been forwarded from DIS directly for publication 2022-01-21 (with annotated regions, shutter interval, and miscellaneous corrections) with an editing period, submitted to ITTF in 2022-05 after consultation with ISO staff on format of graphics files, upgraded to “DIS approved for registration” in ISO Project system 2022-07-04, published 2022-11-07
  + Preliminary draft text for YCgCo-Re and YCgCo-Ro issued at 26th meeting, second draft including SMPTE ST 2128 IPT-PQ-C2 issued at 28th meeting 2022-10, third draft issued at 29th meeting 2023-01, fourth draft issued at 30th meeting 2023-04, formal project requested and CD of 11th edition issued at 31st meeting 2023-07, DIS issued at 32nd meeting 2023-10, DAM ballot closed 2024-04-15.
    - H.264 V15 Consented 2024-04-26, last call began 2024-07-16, approved 2024-08-13, published 2024-11-13
    - ISO/IEC 14496-10:202x (Ed. 11) FDIS issued at 34th meeting 2024-04, DIS approved for registration as FDIS 2024-09-17, FDIS ballot issued 2025-01-14, FDIS ballot closed 2025-03-23; pending publication
  + Amendment to support some SEI messages of VSEI v4 requested at 37th meeting 2025-01, registered to work programme 2025-01-25, ready for action to issue ISO/IEC CDAM
  + Conformance testing (twin text)
    - ITU-T H.264.1 V6 Approved 2016-02-13, published 2016-06-17
    - Various amendments of ISO/IEC 14496-4:2004, including:
      * ISO/IEC 14496-4:2004/AMD 6:2005 Advanced Video Coding conformance
      * ISO/IEC 14496-4:2004/AMD 9:2006 AVC fidelity range extensions conformance
      * ISO/IEC 14496-4:2004/AMD 30:2009 Conformance testing for new profiles for professional applications
      * ISO/IEC 14496-4:2004/AMD 31:2009 Conformance testing for SVC profiles
      * ISO/IEC 14496-4:2004/AMD 38:2010 Conformance testing for Multiview Video Coding
      * ISO/IEC 14496-4:2004/AMD 41:2014 Conformance testing of MVC plus depth extension of AVC
      * ISO/IEC 14496-4:2004/AMD 42:2014 Conformance testing of Multi-Resolution Frame Compatible Stereo Coding extension of AVC
      * ISO/IEC 14496-4:2004/AMD 43:2015 3D-AVC conformance testing
      * ISO/IEC 14496-4:2004/AMD 45:2016 Conformance Testing for the Multi-resolution Frame Compatible Stereo Coding with Depth Maps Extension of AVC
  + Reference software (twin text)
    - ITU-T H.264.2 V7 Approved 2016-02-13, published 2016-05-30
    - Various amendments of ISO/IEC 14496-5:2001 have been published, including:
      * ISO/IEC 14496-5:2001/AMD 6:2005 Advanced Video Coding (AVC) and High Efficiency Advanced Audio Coding (HE AAC) reference software
      * ISO/IEC 14496-5:2001/AMD 8:2006 AVC fidelity range extensions reference software
      * ISO/IEC 14496-5:2001/AMD 15:2010 Reference software for Multiview Video Coding
      * ISO/IEC 14496-5:2001/AMD 18:2008 Reference software for new profiles for professional applications
      * ISO/IEC 14496-5:2001/AMD 19:2009 Reference software for Scalable Video Coding
      * ISO/IEC 14496-5:2001/AMD 33:2015 Reference software for MVC plus depth extension of AVC
      * ISO/IEC 14496-5:2001/AMD 34:2014 Reference software of the multi-resolution frame compatible stereo coding of AVC
      * ISO/IEC 14496-5:2001/AMD 35:2015 3D-AVC Reference software
      * ISO/IEC 14496-5:2001/AMD 39:2016 Reference software for the Multi-resolution Frame Compatible Stereo Coding with Depth Maps of AVC
      * ISO/IEC 14496-5:2001/AMD 42:2017 Reference software for the alternative depth information SEI message extension of AVC
* HEVC (twin text)
  + ITU-T H.265 V7 approved 2019-11-29, published 2020-01-10
  + ISO/IEC 23008-2:2020 (Ed. 4) FDIS ballot closed 2020-07-16, published 2020-08-27
  + ITU-T H.265 V8 Consented at the 22nd meeting (shutter interval information SEI message and miscellaneous corrections), published 2020-10-13
  + ISO/IEC 23008-2:2020/AMD 1:2021 (shutter interval information SEI message) published 2021-07-12
  + ISO/IEC 23008-2:2023 (Ed. 5) began as CDAM 2 High-range levels output of 25th meeting of January 2022, CDAM ballot closed 2022-04-15, conversion to 5th edition with miscellaneous corrections planned at 26th meeting of 2022-04, text submitted for DIS ballot 2022-07-10, DIS ballot closed 2023-01-10, FDIS issued 29th meeting of 2023-01, FDIS ballot opened 2023-08-06, closed 2023-10-02, published 2023-10-30
  + ITU-T H.265 V9 Consented at 31st meeting 2023-07, approved 2023-09-13, and pre-published 2023-09, published 2023-11-24.
  + Preliminary draft HEVC text for YCgCo-Re and YCgCo-Ro issued at 26th meeting 2022-04, second draft including SMPTE ST 2128 issued at 28th meeting 2022-10, third draft at 29th meeting 2023-01, fourth draft at 30th meeting 2023-04, formal work item requested and CDAM1 issued 31st meeting 2023-07, DAM issued with new (multiview) profiles and SEI messages at 32nd meeting 2023-10, DAM ballot closed 2024-04-08
    - H.265 V10 Consented 2024-04-26, last call opened 2024-07-01, closed 2024-07-28, approved 2024-07-29, pre-published 2024-08-06, published 2024-10-07
    - ISO/IEC 23008-2:2025 (Ed. 6) FDIS issued from 35th meeting 2024-04, DIS approved for registration as FDIS 2024-10-03, FDIS registered for formal approval 2024-10-13, FDIS ballot issued 2024-12-30, FDIS ballot closed 2025-02-24, published 2025-03-20
  + Amendment to support additional (multiview) profiles and some SEI messages of VSEI v4, project requested at 36th meeting 2024-11, project registered in ISO/IEC work programme 2025-01-25, CDAM issued at 37th meeting, consulation began 2025-02-01, pending closure of comment period
  + Conformance testing (twin text)
    - ITU-T H.265.1 V3 approved 2018-10-14, published 2019-01-15
    - ISO/IEC 23008-8:2018 (Ed. 2) Conformance specification for HEVC, published 2018-08-06
    - ISO/IEC 23008-8:2018/AMD 1:2019 Conformance testing for HEVC screen content coding (SCC) extensions and non-intra high throughput profiles, published 2019-10-15
  + Reference software (twin text)
    - ITU-T H.265.2 V4 approved 2016-12-22, published 2017-04-10
    - ISO/IEC 23008-5:2017 (Ed. 2) Reference software for high efficiency video coding, FDIS issued from 2016-02 meeting, published 2017-03-01
    - ISO/IEC 23008-5:2017/AMD 1:2017 Reference software for screen content coding extensions, FDAM issued from 2017-04 meeting, FDAM ballot opened 2017-08-10, closed 2017-10-07, published 2017-11-09
* VVC (twin text)
  + ITU-T H.266 V1 approved 2020-08-29, published 2020-11-10
  + ISO/IEC 23090-3:2021 (Ed. 1) published 2021-02-16
  + ITU-T H.266 V2 with operation range extensions, Consented 2022-01-28, Last Call began 2022-04-01, Approved 2022-04-29, pre-published 2022-06-06, published 2022-07-12
  + ISO/IEC 23090-3:2022 (Ed. 2) with operation range extensions, approval at WG level to proceed to FDIS 2022-01-21, FDIS ballot opened 2022-06-29, closed 2022-08-24, published 2022-09-25
  + ISO/IEC 23090-3:2024 (Ed. 3), initated as (Ed. 2) / Amd.1 New level and systems-related supplemental enhancement information, CDAM 1 issued from 26th meeting, ballot closed 2022-07-14, DAM 1 issued from 27th meeting, ballot closed 2023-01-03, FDIS issued at WG level 2023-07, FDIS ballot opened 2024-05-11, closed 2024-06-26, published 2024-07-17
  + ITU-T H.266 V3 Consented 2023-07, approved 2023-09-29 and pre-published 2023-09, published 2023-11-29
  + ISO/IEC 23090-3:2024/CDAM 1 Request & CDAM issued 2024-04, consultation deferred due to meeting timing, updated text issued 2024-07, consultation initiated 2024-09-05, closed 2024-10-31, ready for action to issue ISO/IEC DAM (or DIS)
  + Conformance testing (twin text)
    - ITU-T H.266.1 V1 Consented 2022-01-28, Last Call began 2022-04-01, Approved 2022-04-29, pre-published 2022-05-17, published 2022-07-12
    - ISO/IEC 23090-15:2022 (Ed. 1) approval at WG level to proceed to FDIS 2022-10-15, upgraded to “DIS approved for registration” in ISO Projects system 2021-10-24, upgraded to “FDIS registered for formal approval” 2022-07-11, FDIS ballot closed 2022-11-04, published 2022-11-24
    - ISO/IEC 23090-15:2024 (Ed. 2) began as Amd.1 Operation range extensions – CDAM 1 issued from 24th meeting 2021-10, DAM 1 issued from 25th meeting 2022-01-21, upgraded to “CD approved for registration as DIS” status in ISO Projects system 2022-05-31, upgraded to “DIS registered” 2022-06-22, DAM ballot closed 2022-11-15, consolidated into FDIS 2nd edition issued as an output of the 29th meeting in January 2023, ballot opened 2024-04-08, closed 2024-06-03, published 2024-07-04.
    - ITU-T H.266.1 V2 Consented 2023-07, approved 2023-09-13 and pre-published 2023-09, published 2023-10-19
    - ISO/IEC 23090-15 (Ed. 3) project requested at 37th meeting, project registered in work programme 2025-01-25, ready for action to issue CD.
  + Reference software (twin text)
    - ITU-T H.266.2 V1 Consented 2022-01-28, Last Call began 2022-04-01, Approved 2022-04-29, pre-published 2022-05-17, published 2022-07-12
    - ISO/IEC 23090-16:2022 V1 approval at WG level to proceed to FDIS 2022-01-21, upgraded to “DIS approved for registration” status in ISO Projects system 2022-04-21, upgraded to “FDIS registered for formal approval” 2022-04-22, FDIS ballot initiated 2022-07-24, FDIS ballot closed 2022-09-19, published 2022-10-23
    - H.266.2 V2 Consented 2024-04-26, last call opened 2024-05-16, closed 2024-06-12, approved 2024-06-13, pre-published 2024-08-06, published 2024-10-09
    - ISO/IEC 23090-16:202x (Ed. 2) Request & CD issued 2024-04, consultation deferred due to meeting timing, consultation initiated 2024-09-06, closed 2024-11-01, DIS issued at 36th meeting 2024-11, approved for registration as DIS 2024-12-18, DIS registered 2025-01-7, DIS ballot opened 2025-03-09, no action at the current meeting (Roughly corresponding to H.266.2 V2 already approved and published in ITU-T)
* VSEI (twin text)
  + ITU-T H.274 V1 approved 2020-08-29, published 2020-11-10
  + ISO/IEC 23002-7:2021 (Ed. 1) published 2021-01-28
  + ITU-T H.274 V2 Consented 2022-01-28, Last Call began 2022-04-01, Approved 2022-05-22 (after 1 Last Call comment and Additional Review), pre-published 2022-06-17, published 2022-07-25
  + ISO/IEC 23002-7:2022 (Ed. 2) approval at WG level to proceed to FDIS 2022-01-21, upgraded to “DIS approved for registration” status in ISO Projects system 2022-05-05 and “FDIS registered for formal approval” 2022-05-08, FDIS ballot closed 2022-09-27, published 2022-10-30
  + ISO/IEC 23002-7:2024 (Ed. 3) began as (2nd Ed.) Amd.1 Request for new edition and CD for additional SEI messages issued at 27th meeting, ballot closed 2022-10-10, DAM registered 2022-11-13, DAM ballot closed 2022-04-06, FDIS 3rd edition issued 2023-07, FDIS ballot began 2024-07-25, closed 2024-09-20, published 2024-10-30
  + ITU-T H.274 V3 Consent 2023-07, approved 2023-09-29, pre-published 2023-10-11, published 2024-03-12.
  + ISO/IEC 23002-7:202x (Ed. 4) Request & CDAM 1 issued 2024-04, consultation deferred due to meeting timing, updated text issued 2024-07, CD consultation initiated 2024-09-05, closed 2024-10-31, ready for action to issue ISO/IEC DAM (or DIS)
* CICP (twin text)
  + ITU-T H.273 V2 (with 4:2:0 sampling alignment and corrections for range of values for sample aspect ratio, ICTCP equations for HLG, and transfer characteristics function for sYCC of IEC 61966-2-1) Consented on 2021-04-30, Last Call closed during the 23rd meeting with approval on 2021-07-14, published 2021-09-24
  + ISO/IEC 23091-2:2021 (Ed. 2) had been forwarded from DIS directly for publication in 2021-04 and published 2021-10-18
  + ITU-T H.273 V3 Consent 2023-07, approved 2023-09, not published due to waiting for publication of SMPTE ST 2128.
  + ITU-T H.273 V4 Consented 2024-04-26, last call opened 2024-06-16, closed 2024-07-13, approved 2024-07-14, pre-published 2024-08-06, published 2024-10-07.
  + ISO/IEC 23091-2:2025 (Ed. 3) Request for new edition and CD for new edition (including YCgCo-Re and YCoCg-Ro) issued at 27th meeting, ballot closed 2022-10-10, DIS registered 2022-11-13, DIS ballot closed 2023-04-06, preliminary draft text for including SMPTE ST 2128 issued at 28th meeting, incorporated into preliminary FDIS at 30th meeting 2023-04, FDIS issued 2024-04 (after waiting for publication of SMPTE ST 2128, then proceeding), FDIS registered for formal approval 2024-10-24, FDIS ballot issued 2024-12-03, FDIS ballot closed 2025-01-28, published 2025-02-25.
* Conversion and coding practices for HDR/WCG Y′CbCr 4:2:0 video with PQ transfer characteristics (twin text)
  + H.Sup15 V1, approved 2017-01-27, published 2017-04-12
  + ISO/IEC TR 23008-14:2018 (Ed. 1) published 2018-08-06
* Signalling, backward compatibility and display adaptation for HDR/WCG video coding (twin text)
  + H.Sup18 V1, approved 2017-10-27, published 2018-01-18
  + ISO/IEC TR 23008-15:2018 (Ed. 1) published 2018-08
* Usage of video signal type code points (twin text)
  + H.Sup19 V3 approved 2021-04-30, published 2021-06-04
  + ISO/IEC TR 23091-4:2021 (Ed. 3) published 2021-05-23
* Working practices using objective metrics for evaluation of video coding efficiency experiments (twin text)
  + HSTP-VID-WPOM V1 approved 2020-07-03, published 2020-11
  + ISO/IEC TR 23002-8:2021 (Ed. 1) published 2021-05-20
* Film grain synthesis technologies for video applications (twin text)
  + ISO/IEC TR 23002-9:2024 (Ed. 1) Request for subdivision and WD 1 issued at 25th meeting 2022-01-21, WD 2 issued at 27th meeting, WD 3 issued at 28th meeting, CDTR issued at 29th meeting 2023-01, consultation period ended 2023-07-09, DTR text was issued from the 31st meeting in July 2023, put on hold by ISO staff editors, DTR ballot opened 2024-03-05, closed 2024-04-30, NB comments handled by ISO staff editor in consultation with project editors, published 2024-07-24
  + ITU-T H-Series Supplement 21 (ex H.Sup-FGST), Agreement 2025-01-24 by ITU-T SG21, pre-publication website malfunctioning as of 2025-03-25
  + Edition 2 planned but not yet in formal work programme of ISO/IEC
* Optimization of encoders and receiving systems for machine analysis of coded video content (twin text)
  + ISO/IEC 23888-3 (Ed. 1) Request for subdivision issued from 33rd JVET meeting 2024-01, CDTR issued from 34th meeting 2024-04, consultation deferred due to meeting timing, updated text issued from 35th meeting 2024-07, consultation further deferred due to meeting timing, further updated text issued from 36th meeting 2024-11, consultation initiated 2025-01-14, consultation period ended 2025-03-11, ready for action to issue DTR
  + ITU-T provisional name H.Sup-MACVC
* The following freely available standards are published here in ISO/IEC:  
  <https://standards.iso.org/ittf/PubliclyAvailableStandards/index.html> as of the time of the current meeting:
  + ISO/IEC 13818-4:2004 Conformance testing for MPEG-2
  + ISO/IEC 13818-4:2004/Amd 3:2009 Level for 1080@50p/60p conformance testing
  + ISO/IEC TR 13818-5:2005 Software simulation for MPEG-2
  + Various amendments of ISO/IEC 14496-4:2004 Conformance for AVC
  + Various amendments of ISO/IEC 14496-5:2001 Reference software for AVC
  + ISO/IEC 14496-10:2022 (Ed. 10) AVC
  + ISO/IEC 23090-16:2022 (Ed. 1) Reference software for VVC
* The following standards that have been intended by JVET to be publicly available were not available at <https://standards.iso.org/ittf/PubliclyAvailableStandards/index.html> as of the time of the current meeting. (These should be checked for previously issued requests for free availability.)
  + ISO/IEC 23002-7:2024 (Ed. 3) – VSEI, published 2024-10-30 (public availability requested 2023-07)
  + ISO/IEC 23008-2:2025 (Ed. 6) HEVC, published 2023-10-30 (need to check for public availability request)
  + ISO/IEC 23008-5:2017 (Ed. 2) Reference software for HEVC, published 2017-03-01 (public availability requested 2016-02)
  + ISO/IEC 23008-5:2017/AMD 1:2017 Reference software for HEVC screen content coding extensions, published 2017-11-09 (not requested 2017-01, 2017-04, 2017-07, 2017-10, 2018-01)
  + ISO/IEC 23008-8:2018 (Ed. 2) Conformance specification for HEVC, published 2018-08-06 (public availability requested 2018-10)
  + ISO/IEC 23008-8:2018/AMD 1:2019 Conformance testing for HEVC screen content coding (SCC) extensions and non-intra high throughput profiles, published 2019-10-15
  + ISO/IEC 23090-3:2024 (Ed. 3) VVC, published 2024-07-17
  + ISO/IEC 23090-15:2024 (Ed. 2) Conformance specification for VVC, published 2024-07-04.
  + ISO/IEC 23091-2:2025 (Ed. 3) CICP, published 2025-02-25
* The following technical reports by JVET may not have been requested to be publicly available due to a former policy interpretation by ITTF that has since been changed. (These should be checked for previously issued requests for free availability.)
  + ISO/IEC TR 23008-14:2018 (Ed. 1) Conversion and coding practices for HDR/WCG Y′CbCr 4:2:0 video with PQ transfer characteristics, published 2018-08-06
  + ISO/IEC TR 23008-15:2018 (Ed. 1) Signalling, backward compatibility and display adaptation for HDR/WCG video coding, published 2018-08
  + ISO/IEC TR 23091-4:2021 (Ed. 3) Usage of video signal type code points, published 2021-05-23
  + ISO/IEC TR 23002-8:2021 (Ed. 1) Working practices using objective metrics for evaluation of video coding efficiency experiments, published 2021-05-20
  + ISO/IEC TR 23002-9:2024 (Ed. 1) Film grain synthesis technologies for video applications, published 2024-07-24
* It appears necessary to check if all older software and conformance packages are publicly available – it might be that this was never requested, e.g. for those that were produced by JCT-3V. This topic was left TBD until the next meeting – perhaps it would be best to compile a list of all relevant software and conformance parts of AVC, HEVC, MPEG-2 aka H.262, CICP, and request these in bulk.

## Draft standards progression status for active work items

* AVC ISO/IEC 14496-10:202x/CDAM 1 to support some SEI messages of VSEI v4 requested at 37th meeting 2025-01, registered to work programme 2025-01-25, ready for action to issue ISO/IEC CDAM
* HEVC ISO/IEC 23008-2:2025/CDAM 1 to support additional (multiview) profiles and some SEI messages of VSEI v4, project requested at 36th meeting 2024-11, project registered in ISO/IEC work programme 2025-01-25, CDAM issued at 37th meeting, consulation began 2025-02-01, pending closure of comment period
* VVC ISO/IEC 23090-3:2024/CDAM 1, Request & CDAM issued 2024-04, consultation deferred due to meeting timing, updated text issued 2024-07, consultation initiated 2024-09-05, closed 2024-10-31, ready for action to issue ISO/IEC DAM (or DIS)
* VVC conformance ISO/IEC 23090-15 (Ed. 3) project requested at 37th meeting, project registered in work programme 2025-01-25, ready for action to issue CD.
* VVC reference software ISO/IEC 23090-16:202x (Ed. 2) Request & CD issued 2024-04, consultation deferred due to meeting timing, consultation initiated 2024-09-06, closed 2024-11-01, DIS issued at 36th meeting 2024-11, approved for registration as DIS 2024-12-18, DIS registered 2025-01-7, DIS ballot opened 2025-03-09, no action at the current meeting. (Roughly corresponding to H.266.2 V2 already approved and published in ITU-T.)
* VSEI ISO/IEC 23002-7:202x (Ed. 3) / CDAM 1 Request & CDAM issued 2024-04, consultation deferred due to meeting timing, updated text issued 2024-07, CD consultation initiated 2024-09-05, closed 2024-10-31, ready for action to issue ISO/IEC DAM (or DIS)
* Film grain synthesis technology for video applications – Edition 2 planned but not yet in formal work programme of ISO/IEC
* Optimization of encoders and receiving systems for machine analysis of coded video content – ISO/IEC 23888-3 Request for subdivision issued from 33rd JVET meeting 2024-01, CDTR issued from 34th meeting 2024-04, consultation deferred due to meeting timing, updated text issued from 35th meeting 2024-07, consultation further deferred due to meeting timing, further updated text issued from 36th meeting 2024-11, consultation initiated 2025-01-14, consultation period ended 2025-03-11, ready for action to issue DTR. ITU-T provisional name H.Sup-MACVC.
* A request for free availability in ISO/IEC has to be made for each edition, amendment and corrigendum, and the request needs to be approved in the WG 5 Recommendations. A request form also needs to be filled out (but the form does not need to be issued as a WG 5 document). A freely available URL for the ITU publication should be provided for the ongoing work items when they become finalized.

## Opening remarks

Remarks during the opening session of the meeting Wednesday 26 March at 0535-0620 UTC were as follows.

* Timing and organization of the meeting and online access and calendar posting of session plans were reviewed
  + The initial number of documents was slightly higher than for last meeting (approximately 215 vs. 205 by the time of opening the meeting) – parallel sessions were announced to be necessary.
  + Start of parallel sessions (HLS) Thursday morning
  + JVET will not meet during the MPEG information exchange sessions on Monday 31 March (0500-0800 UTC) and Wednesday 02 April (0500-0600 UTC). The information exchange on Friday 04 April (2100 UTC) is scheduled after the regular JVET time slots.
* Plans for subsequent hybrid meetings (with best-effort remote access) were reviewed: June/July 2025 (Daejeon), Oct. 2025 (Geneva), April 2026 (Santa Eulària), June/July 2026 (Geneva), October 2026 (Hangzhou).
* The January 2026 meeting is currently planned to be virtual.
* Depending on the status of preparing future standardization activities, it may be necessary to extend the duration of meetings.
* Significant workload was expected at this meeting for AHG17 activities – a hybrid AHG meeting in Aachen was held, and follow-up discussion is necessary to make a step forward in drafting the Call for Evidence. It was suggested to start this discussion early at the current meeting (Wednesday afternoon) – joint meetings with parent bodies are expected starting from Monday.
* The meeting logistics, agenda, working practices, policies, and document allocation considerations were reviewed.
  + Access to the meeting was provided using Zoom. The meeting notes by the session chair were to be continually shared via zoom screen sharing. In the meeting room C, it is also possible to show them on a separate projection screen in parallel with another presentation.
  + Having text and software available is crucial (and not just arriving at the end of the meeting).
* The results of the previous meeting and the meeting report JVET-AK1000 were reviewed. Only minor issues in the meeting report were noted and were not considered sufficient to warrant issuing a revision.
* At the current meeting, on-site attendance will be recorded via the zoom records. It is therefore important to follow the conventions of naming participants. Participants who cannot be correctly identified will not appear in the attendance sheet and will also be removed from the zoom sessions.
* All cross-check documents were late, whereas the number of late non-cross-check documents seemed to have slightly decreased relative to the last meeting. Several contributions did not report any results initially, and were also flagged as late (so-called “placeholder” uploads). There were no objections voiced in the opening plenary to the consideration of late contributions.
* There were again a few documents registered where authors’ given names were not abbreviated according to the JVET custom (which helps produce shorter headings in the JVET meeting report), and/or company affiliation was missing in the authors’ list. Participants were reminded to stick to JVET’s conventions.
* Experts were asked not to pick a specific JVET number for regular documents – this function is reserved for AHG reports, summary reports, and output docs. Reserving numbers without filling a precise title shall also be avoided – the chair may flag such documents as withdrawn, as they cannot be allocated to a certain category in the meeting notes.
* Experts were asked to always register JVET documents via the “jvet-experts.org” site, not via the MPEG DMS site, as WG 5 docs (as that feature of the DMS site has not been working properly).
* Experts were asked to inform the chair when the title of a document is changed, or if authors are added. Otherwise, that might not be correct in the meeting notes. Provisional titles such as “EEx contribution” shall be avoided.
* The practice introduced in the Kemer meeting, submitting WG 5 N-numbered output documents only in cases of standards text submitted for ballot, DoCRs, standards/parts requests, and meeting reports has turned out to be useful. This has also helped in making the documents in the MPEG dms and ISO documents available in a timely fashion.
* Still, only the newest versions of the JCT-VC and JCT-3V documents are available from the links in the JVET site, but a second source for JVET, JCT-VC and JCT-3V documents was set up in the ITU ftp directories of each meeting. This includes all versions of documents with original upload times.
* The following ballot results had become available through the SC 29 secretariat:
  + CDTR on machine analysis [m72107](https://dms.mpeg.expert/doc_end_user/current_document.php?id=98435&id_meeting=202)
  + CDAM HEVC [m72110](https://dms.mpeg.expert/doc_end_user/current_document.php?id=98438&id_meeting=202)
* DAM for VVC and VSEI version/edition 4, as well as HEVC are planned to be done at the current meeting. In order to have but ballot results available prior to the October meeting (when also submission for ITU consent is planned), only a relatively short editing period is possible (April 25 at latest). It had been emphasized in the previous meeting that only minor improvements might be made during the March/April meeting. Considering the large number of input documents requesting changes, this is critical – some priority needs to be assigned, and potentially leave some aspects open until the final stage. Draft DoCs exist reflecting the status of JVET-AK2005 and JVET-AK2006.
* The CDTR could also be promoted to DTR (as SEI messages in VSEI v4 DAM are referred in the draft). The version issued from the last meeting appears stable, no input requesting changes was submitted. Editors will look at the ballot comments and report back. Revisit.
* DIS of VVC software was submitted for ballot – matching the ITU edition that was issued in April. Starting work towards an amendment or a next edition could be targeted for October, considering the implementation maturity of new SEI messages.
* The primary goals of the meeting were:
  + VVC and VSEI DAM texts, for ISO/IEC ballot
  + HEVC DAM text, for ISO/IEC ballot
  + AVC CDAM text, for ISO/IEC ballot
  + VVC conformance CD text, for ISO/IEC ballot?
  + New software versions VTM/HM/JM – support for SEI messages?
  + Lot of activity in AHG17 – draft/preliminary CfE as output
  + Exploration Experiments
    - Neural network-based video coding
    - Enhanced compression beyond VVC
  + Liaison communication?
  + VSEI and VVC white papers – further work until next meeting
* Joint meetings were expected with MPEG AG 5 (on matters involving visual quality assessment), and with MPEG WG 2 Requirements and ITU-T VCEG on future video standardization (see section 7.3).
* As a follow-up to liaison communication after the April meeting, parent bodies were expected to conduct discussion about future JVET management structures. This has not happened so far.
* Principles of standards development were discussed.
* Scheduling of sessions was discussed – see under sections 2.6 and 2.12.

## Scheduling of discussions

The plans for the times of meeting sessions were established as follows, in UTC (which for this meeting was 1 hour behind the time in Geneva and Paris – 2 hours from Sunday 30 March; 7 hours ahead of the time in Los Angeles, 8 hours behind the time in Beijing, 9 hours behind the time in Seoul and Tokyo, etc.). No session was scheduled to last longer than 2 hrs.

* 0500–0700 1st “morning” session [break after 2 hours]
* 0720–0920 2nd “morning” session
* [“midday” break – nearly 4 hours]
* 1300–1500 1st “afternoon” session [break after 2 hours]
* 1520–1720+1 2nd “afternoon” session

Particular scheduling notes are shown below, although not necessarily 100% accurate or complete. Times are recorded in the local timezone of the meeting venue, except as otherwise noted:

* Wed. 26 March, 1st day
  + Morning sessions:
    - 0500–0620 Opening remarks, review of practices, agenda, IPR policy reminder
    - 0625–0700 Reports of AHGs 1-3
    - 0720–0925 Reports of AHGs 4-11
  + Afternoon sessions:
    - 1300–1400 Reports of AHGs 12-18
    - 1405–1505 CfE planning
    - 1525–1725 CfE planning
* Thu. 27 March, 2nd day
  + Morning sessions:
    - 0500–0700 review 5.1.1 EE1 summary
    - 0720–0920 review 5.1.1 EE1 summary and 5.1.3 NNVC proposals
    - 0520–0920 HLS (chaired by J. Boyce)
  + Afternoon sessions:
    - 1300–1500 EE2 review 5.2.1 EE2 summary
    - 1520–1720 EE2 review 5.2.1 EE2 summary
    - 1320–1720 HLS (chaired by J. Boyce)
* Fri. 28 March, 3rd day
  + Morning sessions:
    - 0500–0700 continue review 5.2.1 EE2 summary and 5.2.3 EE2 related
    - 0720–0920 continue review 5.1.3 NNVC proposals
    - 0520–0920 HLS (chaired by J. Boyce)
  + Afternoon sessions:
    - 1300–1510 CfE planning (4.16)
    - 1530–1735 CfE planning (4.16), 4.8
    - 1320–1720 HLS (chaired by J. Boyce)
* Mon. 31 March, 4th day
  + 0500–0800 MPEG information sharing session
  + Morning sessions
    - 0820–0920 …
    - …
  + Afternoon sessions:
    - 1300–1500 …
    - 1520–1720 …
    - …
* Tue 1 April, 5th day
  + Morning sessions:
    - 0500–0700 …
    - 0720–0920 …
    - …
  + Afternoon sessions:
    - 1300–1500 …
    - 1520–1720 …
    - …
* Wed. 2 April, 6th day
  + 0500–0600 MPEG information sharing session
  + Morning sessions:
    - 0600–0700 …
    - 0720–0920 …
    - …
  + Afternoon sessions:
    - 1300–1500 …
    - 1520–1720 …
    - …
* Thu. 25 January, 7th day
  + Morning sessions:
    - 0500–0700 …
    - 0720–0920 …
    - …
  + Afternoon sessions:
    - 1300–1500 …
    - 1520–1720 …
    - …
* Fri. 26 January, 8th day
  + Morning sessions:
    - 0500–0700 …
    - 0720–0920 …
    - …
  + 1300–1720 (with break) JVET wrap-up plenary:
    - Approval of output docs
    - Establishment of AHGs
    - Review of meeting recommendations
    - Future planning, a.o.b.
  + 2100–2300 MPEG information sharing session
  + XXXX–XXXX WG 5 approval of meeting recommendations, closing of meeting

## Contribution topic overview (update doc count)

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 summary reports, and may not be completely accurate; documents which are allocated to multiple sections are only counted in one of them):

* AHG reports (18) (section 3)
* Project development (section 4)
  + AHG1: Development, deployment and advertisement of standards (4)
  + AHG2: Text development and errata reporting (2)
  + AHG3: Software development (0)
  + AHG3: Test conditions (3)
  + AHG4: Subjective quality testing and verification testing (1)
  + AHG4: Test and training material (0)
  + AHG5: Conformance test development (0)
  + AHG7: ECM tool assessment (5)
  + AHG8: Optimization of encoders and receiving systems for machine analysis of coded video content (1)
  + AHG10: Encoding algorithm optimization (3)
  + AHG13: Film grain synthesis (1)
  + Implementation studies (0)
  + Profile/tier/level specification (0)
  + AHG15: Gaming content compression (0)
  + AHG16: Generative face video (2)
  + AHG17: CfE preparation (14)
  + AHH18: Ultra-low latency and error resilience (3)
  + CICP (4)
* Low-level tool technology proposals (section 4.16) with subtopics (number counts excluding BoG and summary reports)
  + AHG11/AHG14 and EE1: Neural network-based video coding (27) (section 5.1)
  + AHG6/AHG12 and EE2: Enhanced compression beyond VVC capability (76) (section 5.2)
* AHG9: High-level syntax (HLS) proposals (section 6) with subtopics
  + Additions for HEVC and AVC (6) (section 6.1)
  + SEI messages in VSEIv4 (47) (section 6.2)
  + SEI messages in TuC doc (15) (section 6.3)
  + SEI messages on other topics (10) (section 6.4)
  + Non-SEI HLS aspects (0) (section 6.5)
* Joint meetings, plenary discussions, BoG reports (0) liaison (0), summary of actions (section 7)
* Project planning (section 8)
* Establishment of AHGs (section 9)
* Output documents (section 10)
* Future meeting plans and concluding remarks (section 11)

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

# AHG reports (18)

These reports were discussed during 0625–0700, 0720–0925 and 1300–1400 on Wednesday 26 March 2025 (chaired by JRO).

[JVET-AL0001](https://jvet-experts.org/doc_end_user/current_document.php?id=15384) JVET AHG report: Project Management (AHG1) [J.-R. Ohm (chair), G. J. Sullivan (vice chair)]

The work of the JVET overall had proceeded well in the interim period with similar number of input documents (as compared to the previous meeting) submitted to the current meeting. Intense discussion had been carried out on the group email reflector, and most output documents from the preceding meeting had been produced as planned.

Output documents from the preceding meeting had been made initially available at the JVET web site (<https://jvet-experts.org/>) or the ITU-based JVET ftp site (<http://wftp3.itu.int/av-arch/jvet-site/2025_01_AK_Geneva/>). It is noted that the previous document sites http://phenix.int-evry.fr/jvet/, http://phenix.int-evry.fr/jct/, and http://phenix.int-evry.fr/jct3v/ were shut down, but JCT-VC and JCT-3V documents can be accessed directly via the JVET site. All documents of JCT-VC, JCT-3V and JVET are also available from the ITU-based ftp site, where sub-folders ‘./documents/’ were created in the folders of the respective meetings (it is noted that for practicality reasons, this is only done after all meeting documents including output documents are completely available in all versions). All those files come with the original time stamps by which the original versions of documents were uploaded.

The list of output documents produced since the last meeting included the following:

* JVET-AK1004 Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP [Posted 2025-02-18, last update 2025-03-06]
* JVET-AK1006 HEVC additional profiles and SEI messages, also issued as WG 5 CDAM N 336 [Posted 2025-01-29]
* JVET-AK1017 Support for additional VSEI messages in AVC (draft 1) [Posted 2025-02-18]
* JVET-AK2005 Additions and corrections for VVC version 4 (Draft 11), also issued as WG 5 preliminary DAM update N 337 [Posted 2025-02-18, last update 2025-02-27]
* JVET-AK2006 Additional SEI messages for VSEI version 4 (Draft 5), also issued as WG 5 preliminary DAM update N 335 [Posted 2025-02-07, last update 2025-03-13]
* JVET-AK2010 VTM and HM common test conditions and software reference configurations for SDR 4:2:0 10 bit video [Posted 2025-03-22]
* JVET-AK2019 Description of algorithms version 10 and software version 12 in neural network-based video coding (NNVC) [Posted 2025-03-25]
* JVET-AK2020 Film grain synthesis technology for video applications ed. 2 (Draft 2) [not available yet by beginning of meeting]
* JVET-AK2023 Exploration experiment on neural network-based video coding (EE1) [Posted 2025-01-22, last update 2025-02-07]
* JVET-AK2024 Exploration experiment on enhanced compression beyond VVC capability (EE2) [Posted 2025-01-22, last update 2025-02-21]
* JVET-AK2025 Algorithm description of Enhanced Compression Model 16 (ECM 16) [Posted 2025-03-17]
* JVET-AK2026 Testing of video coding technology beyond conditions of exploration experiments [Posted 2025-03-03]
* JVET-AK2030 Optimization of encoders and receiving systems for machine analysis of coded video content (draft 8, for future updates) [Posted 2025-03-13]
* JVET-AK2032 Technologies under consideration for future extensions of VSEI (version 7) [Posted 2025-02-28]
* JVET-AK2038 Draft white paper on VSEI [Posted 2025-03-26]
* JVET-AK2039 Announcement of JVET AHG17 Meeting, Aachen (Germany), 10-12 March 2025 [Posted 2025-02-03]

The eighteen *ad hoc* groups had made progress, and reports from those activities had been submitted. Various teleconferences had been held by AHGs, and a hybrid meeting of AHG17 was conducted during 10-12 March 2025 in Aachen, DE, attended by almost 30 on-site participants. Furthermore, two exploration experiments (EE) on neural network-based video coding and on enhanced compression beyond VVC capability were conducted.

The arrangements for the 38th meeting had been announced in the JVET reflector, in the JVET logistics document (<https://www.itu.int/wftp3/av-arch/jvet-site/2025_03_AL_Virtual/JVET-AL_Logistics.docx>), and in the WG 5 calling notice (N 341) and agenda (N 342) for the 19th WG 5 meeting.

Software integration was finalized approximately according to the plan.

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

Roughly 220 input contributions (not counting the AHG reports, summary reports and crosschecks) had been registered for consideration at the current meeting.

It is further noted that, starting from the twentieth JVET meeting, work items which had originally been conducted by the Joint Collaborative Team on Video Coding (JCT-VC) were continued to be conducted in JVET as a single joint team, as negotiated by the parent bodies. This particularly consists of work on

* *High Efficiency Video Coding* (HEVC) and its extensions, the development of associated conformance test sets, reference software, verification testing, maintenance, and non-normative guidance information,
* Specification of *Coding-independent Code Points (Video)* (CICP), and associated technical report(s),
* Maintenance and enhancement work on the *Advanced Video Coding* (AVC) standard, associated conformance test sets and reference software.

To retain a consistent numbering scheme, the number range of output documents starting from 1001 was reserved for the previous JCT-VC and JCT-3V topic items listed above, whereas the number range starting from 2001 was retained for VVC, VSEI and exploration activities.

A preliminary basis for the document subject allocation and meeting notes for the 38h meeting had been made publicly available on the ITU-hosted ftp site as <http://wftp3.itu.int/av-arch/jvet-site/2025_03_AL_Virtual/JVET-AL_notes_d0.docx>.

1. **Recommendations**

* The AHG recommends its continuation.
* The AHG recommends continued communication between JVET’s parent bodies about appointment of an extended management support team.

[JVET-AL0002](https://jvet-experts.org/doc_end_user/current_document.php?id=15385) JVET AHG report: Draft text and test model algorithm description editing (AHG2) [B. Bross, C. Rosewarne (co-chairs), F. Bossen, A. Browne, S. Kim, S. Liu, J.-R. Ohm, G. J. Sullivan, A. Tourapis, Y.-K. Wang, Y. Ye (vice chairs)]

**Output documents produced**

**JVET-AK1004 Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP**

This document contains a list of reported errata items for VVC, VSEI, HEVC, AVC, and Video CICP, for tracking purposes. Some of the items have been confirmed by the JVET and have been agreed to require fixing. This document also provides publication status backgrounds of these standards.

Incorporated items at the JVET-AK meeting:

* For VSEI:
  + Removed/updated VSEI errata items that have been fully or partially integrated into JVET-AK2006.
* For HEVC:
  + Added the following item: In H.265v10 published by ITU-T, there’s an extraneous bullet item “k)” in clause A.4.2 immediately above Table A.9, with font size of 4 (thus not easily visible). (reported by [Cliff Reader](mailto:cliff@reader.com) – thanks!) The error is not in the HEVC 6th edition that was in the final stage of the publication process as 2025-03-03.

**JVET-AK1006 HEVC additional profiles and SEI messages (draft 2)**

This document contains the draft text for changes to the High Efficiency Video Coding (HEVC) standard (Rec. ITU‑T H.265 | ISO/IEC 23008‑2). The changes include the support of a new profile, namely the Multiview Main 10 profile, and the support of five new SEI messages, namely the source picture timing information, modality information, digitally signed content initialization, digitally signed content selection, and digitally signed content verification SEI messages, through referencing the Versatile Supplemental Enhancement Information (VSEI) standard (Rec. ITU‑T H.274 | ISO/IEC 23002‑7). The changes also include some corrections to the previous version of the HEVC standard.

**Changes that have been integrated for the 37th JVET meeting in January 2025:**

1. JVET-AK0107 AHG9: Modality Information SEI for HEVC
2. JVET-AK0168 AHG9: On SPTI SEI message: Robustness and source constant framerate
3. JVET-AK0194 AHG9: Digitally Signed Content SEI messages for AVC and HEVC

**JVET-AK1017 Support for additional SEI messages in AVC (draft 1)**

This document contains the draft text for changes to the Advanced Video Coding (AVC) standard (Rec. ITU‑T H.264 | ISO/IEC 14496-10). The changes include the support of five new SEI messages, namely the source picture timing information, modality information, digitally signed content initialization, digitally signed content selection, and digitally signed content verification SEI messages, through referencing the Versatile Supplemental Enhancement Information (VSEI) standard (Rec. ITU‑T H.274 | ISO/IEC 23002‑7).

**Changes that have been integrated for the 37th JVET meeting in January 2025:**

1. JVET-AK0107 AHG9: Modality Information SEI for HEVC
2. JVET-AK0168 AHG9: On SPTI SEI message: Robustness and source constant framerate
3. JVET-AK0194 AHG9: Digitally Signed Content SEI messages for AVC and HEVC

**JVET-AK2005 Additions and corrections for VVC version 4 (Draft 11)**

This document contains the draft text for changes to the Versatile Video Coding (VVC) standard (Rec. ITU-T H.266 | ISO/IEC 23090-3). The changes include the support of 15 new SEI messages, namely 1) SEI processing order, 2) processing order nesting, 3) encoder optimization information, 4) source picture timing information, 5) object mask information, 6) modality information, 7) text description information, 8) digitally signed content initialization, 9) digitally signed content selection, 10) digitally signed content verification, 11) generative face video, 12) generative face video enhancement, 13) AI usage restrictions, 14) packed regions information, and 15) image format metadata, through referencing the Versatile Supplemental Enhancement Information (VSEI) standard (Rec. ITU‑T H.274 | ISO/IEC 23002‑7). The changes also include updates to the interface text for support of the two neural-network post-filter (NNPF) SEI messages as well as some corrections to the previous version of the VVC standard.

**Changes to be integrated or checked:**

1. Elements from JVET-AG1004 (errata), and bug fixes from JVET-AH0002 for tickets [#1609](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1609) (NoBackwardPredFlag derivation ambiguity), [#1617](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1617) (Not initialized NumCtusInSlice[ 0 ] to 0), [#1624](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1624) (Incorrect indexing in computation of motion vector offset), [#1628](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1635) (Derivation of ModeTypeCondition should say “one or more”), [#1630](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1630) (Missing equations for applying AmvrShift), [#1631](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1631) (Should “Motion vector storing process for geometric partitioning mode” store HpelIfIdx? BBross: HpekIfIdx should always be written since it might be accessed later so it is definitely missing in "Motion vector storing process for geometric partitioning mode".), [#1632](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1632) (Incorrect indexing used for choosing matrix intra sample prediction), [#1634](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1634) (Matrices QStateTransTable,levelScale,AlfFixFiltCoeff,AlfClassToFiltMap are incorrectly transposed).

**Changes that have been integrated for the 37th JVET meeting in January 2025:**

1. JVET-AK0053 AHG9: NNPF interface text in VVC
2. JVET-AK0114 AHG9: Updates and suggestion on AI usage restrictions SEI message (add the support of the AI usage restrictions SEI message)
3. JVET-AK0140 AHG9: AHG9/AHG8: Showcase for packed regions information SEI (add the support of the packed regions information SEI message)
4. JVET-AK0168 AHG9: On SPTI SEI message: Robustness and source constant framerate
5. JVET-AK0178 AHG9: Proposed plan for initiating version 5 of VSEI (add the support of the image format metadata SEI message)
6. JVET-AK0194 AHG9: Digitally Signed Content SEI messages for AVC and HEVC (inclusion of the VPS NAL unit type to nonVclDigitallySignedNalUnitsList)
7. JVET-AK0080 AHG9: Comments on the GFV and GFVE SEI messages (inclusion of subclauses for the use of the GFV and GFVE SEI messages)
8. JVET-AK0160 AHG9: On VVC interface of object mask information and annotated regions SEI messages (removal of ConfWinLeftOffset and ConfWinTopOffset from the interface of the annotated regions SEI message and inclusion of a subclause for the use of the OMI SEI message)
9. JVET-AK0281 AHG9: On AI usage restrictions SEI message (inclusion of the payload type value of the AI usage restrictions SEI message in the SeiProcessingOrderSeiList)
10. JVET-AK0075 AHG9: Additional information on object-based optimization for the encoder optimization information SEI message (inclusion of a subclause "Use of the encoder optimization information SEI message")

**JVET-AK2006 Additional SEI messages for VSEI version 4 (Draft 5)**

This document contains the draft text for changes to the versatile supplemental enhancement information messages for coded video bitstreams (VSEI) standard (Rec. ITU-T H.274 | ISO/IEC 23002-7), to specify 15 additional SEI messages, namely 1) SEI processing order, 2) processing order nesting, 3) encoder optimization information, 4) source picture timing information, 5) object mask information, 6) modality information, 7) text description information, 8) digitally signed content initialization, 9) digitally signed content selection, 10) digitally signed content verification, 11) generative face video, 12) generative face video enhancement, 13) AI usage restrictions, 14) packed regions information, and 15) image format metadata. The changes also include updates to some of the existing SEI messages, including the two neural-network post-filter (NNPF) SEI messages, as well as some corrections to the previous version of the VSEI standard.

**Editors’ notes and changes yet to be integrated:**

* All automatically generated numbering and cross-reference fields will need to be updated after the changes are integrated into the basis text.Check the use of “pertain”; the word is not used in a similar way anywhere in the existing standard.payloadType values are to be specified the corresponding VVC, HEVC or AVC draft text. The use of prefix SEI NAL unit was enabled for all new SEI messages, whereas the use of suffix SEI NAL unit was enabled for encoder optimization information and object mask information SEI messages, since their content may be determined while the encoder encodes the associated picture.
* (JVET-AH0121 item 5) check/fix the ChromaFormatIdc derivation for the use of the colour transform information SEI message as a part of a processing chain in a similar manner as done for the film grain characteristics SEI message in JVET-AG2027 (to carefully check and communicate offline for correctness, e.g., w.r.t. JVET-AH0047).
* (JVET-AH0121 item 6) check/fix the interface variable derivation for the use of the NNPFC and NNPFA SEI messages as a part of a processing chain in a similar manner as done for the film grain characteristics SEI message in JVET-AG2027 (to carefully check and communicate offline for correctness, e.g., w.r.t. JVET-AH0047).

To be integrated:

* General editorial improvements
  + JVET-AJ0185 Editorial updates for NNPFC, SPO and TDI SEI messages
    - Item 2

**Changes that have been integrated:**

*A description of the contributions reflected in this document relative to JVET-AJ2006:*

* Source Picture Timing Information
  + JVET-AK0168 AHG9: On SPTI SEI message: Robustness and source constant framerate
* Object Mask Information
  + JVET-AK0160 AHG9: On VVC interface of object mask information and annotated regions SEI messages
  + JVET-AK0330 AHG9: Fixes to object mask information SEI message
* Generative Face Video
  + JVET-AK0080 AHG9: Comments on the GFV and GFVE SEI messages
  + JVET-AK0164 AHG9: Supplementation of value range definition and editorial bugs fixes on the GFVE pupil position SEI messages
  + JVET-AK0127 AHG9: On miscellaneous aspects of GFV and DSCI SEI messages (Item 1)
  + JVET-AK0128 AHG9: Editorial updates for GFV SEI message
  + JVET-AK0238 AHG9: Semantics fixes for generative face video
  + JVET-AK0239 AHG9: On generative face video enhancement
* SEI Processing Order
  + JVET-AK0055 AHG9: Semantics of the SPO SEI message
  + JVET-AK0205 AHG9: On SEI messages in spoPropertySeiList
  + JVET-AK0333 AHG9: On SPO sub-chain signaling
* NN Post Filter
  + JVET-AK0054 AHG9: Semantics of the NNPFC and NNPFA SEI messages
  + JVET-AK0072 AHG9: Comments on NNPF SEI messages
  + JVET-AK0326 AHG9: Proposed specification of seed value for NNPF
  + JVET-AK0152 AHG9: On Spatial Extrapolation for NNPF
* Digitally Signed Content
  + JVET-AK0109 AHG9: On signaling and constraint for RefDigest in digitally signed content SEI messages
  + JVET-AK0125 AHG9: On presence and persistency of digitally signed content SEI messages
  + JVET-AK0127 AHG9: On miscellaneous aspects of GFV and DSCI SEI messages (Item 2 & 3)
  + JVET-AK0206 AHG9: On digitally signed content SEI messages
  + JVET-AK0287 AHG9: Multilayer digitally signed content authentication SEI messages
* Encoder optimization information
  + JVET-AK0075 AHG9: Additional information on object-based optimization for the encoder optimization information SEI message
* AI usage restrictions
  + JVET-AK0114 AHG9: Updates and suggestion on AI usage restrictions SEI message
  + JVET-AK0281 On AI usage restrictions SEI message
* Image format metadata
  + JVET-AK0178 Move IFM to VSEI-v4
* Packed regions information
  + JVET-AK0140 Move PRI to VSEI-v4
* Annotated regions
  + JVET-AK0160 AHG9: On VVC interface of object mask information and annotated regions SEI messages
* General editorial improvements
* Errata items 1 to 6 in subclause 3.3 of JVET-AJ1004-v1

**Related input contributions**

Input contributions were noted as relevant to the work of this ad hoc group:

* JVET-AL0223 AHG2: Corrections and clarifications for profile-related aspects of the draft text for HEVC [G. J. Sullivan (Dolby Labs)]

**Remaining VVC spec tickets**

Closed since JVET-AK0002 was reported:

* (none)

Carried over (strikethough means addressed in the indicated errata report and can be closed):

* [#1609](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1609) NoBackwardPredFlag derivation ambiguity (Addressed in JVET-AI1004)
* [#1617](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1617) Not initialized NumCtusInSlice[0] to 0. (Addressed in JVET-AI1004)
* [#1624](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1624) Incorrect indexing in computation of motion vector offset. (Addressed in JVET-AI1004)
* [#1627](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1627) "Decoding process for palette mode" does not say what to do with output samples. (Discussed in JVET-AI1004)
* [#1628](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1628) Derivation of ModeTypeCondition should say "one or more". (Addressed in JVET-AI1004)
* [#1629](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1629) mtt\_split\_cu\_vertical\_flag context uses undefined variable chType. (Discussed in JVET-AI1004)
* [#1630](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1630) Missing equations for applying AmvrShift. (Discussed in JVET-AI1004)
* [#1631](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1631) Should "Motion vector storing process for geometric partitioning mode" store HpelIfIdx? (addressed in JVET-AI1004)
* [#1632](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1632) Incorrect indexing used for choosing matrix intra sample prediction. (Addressed in JVET-AI1004)
* [#1634](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1634) Matrices QStateTransTable, levelScale, AlfFixFiltCoeff, AlfClassToFiltMap are incorrectly transposed. (Addressed in JVET-AI1004)
* [#1635](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1635) Incorrect inference for tu\_y\_coded\_flag. (Discussed in JVET-AI1004)
* [#1644](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1644) Correction of wrong reference on VVC Annex C.4 regarding DpbOutputInterval constraint. Applicable to and corrected in HEVC as well. (Addressed in JVET-AI1004)
* [#1650](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1650) Incorrect indexing for the h location component in ALF process. (Discussed in JVET-AJ1004)
* [#1651](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1651) References to various non-existent syntax elements relating to sps\_partition\_constraints\_override\_enabled\_flag.

New (since JVET-AK0002 was reported)

* [#1652](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1652) Incorrect heading style in JVET-S2001-v17.

**Remaining HEVC spec tickets**

Closed since JVET-AK0002 was reported:

* (none)

Carried over:

* [#1427](https://hevc.hhi.fraunhofer.de/trac/hevc/ticket/1427) (8-155) and (8-157) do not seem to be used
* [#1491](https://hevc.hhi.fraunhofer.de/trac/hevc/ticket/1491) Duplicate invocation of 9.3.4.3 arithmetic decoding process
* [#1498](https://hevc.hhi.fraunhofer.de/trac/hevc/ticket/1498) Typos in the Table 9-43
* [#1500](https://hevc.hhi.fraunhofer.de/trac/hevc/ticket/1500) Typo in equation (8-69),(8-70)
* [#1504](https://hevc.hhi.fraunhofer.de/trac/hevc/ticket/1504) Small typos in profile\_tier\_level syntax in tabular form (7.3.3)
* [#1505](https://hevc.hhi.fraunhofer.de/trac/hevc/ticket/1505) Misleading bitstream requirement related to EOB NAL unit
* [#1507](https://hevc.hhi.fraunhofer.de/trac/hevc/ticket/1507) Duplicate row entries for CU QP delta syntax elements in Table 9-48
* [#1520](https://hevc.hhi.fraunhofer.de/trac/hevc/ticket/1520) Some smaller errors in the multiview spec
* [#1522](https://hevc.hhi.fraunhofer.de/trac/hevc/ticket/1522) Offset issue in clause 8.5.4.3
* [#1644](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1644) Correction of wrong reference on VVC Annex C.4 regarding DpbOutputInterval constraint. Filed as VVC ticket but applicable to and corrected in HEVC as well. (Addressed in JVET-AI1004)

New (since JVET-AK0002 was reported):

* (none)

**Recommendations**

The AHG recommends to:

* Approve JVET-AK1004, JVET-AK1006, JVET-AK1017, JVET-AK2005, and JVET-AK2006 documents as JVET outputs,
* 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 text and the algorithm and encoder description,
* Continue to improve the editorial consistency of VVC text specification 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 specification text is made available in a timely manner,
* Review bug tickets, and other AHG2 related inputs and act on them if found to be necessary.

It was further suggested to move the bug tracking to gitlab for better stability, and keep the old system for archiving.

[JVET-AL0003](https://jvet-experts.org/doc_end_user/current_document.php?id=15386) JVET AHG report: Test model software development (AHG3) [F. Bossen, X. Li, K. Sühring (co-chairs), E. François, Y. He, K. Sharman, V. Seregin, A. Tourapis (vice chairs)]

The software model versions prior to the start of the meeting were:

* [VTM 23.8](https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/-/releases/VTM-23.6) (Feb. 2025)
* [HM-18.0](https://vcgit.hhi.fraunhofer.de/jvet/HM/-/releases/HM-18.0) (Apr. 2023)
* [HM-16.21+SCM-8.8](https://vcgit.hhi.fraunhofer.de/jvet/HM/-/tags/HM-16.21+SCM-8.8) (Mar. 2020)
* [SHM 12.4](https://vcgit.hhi.fraunhofer.de/jvet/SHM/-/tags/SHM-12.4) (Jan. 2018)
* [HTM 16.3](https://vcgit.hhi.fraunhofer.de/jvet/HTM/-/tags/HTM-16.3) (Jul. 2018)
* [JM 19.1](https://vcgit.hhi.fraunhofer.de/jvet/JM/-/releases/JM-19.1) (Apr. 2023)
* [JSVM 9.19.15](https://vcgit.hhi.fraunhofer.de/jvet/jsvm/-/tags/JSVM_9_19_15)
* [JMVC 8.5](https://vcgit.hhi.fraunhofer.de/jvet/jmvc/-/tags/JMVC_8_5)
* [3DV ATM 15.0](https://vcgit.hhi.fraunhofer.de/jvet/3dv-atm/-/tags/3DV-ATM_v15.0) (no version history)
* [HDRTools 0.24](https://gitlab.com/standards/HDRTools/-/tags/v0.24) (March 2023)

Software for MFC and MFCD is only available as published by ITU-T and ISO/IEC. It is planned to create repositories with the latest versions available in ITU-T H.264.2 (02/2016). All development history is lost.

1. **Software development**

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

The server is located at:

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

The registration and development workflow are documented at:

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

Although the development process is described in the context of the VTM software, it can be applied to all other software projects hosted on the GitLab server as well.

Between the 31st and 32nd meetings, the GitLab server was affected by a huge number of spam issues, which were generated using newly registered accounts. Administrator user account confirmation was enabled to protect the server from spam postings. Proponents should plan for some time for server admins to confirm new accounts.

Between the 37th and 38th JVET meeting extensive renewal work was performed on the build server infrastructure. To finish these works, changes to the build configurations are required for all software projects using build pipelines. The necessary information will be communicated to the software coordinators during or shortly after the 38th JVET meeting.

1. **VTM related activities**

The VTM software can be found at

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

The software development continued on the GitLab server. VTM version 23.7 was tagged on Jan. 30, 2025. VTM 23.8 was tagged on Feb. 2. VTM 23.9 is expected during the 38th JVET meeting.

VTM 23.7 was tagged on Jan. 30, 2025. Changes include:

* DSC corrections
* SEI related cleanups
* JVET-AJ0234: Allow for patch-wise operation when using spatial extrapolation
* JVET-AJ0128: Adding functionality to po\_processing\_degree\_flag[i] of the SPO SEI message
* Fix for decoder when DSC SEI is not present
* JVET-AJ0131: Add nnpfc\_inband\_prompt\_flag to gate NNPF text prompt
* fix ScalingList for multilayer, when used for only one layer that is not the...
* JVET-AJ0151: Digitally Signed Content SEI messages
* Port ET with millisecond precision (from ECM MR 803)
* JVET-AJ0063: Proposal 1,2,4,5
* JVET-AJ0207: GFV SEI message
* Fix GCC 14 warning
* JVET-AJ0241: Text description SEI purpose for encoder description
* JVET-AJ0129: Add more SEI types to the list of allowed SEI types in SPO SEI
* JVET-AJ0225: Changes to RDO for enhancement layer
* Take bit depth into account when applying temporal prefilter

VTM 23.8 was tagged on Feb. 2, 2025. Changes only include removal of macros from previous meeting cycles.

VTM 23.9 is expected to be tagged during the 38th JVET meeting. Changes are expected to include:

* JVET-AK2006: Updates for SPTI SEI message
* JVET-AH0174/JVET-AJ0073: Add nnpfc\_scan\_type\_idc syntax element in the NNPFC SEI message
* JVET-AK0239: GFVE SEI message
* Merge and move configuration files for RA adaptive resolution
* JVET-AK0181: alternative configurations
* Rename "high performance" configuration folder for better reference in CTC
* JVET-AK0072 item 3: NNPF prompt null string constraint
* fix memory leak
* JVET-AJ0104\_AJ0114: Implementation of input prompt and input picture shift in NNFPA SEI message
* fixes for multilayer
* JVET-AJ0048: Update SeiProcessingOrderSeiList
* JVET-AK0075: QP threshold for object-based optimization in EOI SEI
* JVET-AK0072 items 1 and 2: nnpfc\_input\_pic\_filering flag inference and constraint
* Fix the JVET document number reference in the macro
* Update copyright header to include the year 2025
* Check minimum required version of OpenSSL
* JVET-AK0181: Fix to remove enabling of the DMVR encoder control when GOPbasedRPR is enabled
* Add cmake option ENABLE\_SEARCH\_OPENSSL
* JVET-AK0194 related: add VPS to list of signed non-VCL NAL units
* JVET-AJ0170: Flag to indicate the direction of the signalled source picture intervals

***CTC Performance***

VTM 23.8 shows identical performance compared to VTM 23.6 in SDR CTC.

For the HDR CTCs, coding performance of VTM 23.8 and VTM 23.6 are identical. Encoding/decoding run times are very close.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | |
|  | **Over VTM-23.5** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.00% | 0.00% | 0.00% | 100% | 98% |
| Class A2 | 0.00% | 0.00% | 0.00% | 100% | 98% |
| Class B | 0.00% | 0.00% | 0.00% | 100% | 98% |
| Class C | 0.00% | 0.00% | 0.00% | 100% | 103% |
| Class E | 0.00% | 0.00% | 0.00% | 100% | 100% |
| **Overall** | 0.00% | 0.00% | 0.00% | 100% | 99% |
| Class D | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class F | 0.00% | 0.00% | 0.00% | 103% | 100% |
| Class TGM | #VALUE! | #VALUE! | #VALUE! | #NUM! | #NUM! |
|  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | |
|  | **Over VTM-23.5** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.00% | 0.00% | 0.00% | 99% | 99% |
| Class A2 | 0.00% | 0.00% | 0.00% | 99% | 100% |
| Class B | 0.00% | 0.00% | 0.00% | 99% | 101% |
| Class C | 0.00% | 0.00% | 0.00% | 99% | 101% |
| Class E |  |  |  |  |  |
| **Overall** | 0.00% | 0.00% | 0.00% | 99% | 100% |
| Class D | 0.00% | 0.00% | 0.00% | 99% | 102% |
| Class F | 0.00% | 0.00% | 0.00% | 100% | 103% |
| Class TGM | #VALUE! | #VALUE! | #VALUE! | #NUM! | #NUM! |
|  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | |
|  | **Over VTM-23.5** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | 0.00% | 0.00% | 0.00% | 99% | 99% |
| Class C | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class E | 0.00% | 0.00% | 0.00% | 99% | 102% |
| **Overall** | 0.00% | 0.00% | 0.00% | 99% | 100% |
| Class D | 0.00% | 0.00% | 0.00% | 99% | 100% |
| Class F | 0.00% | 0.00% | 0.00% | 100% | 101% |
| Class TGM | #VALUE! | #VALUE! | #VALUE! | #NUM! | #NUM! |
|  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | |
|  | **Over VTM-23.5** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class C | 0.00% | 0.00% | 0.00% | 100% | 102% |
| Class E | 0.00% | 0.00% | 0.00% | 100% | 103% |
| **Overall** | 0.00% | 0.00% | 0.00% | 100% | 101% |
| Class D | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class F | 0.00% | 0.00% | 0.00% | 100% | 102% |
| Class TGM | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! |

For the high bit depth CTCs, VTM 23.8 also shows no changes in coding performance compared to VTM 23.6.

With VTM 23.8 the “Random access, adaptive resolution” configuration gives slightly better compression that the “Random access” configuration:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **Random access Main10** |  |  |
|  |  |  | **Over VTM 23.8** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -0.97% | -1.49% | -1.48% | 98% | 87% |
| Class A2 | -0.53% | 3.35% | 2.41% | 97% | 92% |
| Class B | 0.04% | 0.12% | -0.16% | 101% | 96% |
| Class C | 0.00% | 0.00% | 0.01% | 101% | 100% |
| Class E |  |  |  |  |  |
| **Overall** | -0.29% | 0.41% | 0.13% | 99% | 94% |
| Class D | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class F | 0.01% | 0.01% | 0.00% | 102% | 100% |

***Issues in VTM affecting conformance***

The following issues in VTM master branch may affect conformance:

* Missing HLS features (see sections below)

Several merge requests for proposals from the 36th or 37th JVET meeting, mostly related to SEI messages in VSEI are still pending review and/or waiting for resolution of comments and rebasing.

***Status of implementation of proposals of previous JVET meetings***

The following list contains all adoptions of the Q and R meetings that were not marked as merged (or submitted) or specification only change in the software coordinator tracking sheet:

* JVET-Q0112
* JVET-Q0154: Disallow mixing of GDR and IRAP (Disallow mixing of GDR with any non-GDR).
* JVET-Q0164
* JVET-Q0402
* JVET-R0178: Require that when no\_aps\_constraint\_flag is equal to 1, sps\_lmcs\_enabled\_flag and sps\_scaling\_list\_enabled\_flag shall be equal to 0
* JVET-R0221
* JVET-R0046: Change the description of the bitstream extraction process per the value of max\_tid\_il\_ref\_pics\_plus1[ ][ ] (aspect 1.2 per JVET-R0046-v4).
* JVET-R0065: Specify that GDR AUs shall be complete – i.e., all of the layers in the CVS shall have a picture in the AU (as with IRAP AUs).
* JVET-R0191: Update the range value for num\_ols\_hrd\_params\_minus1.
* JVET-R0222 aspect 1: Infer vps\_max\_sublayers\_minus1 to be equal to 6 when sps\_video\_parameter\_set\_id is equal to 0 (i.e. VPS is not present). The exact editorial expression is at the discretion of the editor.
* JVET-S0196 (JVET-S0144 item 17)
* JVET-S0227 (JVET-S0144 item 22)
* JVET-S0077 (JVET-S0139 item 5)
* JVET-S0174 aspect 2 (JVET-S0139 item 18.b)
* JVET-S0156 aspect 3 (JVET-S0139 item 21)
* JVET-S0139 item 26 (no source listed, text only?)
* JVET-S0188 aspect 1 (JVET-S0139 item 28)
* JVET-S0139 item 40 (item does not exist)
* JVET-S0042 (JVET-S0142 item 1.b)
* JVET-S0174 aspect 1 (JVET S0143 item 19)
* JVET-S0096 aspect 3 (JVET-S0140 item 10)
* JVET-S0096 aspect 4 (JVET-S0140 item 13)
* JVET-S0159 aspect 3 (JVET-S0140 item 16)
* JVET-S0171 (JVET-S0256)
* JVET-S0118 (JVET-S0141 item 7)
* JVET-S0102 (JVET-S0141 item 9.a)
* JVET-S0157 item 2 (JVET-S0141 item 13)
* JVET-S0157 item 4 (JVET-S0141 item 14)
* JVET-S0175 aspect 3 (JVET-S0141 item 16)
* JVET-S0175 aspect 1, 2 (JVET-S0141 item 17)
* JVET-S0175 aspects 4 and 5 (JVET-S0141 item 18)
* JVET-S0175 aspect 6 (JVET-S0141 item 19)
* JVET-S0198/ JVET-S0223 (JVET-S0141 item 24)
* JVET-S0173 aspect 2 (JVET-S0141 item 40.b)
* JVET-S0173 item 1 (JVET-S0141 item 51)
* JVET-S0173 item 3 (JVET-S0141 item 52)
* JVET-S0173 item 5 (JVET-S0141 item 53)
* JVET-S0173 item 6 (JVET-S0141 item 54)
* JVET-S0173 item 4 (JVET-S0141 item 56)
* JVET-S0176 item 4 (JVET-S0141 item 60)
* JVET-S0154 aspect 5 (JVET-S0141 item 68)
* JVET-S0154 aspect 6 (JVET-S0141 item 69)
* JVET-S0154 aspect 8 (JVET-S0141 item 71)
* JVET-S0095 aspect 5 (JVET-S0145 item 5)
* JVET-S0095 aspect 6 (JVET-S0145 item 6)
* JVET-S0100 aspect 1, depends on JVET-R0193 (JVET-S0147 item 2)
* FINB ballot comments
* Make high tier support up to 960.

***SEI TuC software***

Per the decision during the 32nd JVET meeting, an SEI TuC repository was created based on VTM-22.2. The repository is located at:

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

VTM-22.2-TuC-4.0 was tagged on Jan. 31, 2025. Changes include:

* JVET-AI0182: Bitdepth range information SEI (review pending)
* Fix typos in constituent rectangles implementation (review pending)
* JVET-AI0181: Support for Display Overlays Information (DOI) SEI (minor comments pending)

It should be noted that some of the technologies for which merge requests were submitted to TuC, got moved into the working draft. The merge requests were closed, when appropriate merge requests for VTM were available.

VTM-22.2-TuC-5.0 is expected to be tagged during the 38th JVET meeting. The following merge requests were submitted:

* JVET-AK0142: "AHG9: Display Rectangles SEI"
* JVET-AK0153: Photosensitive content SEI messages
* JVET-AJ0245: Multi-layer support for Constituent Rectangles SEI
* Draft: JVET\_AJ0060: multilayer adaptation of Packed regions information SEI message
* JVET-AI0340: Implementation of AI-restrictions usage SEI message

1. **HM related activities**

There was no new HM version tagged during this meeting cycle.

The following MRs were merged:

* Implement phase indication SEI message (JVET-AE0101)
* Update auto-build from VTM build definition
* Update copyright headers to include 2025
* JVET-AK0107: Modality Information SEI

The following MRs are pending [with status indicated]:

* JVET-AK0194: Digitally Signed Content SEI messages (pending review)
* Add support for NNPF SEI messages (pending review/rebasing)
* JVET-AL0062: AI usage restrictions SEI message (upcoming meeting to be decided)
* JVET-AK2006: Add support for SPTI SEI message (pending review/rebasing)
* JVET-AL0061: Import encoder optimization information SEI Message form VTM (pending review/rebasing)
* Port the Y4M support [one issue remains]
* Mark the current picture as short-term ref (for SCM) [need SCC expert reviewer]

A new version of HM is expected to be tagged during or after the 38th JVET meeting.

The HM SCC (SCM) branch (HM-16.21+SCM-8.8) has not been updated for the recent HM versions. Updating SCM to, for example, HM-18.0+SCM-8.8 should be considered. It may though be helpful to move SCC related functionality into separate source files. Volunteer work towards merging the branches would be appreciated.

As reported in the previous reports, further information on lambda optimisation in HM would be appreciated, including comparison of allocation of bits within the GOP structures between HM and VTM.

Otherwise the [HEVC bug tracker](https://hevc.hhi.fraunhofer.de/trac/hevc/query?status=accepted&status=assigned&status=new&status=reopened&component=HM&col=id&col=summary&col=status&col=type&col=priority&col=milestone&col=time&col=reporter&report=16&order=time) lists:

* 44 tickets for “HM”, (most of which were created before 2019; 1 created in last year),
* 1 ticket for “HM RExt” (created in 2020),
* 9 tickets for “HM SCC” (most of which were created before 2018),
* 1 ticket for “RExt Text” (created in 2015),
* 1 ticket for “SCC Text” (created in 2016),
* 8 tickets for text (6 created before 2021; 2 created in the last year),
* 2 tickets for encoder description (created in 2020 and 2014)

Help to address these tickets would be appreciated.

1. **360Lib related activities**

The latest 360Lib software can be found at <https://vcgit.hhi.fraunhofer.de/jvet/360lib/-/tags/360Lib-13.6>

The following table is for the projection formats comparison using VTM-23.0 according to 360-degree video CTC (JVET-U2012) compared to that using VTM-22.0 (VTM-22.0 as anchor).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **End-to-end WS-PSNR** | | | **End-to-end S-PSNR-NN** | | |
|  | Y | U | V | Y | U | V |
| Class S1 | 0.00% | -0.01% | 0.05% | 0.00% | 0.00% | 0.05% |
| Class S2 | 0.08% | 0.16% | 0.34% | 0.08% | 0.15% | 0.34% |
| **Overall** | 0.03% | 0.06% | 0.17% | 0.03% | 0.06% | 0.16% |

The following table compares generalized cubemap (GCMP) coding and padded equi-rectangular projection (PERP) coding using VTM-23.0 (PERP as anchor).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **End-to-end WS-PSNR** | | | **End-to-end S-PSNR-NN** | | |
|  | Y | U | V | Y | U | V |
| Class S1 | -11.52% | -5.47% | -6.09% | -11.50% | -5.41% | -6.03% |
| Class S2 | -3.65% | 0.98% | 1.48% | -3.62% | 1.08% | 1.56% |
| **Overall** | -8.37% | -2.89% | -3.06% | -8.35% | -2.82% | -3.00% |

The following tables are for PERP and GCMP coding comparison between VTM-23.0 and HM-16.22 (HM as anchor), respectively.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **End-to-end WS-PSNR** | | | **End-to-end S-PSNR-NN** | | |
|  | Y | U | V | Y | U | V |
| Class S1 | -30.91% | -38.82% | -41.24% | -30.91% | -38.88% | -41.24% |
| Class S2 | -36.84% | -37.23% | -39.43% | -36.82% | -37.27% | -39.49% |
| **Overall** | -33.28% | -38.19% | -40.51% | -33.28% | -38.23% | -40.54% |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **End-to-end WS-PSNR** | | | **End-to-end S-PSNR-NN** | | |
|  | Y | U | V | Y | U | V |
| Class S1 | -34.64% | -40.04% | -42.14% | -34.59% | -40.02% | -42.09% |
| Class S2 | -38.34% | -38.18% | -40.06% | -38.32% | -38.19% | -40.11% |
| **Overall** | -36.12% | -39.30% | -41.31% | -36.08% | -39.29% | -41.30% |

1. **SCM related activities**

There had not been any further developments to SCC’s SCM during this meeting cycle.

1. **SHM related activities**

There had not been any further developments to SHVC’s SHM during this meeting cycle.

1. **HTM related activities**

There had not been any releases of HTM of MV-HEVC and 3D-HEVC.

One merge request is was merged:

* JVET-AE0295: MV Main 10 profile support (waiting for proponent response)

The next release will also include the following changes:

* JVET-Z0209: Early termination during calculating RDcost of depth

1. **HDRTools related activities**

There had not been any further developments to HDRTools during this meeting cycle.

1. **JM, JSVM, JMVM related activities**

There had not been any further developments to JSVM or JMVM during this meeting cycle.

There was no new JM version tagged during this meeting cycle, although merge requests were submitted for SEI messages in VSEI.

The following MRs are pending [with status indicated]:

* JVET-AK0107: Modality Information SEI (pending review)
* JVET-AK2006: NNPFC and NNPFA SEI message (pending review)
* JVET-AL0062: AI usage restrictions SEI message (upcoming meeting to be decided)
* JVET-AK2006: SPTI SEI Message (pending review)
* JVET-AL0061: Encoder Optimization Information SEI Message (pending review)
* JVET-AE0101: implement phase indication SEI message (pending review)

For the previous release of JM only basic testing was performed to confirm that the code still works, but performance testing is pending. Performance changes are unlikely but may occur due to bug fixes. A possible encoder/decoder mismatch was reported privately, but needs more investigation.

1. **Bug tracking**

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

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

The bug tracker uses the same accounts as the HM software bug tracker. Users may need to log in again due to the different sub-domain.

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

New account creation was disabled due to a large amount of spam registration. Extensive maintenance of the Trac bug tracker would be required to keep it secure. It should be considered to move bug tracking to GitLab, although no automatic conversion of existing bugs is available.

Bug tracking for HDRTools is located at:

<https://gitlab.com/standards/HDRTools/-/issues>

Please file all issues related to the VVC reference software and HDRTools into the appropriate 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.

1. **CTC alignment and merging**

There are currently 8 JVET CTC documents:

JVET-AK2010 VTM/HM 4:2:0 test conditions

JVET-Z2011 VTM/HM HDR test conditions

JVET-AA2018 VTM/HM high bit depth test conditions (without spreadsheet)

JVET-T2013 VTM non-4:2:0 test conditions

JVET-AA1100 HM non-4:2:0 test conditions

JVET-U2012 VTM 360 video test conditions

JVET-AC1009 SHVC test conditions

JVET-AC1015 SCM test conditions

JVET-AE1013 3DV test conditions

Further merging of HM RExt CTC into the appropriate VVC CTC was investigated (non 4:2:0 chroma formats), but proper comparable HM configuration files were not yet available by the beginning of this meeting.

The HM HDR test conditions require additional post-processing stages, due to WPSNR, deltaE100 and PSNRL100 values not being generated directly by the HM encoder. Merging of respective functions from VTM is recommended to streamline the process.

1. **Guidelines for reference software development**

Current versions of the software guidelines are:

* [JVET-AC1001](https://jvet-experts.org/doc_end_user/current_document.php?id=12566) Guidelines for HM-based software development [K. Sühring, F. Bossen, X. Li (software coordinators)]
* [JVET-AJ2003](https://jvet-experts.org/doc_end_user/current_document.php?id=14993) Guidelines for VTM-based software development [F. Bossen, X. Li, K. Sühring]

1. **Recommendations**

The AHG recommends to:

* Continue to develop reference software.
* Improve documentation, especially the software manual.
* Encourage people to test VTM and other reference 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 and other reference software.
* Encourage people to submit non-normative changes that either reduce encoder run time without significantly sacrificing compression performance or improve compression performance without significantly increasing encoder run time.
* Design and add configuration files to the VTM software for testing of HLS features.
* Review VTM-related contributions and determine whether features should be added (or removed) from the software.
* Continue to investigate the merging of branches.
* Continue to investigate merging of CTC documents.
* Verify correctness of CTC documents and issue updates as appropriate
* Keep common test conditions aligned for the different standards.

Significant work on implementing SEI messages in VTM. Some which were moved from TuC to v4 are still in the TuC branch of the software. Still no responsibility identified for SPO/PON. Revisit.

Also merge requests submitted implementing new SEI messages in HM and JM, no new versions released yet. For implementation on multiview profiles in HM, see further notes under AHG5.

It was further suggested to move the bug tracking to gitlab for better stability, and keep the old system for archiving.[JVET-AL0004](https://jvet-experts.org/doc_end_user/current_document.php?id=15387) JVET AHG report: Test material and visual assessment (AHG4) [V. Baroncini, T. Suzuki, M. Wien (co-chairs), W. Husak, S. Iwamura, P. de Lagrange, S. Liu, X. Meng, S. Puri, A. Segall, S. Wenger (vice-chairs)]

Activities

***Testing of video coding technology beyond conditions of exploration experiments***

AHG4 has supported the activities of AHG17 on test sequence collection and characterization for the purpose of assessing video coding technology beyond the CTC.

***Test sequences***

The server providing JVET test sequences has been updated. The new site is <https://vqa.lfb.rwth-aachen.de>. A mirror of this site is available at <https://datacloud.hhi.fraunhofer.de> with the same login credentials. The directory structure of the previous ftp server has been maintained. The test sequences used for CfP/CTC are available in directory “/ctc”.

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). Members of JVET may contact the JVET chair for login information. It is suggested to update the password for the site after each meeting with the Zoom password of that meeting.

**Related contributions**

|  |  |  |
| --- | --- | --- |
| [JVET-AL0042](https://jvet-experts.org/doc_end_user/current_document.php?id=15347) | AHG4/AHG17: Additional cropped HDR sequences for non-CTC testing | [A. Filippov](mailto:alexey.filippov@tcl.com), [J. Konieczny](mailto:jacek.k@tcl.com), [Z. Zhi](mailto:zhou.zhi@tcl.com), [V. Rufitskiy](mailto:vasily.rufitskiy@tcl.com), [H. Qin](mailto:hongdong.qin@tcl.com), [T. Dong](mailto:tianyu.dong@tcl.com), [X. Tang (TCL)](mailto:xiaoyong.tang@tcl.com), [S. Shen](mailto:s.shen@nercdtv.org), [Y. Qin](mailto:yf.qin@nercdtv.org), [Y. Wang](mailto:y.wang@nercdtv.org), [X. Wang](mailto:xs.wang@nercdtv.org), [Y. Guan (NERC-DTV)](mailto:yf.guan@nercdtv.org) |

**Recommendations**

The AHG recommends:

* To progress the work in AHG17 towards setting up a test set suitable for performance assessment of video compression technology beyond the JVET CTC.
* To consider the input contribution related to AHG4/AHG17 in the development of the draft text for a potential CfE.
* To continue to discuss and to update the non-finalized categories of the verification test plan for multilayer VVC and the subjective quality test plan for FGC, including those which have not been addressed yet.
* To collect volunteers to conduct further verification tests and subjective quality tests.
* To collect volunteers to actively contribute to the verification test development.
* To review the set of available test sequences for the verification tests as well as subjective quality 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.

Multi-layer to be further discussed in context of JVET-AL0289.

For potential multi-view tests, 10 bit stereo material would be needed.

It was suggested to make updates to various CTC documents regarding the location on content only in cases when they are changed on other issues. Mentioning the location in JVET-AL1012 should be sufficient, or refer to that document in CTC documents.

[JVET-AL0005](https://jvet-experts.org/doc_end_user/current_document.php?id=15388) JVET AHG report: Conformance testing (AHG5) [I. Moccagatta (chair), F. Bossen, T. Ikai, S. Iwamura, H.-J. Jhu, K. Kawamura, P. de Lagrange, S. Paluri, K. Sühring, Y. Yu (vice chairs)]

**Activities**

The AHG communication is conducted through the main JVET reflector, jvet@lists.rwth-aachen.de, with [AHG5] in message headers. However, no correspondence marked as AHG5 was sent between the 36th and 37th meetings.

Timeline

The progress on the Conformance testing specification is proceeding per the timeline below:

* **VVCv1 conformance:**
  + ISO/IEC FDIS 23090-15 issued from 2021-10 meeting, FDIS registered for formal approval 2022-07-11, FDIS ballot closed 2022-11-04, standard published 2022-11-24
  + H.266.1 V1 Consent 2022-01-28, Last Call began 2022-04-01, Approved 2022-04-29, pre-published 2022-05-17, standard published 2022-07-12.
* **VVCv2 conformance:**
  + ISO/IEC 23090-15/Amd.1 CDAM: 2021-10
  + ISO/IEC 23090-15/Amd.1 DAM: 2022-01
  + DAM ballot closed 2022-11-15
  + ISO/IEC FDIS 23090-15:202x 2nd edition text output of 2023-01, preparation delayed to 2023-09, FDIS ballot opened 2024-04-08, FDIS ballot closed 2024-06-03, published 2024-07-04
  + H.266.1 V2 Consent 2023-07, Last Call began 2023-08-16, Approved 2023-09-13, pre-published 2023-10-06, published 2023-10-19
* **VVCv3 conformance:**
  + CDAM: 2025-04-15
  + DAM: 2025-07-25
  + FDAM: 2026-02-20
  + IS: 2026-06-30

**Status on bitstream submission**

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

* conformance bitstreams for VVC:
  + 104 bitstream categories have been identified
  + At least one bitstream has been submitted in each identified category
  + 283 total bitstreams have been provided, checked, and made available
  + Three streams have been re-generated
  + No changes between 37th and 38th meeting.
* conformance bitstreams for VVC operation range extensions:
  + 57 bitstream categories have been identified
  + 1 bitstream of 1 identified category has been re-generated
  + 128 bitstreams of 57 identified categories have been cross-checked and uploaded.
  + No changes between 37th and 38th meeting.
* additional conformance bitstreams for VVC Multilayer:
  + 3 bitstream categories have been identified
  + At least one bitstream has been submitted in each identified category
  + 7 total bitstreams have been provided, cross-checked, and made available
  + No changes between 37th and 38th meeting.
* conformance bitstreams for new HEVC Multiview profiles
  + 2 HEVC Multiview Extended 10 bitstreams have been provided, cross-checked, and made available, no changes between 37th and 38th meeting
  + 2 HEVC Multiview Extended bitstreams have been provided, cross-checked, and made available, no changes between 37th and 38th meeting
  + 2 HEVC Multiview Main 10 bitstreams have been generated and are in the process of being cross-checked.

**Activities and Discussion**

The AHG activities are on schedule with the preliminary timeline shown in section 2.

VVC activities:

The 3 re-generated streams are available at ​[https://www.itu.int/wftp3/av-arch/jvet-site/bitstream\_exchange/VVC2ndEd\_regenerated](https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVC2ndEd_regenerated/). No change in the other bitstreams and/or packages.

VVC operation range extensions activities:

No change in bitstreams and/or packages, 2nd edition packages are available at <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVC2ndEd/>

VVC Multilayer activities:

The streams are available at <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVCMultilayer/>. No change in bitstreams and/or packages.

HEVC Multiview supporting extended bit depth activities:

As far as the new HEVC Multiview Main 10 profile in JVET-AJ0213 added at the 36th meeting and in output document AJ1006, two bitstreams have been generated and are in the process of being cross-checked. It has been reported by the cross-checker that the latest HTM can decode them.

No change in bitstreams and/or packages for the 2 HEVC Multiview Extended 10 and the 2 HEVC Multiview Extended bitstreams. The 4 packages are available at <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/HEVCMultiview/>.

No update on the implementation of the HEVC Multiview monochrome profiles (Multiview Monochrome, Multiview Monochrome 10, Multiview Monochrome 12, and Multiview Monochrome 16 profiles, collectively referred to as the multiview format range extensions profiles) in JVET-AH1006 and in WG5 N0281. Last input report was JVET-AJ0214 from 36th meeting. No update on the generation of corresponding conformance streams either.

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.

**Contributions**

No contributions.

**Ftp site information**

The procedure to exchange the bitstream (ftp cite, bitstream files, etc.) is specified in Sec 2 “Procedure” of [JVET-R2008](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=8861). The ftp and http sites for downloading bitstreams are

* VVC:

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

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

* VVC operation range extensions:

[ftp://ftp3.itu.int/jvet-site/bitstream\_exchange/VVCv2](ftp://ftp3.itu.int/jvet-site/bitstream_exchange/VVCv2/draft_conformance/draft)

<https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVCv2>

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:

Graphical user interface, text, application, email

Description automatically generated

In the Filezilla Edit 🡪 Settings 🡪 Connection menu, it was previously necessary to set the minimum TLS level to 1.0. Since around January 2024, this configuration issue went away, and ITU disabled the use of TLS 1.0 and 1.1 on its servers.

**Recommendations**

The AHG recommends the following:

* Maintain and update the conformance bitstream database and contribute to report problems in JVET document 1004.
* Continue the generation, cross-checking, and documentation of the conformance streams for the HEVC Multiview profiles supporting extended bit depth and the new HEVC Multiview Main 10 profile.
* Prepare for a new edition of VVC conformance with the new multi-layer streams and the corrections of the existing streams.

Bitstreams available for MV 10, MV extended (8), and MV extended 10. No bitstreams yet on multiview monochrome profiles, no activity on implementation since the 36th meeting. Revisit – plan when to issue an HEVC conformance amendment.

It was suggested to issue CD on VVC conformance 3rd ed., and also have a recommendation to not use OSD editing.

[JVET-AL0006](https://jvet-experts.org/doc_end_user/current_document.php?id=15389) JVET AHG report: ECM software development (AHG6) [V. Seregin (chair), J. Chen, R. Chernyak, F. Le Léannec, K. Zhang (vice-chairs)]

**Software development**

ECM software repository is located at <https://vcgit.hhi.fraunhofer.de/ecm/ECM>.

ECM software is based on VTM-10.0 with enabled MCTF including the update from JVET-V0056, and GOP32, which is very close to VTM-11.0.

VTM-11.0ecm anchor <https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/tree/VTM11_ANC>is used for ECM performance evaluation.

The following changes were integrated into ECM-16.0:

Merge AHG7 branch with tools control [MR 822]

JVET-AK0135: CABAC contexts retraining [MR 819]

JVET-AK0064: LFNST/NSPT set derivation for CCP coded block (Test 3.2) [MR 817]

JVET-AK0081 AHG6: wPSNR log output for gaming content in ECM [MR 821]

JVET-AK0076: Extended OBMC for non-inter blocks (Test 1.1a) [MR 816]

JVET-AK0061: On MPM with matrix-based position dependent intra prediction (Test 1.12c) [MR 814]

JVET-AK0091: Using Laplacian Info in ALF [MR 820]

JVET-AK0065: Temporal ALF [MR 818]

JVET-AK0185: TMVP Selection (Test 2.5) [MR 823]

JVET-AK0121: Boundary-Aware Offset Refinement for Loop-Filters(Test 4.3b) [MR 828]

JVET-AK0101: Regression-based GPM with intra and inter prediction (Test 2.3) [MR 827]

JVET-AK0123: Restrictions on ALF coefficient values (Test 4.1a) [MR 830]

JVET-AK0118: Bilateral Filtering for Intra Prediction(Test 1.10a) [MR 829]

JVET-AK0056: Weighted OBIC (Test 1.9) [MR 815]

JVET-AK0095: Enhanced derivation of affine merge candidates (Test 2.2c) [MR 831]

JVET-AK0187: Implicit MTS Extension (Test 3.8b) [MR 825]

JVET-AK0212: OBMC modifications (Test 2.1a) [MR 833]

JVET-AK0097: Last position signaling (Test 3.4b) [MR 838]

JVET-AK0329: MTSS, combination of tests 3.1b\* and 3.7 [MR 836]

JVET-AK0087: 8-tap non-smoothing filter for angular intra prediction (Test EE2-1.11b) [MR 839]

JVET-AK0059: Intra mode coding based on HoG of neighboring templates (Test 1.2c) [MR 832]

JVET-AK0085: TM Boundary Padding (Test 2.6) [MR 844]

Fixes:

Fix: Remove encoder setting based on hash for AJ0260 [MR 834]

Fix clang 16 compiling issues (unused variables) [MR 848]

Convert assert to CHECK [MR 853]

Implementation of Control for JVET-AJ0161 (OBMC Extension with Intra Prediction) [MR 869]

ET with millisecond precision [MR 803]

Store cost for timdSAD [MR 805]

The following changes were integrated into ECM-16.1:

Add missing controls for group5 and group1-5 [MR 883]

Fix MD5sum mismatch with AHG7 group1 off [MR 885]

Fix groupoff4 test [MR 884]

Fix: Change initialization value to 0 for intra mode to be valid in tool off tests for AK0217/AK0187 [MR 886]

Convert some CHECK to CHEKCD [MR 888]

The following changes were integrated into VTM-11.0ecm anchor:

ET with millisecond precision [MR 804]

ECM-16.0 and VTM-11.0ecm16.0 were tagged on February 20, 2025.

ECM-16.1 was tagged on February 28, 2025.

***CTC Performance***

In this section, ECM test results following ECM CTC configuration descried in JVET-AI2017 are summarized.

ECM-16.0 performance over ECM-15.0 anchor is summarized in the tables below.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | |
|  | **Over ECM-15.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -0.32% | -0.63% | -0.34% | 119.1% | 101.3% | 101.7% | 97.3% |
| Class A2 | -0.36% | -0.54% | -0.61% | 111.3% | 100.9% | 104.4% | 97.3% |
| Class B | -0.39% | -0.67% | -0.80% | 111.2% | 103.3% | 98.8% | 97.3% |
| Class C | -0.65% | -0.70% | -0.74% | 108.2% | 105.6% | 102.3% | 97.0% |
| Class E | -0.66% | -0.71% | -0.65% | 114.4% | 103.3% | 106.0% | 96.9% |
| **Overall** | -0.47% | -0.66% | -0.65% | 112.3% | 103.1% | 102.2% | 97.2% |
| Class D | -0.62% | -0.84% | -1.03% | 108.1% | 107.8% | 101.8% | 96.9% |
| Class F | -0.45% | -0.60% | -0.66% | 103.7% | 97.1% | 102.5% | 97.2% |
| Class TGM | -0.24% | -0.14% | -0.18% | 102.5% | 87.7% | 102.5% | 97.5% |
|  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | |
|  | **Over ECM-15.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -0.53% | -0.39% | -0.48% | 113.6% | 107.1% | 102.7% | 100.7% |
| Class A2 | -0.57% | -0.65% | -0.51% | 112.9% | 107.9% | 102.0% | 101.2% |
| Class B | -0.82% | -0.63% | -0.58% | 115.9% | 105.3% | 105.6% | 100.5% |
| Class C | -0.58% | -0.54% | -0.64% | 111.7% | 103.5% | 103.9% | 100.3% |
| Class E |  |  |  |  |  |  |  |
| **Overall** | -0.65% | -0.56% | -0.56% | 113.7% | 105.7% | 103.8% | 100.7% |
| Class D | -0.51% | -0.99% | -0.69% | 111.2% | 103.6% | 102.7% | 100.1% |
| Class F | -0.65% | -0.63% | -0.14% | 126.9% | 100.5% | 103.8% | 100.5% |
| Class TGM | -0.39% | 0.05% | 0.03% | 122.4% | 93.9% | 106.9% | 100.6% |
|  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | |
|  | **Over ECM-15.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -0.54% | -0.39% | -0.33% | 112.9% | 104.3% | 107.3% | 99.7% |
| Class C | -0.50% | -0.44% | -0.21% | 108.0% | 101.1% | 104.7% | 98.0% |
| Class E | -0.43% | -1.31% | -1.63% | 137.2% | 103.9% | 109.1% | 99.7% |
| **Overall** | -0.50% | -0.64% | -0.62% | 116.8% | 103.1% | 106.8% | 99.1% |
| Class D | -0.55% | -0.30% | -0.41% | 108.9% | 101.8% | 103.7% | 97.4% |
| Class F | -0.50% | -0.50% | -0.64% | 121.6% | 106.1% | 106.6% | 98.1% |
| Class TGM | -0.57% | 0.02% | -0.21% | 120.5% | 90.3% | 107.6% | 99.2% |
|  |  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | | |
|  | **Over ECM-15.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -0.62% | -0.28% | -0.34% | 119.5% | 100.7% | 107.6% | 98.0% |
| Class C | -0.48% | 0.23% | -0.83% | 114.3% | 108.7% | 104.5% | 97.3% |
| Class E | -0.71% | 1.17% | 0.89% | 152.0% | 100.0% | 107.0% | 97.3% |
| **Overall** | -0.60% | 0.25% | -0.20% | 125.1% | 103.1% | 106.4% | 97.6% |
| Class D | -0.68% | -1.65% | -0.55% | 112.1% | 105.4% | 103.5% | 97.0% |
| Class F | -0.22% | -0.40% | 0.27% | 125.1% | 96.2% | 107.3% | 98.4% |
| Class TGM | -0.60% | -0.17% | 0.14% | 127.2% | 98.7% | 106.0% | 100.7% |

ECM-16.1 performance over ECM-15.0 anchor is summarized in the tables below.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | |
|  | **Over ECM-15.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -0.32% | -0.63% | -0.34% | 105.4% | 99.9% | 101.7% | 97.3% |
| Class A2 | -0.36% | -0.54% | -0.61% | 103.9% | 101.3% | 104.4% | 97.3% |
| Class B | -0.39% | -0.67% | -0.80% | 106.0% | 103.6% | 98.8% | 97.3% |
| Class C | -0.65% | -0.70% | -0.74% | 104.2% | 106.4% | 102.3% | 97.0% |
| Class E | -0.66% | -0.71% | -0.65% | 103.7% | 104.3% | 106.0% | 96.9% |
| **Overall** | -0.47% | -0.66% | -0.65% | 104.8% | 103.3% | 102.2% | 97.2% |
| Class D | -0.62% | -0.84% | -1.03% | 103.7% | 106.8% | 101.8% | 96.9% |
| Class F | -0.45% | -0.60% | -0.66% | 96.6% | 97.6% | 102.5% | 97.2% |
| Class TGM | -0.24% | -0.14% | -0.18% | 94.2% | 88.5% | 102.5% | 97.5% |
|  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | |
|  | **Over ECM-15.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -0.53% | -0.39% | -0.48% | 104.9% | 105.2% | 102.7% | 100.7% |
| Class A2 | -0.57% | -0.65% | -0.51% | 105.4% | 107.5% | 102.0% | 101.2% |
| Class B | -0.82% | -0.63% | -0.58% | 107.1% | 105.8% | 105.6% | 100.5% |
| Class C | -0.58% | -0.54% | -0.64% | 105.0% | 103.9% | 103.9% | 100.3% |
| Class E |  |  |  |  |  |  |  |
| **Overall** | -0.65% | -0.56% | -0.56% | 105.7% | 105.5% | 103.8% | 100.7% |
| Class D | -0.51% | -0.99% | -0.69% | 104.9% | 103.7% | 102.7% | 100.1% |
| Class F | -0.65% | -0.63% | -0.14% | 105.5% | 102.9% | 103.8% | 100.5% |
| Class TGM | -0.39% | 0.05% | 0.03% | 100.9% | 93.6% | 106.9% | 100.6% |
|  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | |
|  | **Over ECM-15.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -0.54% | -0.39% | -0.33% | 102.9% | 104.9% | 107.3% | 99.7% |
| Class C | -0.50% | -0.44% | -0.21% | 102.1% | 101.6% | 104.7% | 98.0% |
| Class E | -0.43% | -1.31% | -1.63% | 110.6% | 105.1% | 109.1% | 99.7% |
| **Overall** | -0.50% | -0.64% | -0.62% | 104.5% | 103.8% | 106.8% | 99.1% |
| Class D | -0.55% | -0.30% | -0.41% | 101.7% | 102.6% | 103.7% | 97.4% |
| Class F | -0.50% | -0.50% | -0.64% | 102.7% | 102.6% | 106.6% | 98.1% |
| Class TGM | -0.57% | 0.02% | -0.21% | 99.6% | 88.4% | 107.6% | 99.2% |
|  |  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | | |
|  | **Over ECM-15.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -0.62% | -0.28% | -0.34% | 103.7% | 104.3% | 107.6% | 98.0% |
| Class C | -0.48% | 0.23% | -0.83% | 105.5% | 109.9% | 104.5% | 97.3% |
| Class E | -0.71% | 1.17% | 0.89% | 111.6% | 100.9% | 107.0% | 97.3% |
| **Overall** | -0.60% | 0.25% | -0.20% | 106.3% | 105.3% | 106.4% | 97.6% |
| Class D | -0.68% | -1.65% | -0.55% | 102.1% | 104.6% | 103.5% | 97.0% |
| Class F | -0.22% | -0.40% | 0.27% | 102.7% | 99.5% | 107.3% | 98.4% |
| Class TGM | -0.60% | -0.17% | 0.14% | 98.2% | 97.9% | 106.0% | 100.7% |

The below tables show ECM-16.1 performance comparing to VTM-11.0ecm16.0 anchor.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | |
|  | **Over VTM-11.0ecm16.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -14.59% | -15.70% | -26.79% | 1197.4% | 527.4% |  |  |
| Class A2 | -21.11% | -23.87% | -28.39% | 1175.6% | 576.4% |  |  |
| Class B | -14.71% | -22.37% | -20.35% | 1115.0% | 622.9% |  |  |
| Class C | -14.85% | -11.82% | -12.99% | 1050.3% | 586.3% |  |  |
| Class E | -19.17% | -22.39% | -20.59% | 1033.0% | 649.6% |  |  |
| **Overall** | -16.53% | -19.17% | -21.17% | 1109.1% | 594.2% |  |  |
| Class D | -12.71% | -8.95% | -9.88% | 1027.3% | 624.9% |  |  |
| Class F | -30.26% | -33.90% | -34.10% | 719.4% | 656.4% |  |  |
| Class TGM | -43.26% | -48.84% | -48.12% | 543.2% | 622.8% |  |  |
|  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | |
|  | **Over VTM-11.0ecm16.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -27.30% | -23.64% | -35.77% | 1204.6% | 1070.0% |  |  |
| Class A2 | -30.50% | -33.70% | -39.05% | 1162.8% | 1307.0% |  |  |
| Class B | -25.08% | -31.91% | -29.21% | 999.8% | 1139.8% |  |  |
| Class C | -26.76% | -22.11% | -22.88% | 1053.2% | 1226.1% |  |  |
| Class E |  |  |  |  |  |  |  |
| **Overall** | -27.06% | -28.00% | -30.80% | 1084.5% | 1179.5% |  |  |
| Class D | -27.52% | -22.95% | -23.94% | 995.5% | 1342.6% |  |  |
| Class F | -33.16% | -35.27% | -35.81% | 918.3% | 851.5% |  |  |
| Class TGM | -42.58% | -47.84% | -47.64% | 742.3% | 613.8% |  |  |
|  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | |
|  | **Over VTM-11.0ecm16.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -22.10% | -35.80% | -32.15% | 992.7% | 940.5% |  |  |
| Class C | -24.50% | -24.84% | -26.38% | 936.2% | 984.3% |  |  |
| Class E | -21.74% | -26.55% | -25.95% | 952.2% | 623.4% |  |  |
| **Overall** | -22.81% | -29.83% | -28.68% | 963.4% | 861.6% |  |  |
| Class D | -25.88% | -25.77% | -26.68% | 949.4% | 1139.8% |  |  |
| Class F | -30.60% | -38.50% | -38.39% | 846.9% | 748.6% |  |  |
| Class TGM | -40.89% | -50.16% | -50.14% | 737.2% | 550.1% |  |  |
|  |  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | | |
|  | **Over VTM-11.0ecm16.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -19.96% | -44.71% | -41.93% | 867.7% | 913.2% |  |  |
| Class C | -22.51% | -33.82% | -35.20% | 816.9% | 984.3% |  |  |
| Class E | -20.46% | -34.86% | -35.18% | 869.3% | 633.6% |  |  |
| **Overall** | -20.93% | -38.62% | -38.00% | 850.8% | 854.5% |  |  |
| Class D | -25.29% | -37.55% | -37.81% | 800.0% | 1061.4% |  |  |
| Class F | -28.56% | -43.86% | -44.00% | 837.7% | 739.5% |  |  |
| Class TGM | -39.05% | -52.66% | -52.08% | 776.3% | 600.3% |  |  |

**ECM memory consumption**

ECM encoder memory consumption (VmPeak, GiB) is provided in ECM encoder log files and is summarized in the table below as maximum class-wise consumption rounded up to GiB.

|  |  |  |  |
| --- | --- | --- | --- |
|  | AI | RA | LB |
| class A (A1& A2) | 9 | 15 |  |
| class B | 4 | 6 | 5 |
| class C | 2 | 3 | 3 |
| class D | 2 | 2 | 2 |
| class E | 3 |  | 3 |
| class F | 4 | 6 | 5 |
| class TGM | 3 | 8 | 6 |

It is encouraged to care about memory allocation when developing and integrating tools into ECM. In particular, it is strongly recommended to re-use already existed memory wherever possible, rather than systematically allocating new memory, and allocate only the required amount of memory if new memory is needed.

**Recommendations**

The AHG recommends to:

* Continue to develop ECM software.
* Improve the software documentation.
* Encourage people to report all (potential) bugs that they are finding using GitLab Issues functionality <https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/issues>.
* Encourage people to submit merge requests fixing identified bugs.
* Encourage people to continue working on ECM memory consumption reduction.
* Encourage people to continue working on speeding up ECM encoder to reduce the simulation time.

[JVET-AL0007](https://jvet-experts.org/doc_end_user/current_document.php?id=15390) JVET AHG report: ECM tool assessment (AHG7) [X. Li (chair), L.-F. Chen, Z. Deng, J. Gan, E. François, R. Ishimoto, H.-J. Jhu, J. Lainema, X. Li, J. Pardo, A. Stein, H. Wang (vice chairs)]

**Group off tests**

***Test settings and crosschecking***

The following five groups of tools were defined.

* Group 1: Inter template matching tools
* Group 2: Coding tools that interleave the (merge/skip/AMVP/subblock/IBC/etc) list derivation with the intra prediction/reconstruction process
* Group 3: Intra and IBC template matching (with search) related tools
* Group 4: Tools that require more processing on the neighboring reconstructed samples than VVC
* Group 5: Tools with large memory access

The testers and crosscheckers are planed in the table below. However, a crosschecker has a computing resource issue. Another crosschecker ran the test instead but could not achieve full results before the meeting.

|  |  |  |
| --- | --- | --- |
| Tests | Testers / Crosscheckers | Testers / Crosscheckers |
| Group 1 off | Johan Pardo ([johan.esprit.pardo1@huawei.com](mailto:johan.esprit.pardo1@huawei.com)) | Charles Salmon-Legagneur ([charles.salmon-legagneur@interdigital.com](mailto:charles.salmon-legagneur@interdigital.com)) |
| Group 2 off | Jonathan Gan  ([v-jonathan.gan@oppo.com](mailto:v-jonathan.gan@oppo.com)) | Xinwei Li  ([sid.lxw@alibaba-inc.com](mailto:sid.lxw@alibaba-inc.com)) |
| Group 3 off | Ryo Ishimoto ([ishimoto.ryo@mail.sharp](mailto:ishimoto.ryo@mail.sharp)) | Zhipin Deng ([zhipin.deng@bytedance.com](mailto:zhipin.deng@bytedance.com)) |
| Group 4 off | Hong-Jheng Jhu  ([jhuhong-jheng@kwai.com](mailto:jhuhong-jheng@kwai.com)) | Alan Stein  ([alan.stein@v-nova.com](mailto:alan.stein@v-nova.com)) |
| Group 5 off | Lien-Fei Chen ([lienfei.chen@global.tencent.com](mailto:lienfei.chen@global.tencent.com)) | Jani Lainema ([jani.lainema@nokia.com](mailto:jani.lainema@nokia.com)) |
| Group 1-5 off | Xiang Li  ([xlxiangli@google.com](mailto:xlxiangli@google.com)) | Hongtao Wang  ([hongtaow@qti.qualcomm.com](mailto:hongtaow@qti.qualcomm.com)) |

ECM-16.0 and ECM-16.1 were used in the AHG7 tool off tests, as summarized in the table below. Note that encoding/decoding issues were observed for group1, group4 and group5 off. Those issues were fixed in ECM-16.1. The cfg files used are included in the ECM software package.

|  |  |  |
| --- | --- | --- |
| Tests | Testers / Crosscheckers | Testers / Crosscheckers |
| Group 1 off | ECM-16.1 | ECM-16.1 |
| Group 2 off | ECM-16.0 | ECM-16.0 |
| Group 3 off | ECM-16.0 | ECM-16.0 |
| Group 4 off | ECM-16.1 | ECM-16.1 |
| Group 5 off | ECM-16.1 | ECM-16.1 |
| Group 1-5 off | ECM-16.0 (with updated cfg) | ECM-16.0 (with updated cfg) |

***Group 1 off***

Group 1 includes inter template matching tools. The offgroup1.cfg was used in addition to ECM CTC settings.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | **All Intra Main10** | | | | | |
|  | | | | **Over ECM-16.1** | | | | **Over VTM-11ecm16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 0.00% | 0.00% | 0.00% | 101.4% | 100.5% | #DIV/0! | -14.59% | -15.70% | -26.79% | 1179.1% | 600.5% |
| Class A2 | 0.00% | 0.00% | 0.00% | 100.7% | 100.4% | #DIV/0! | -21.11% | -23.87% | -28.39% | 1159.8% | 640.9% |
| Class B | 0.00% | -0.01% | -0.01% | 99.9% | 97.4% | #DIV/0! | -14.72% | -22.37% | -20.35% | 1080.0% | 659.8% |
| Class C | -0.01% | -0.01% | -0.01% | 100.0% | 99.9% | #DIV/0! | -14.85% | -11.82% | -13.00% | 1077.6% | 618.8% |
| Class E | -0.01% | -0.01% | -0.01% | 98.0% | 99.4% | #DIV/0! | -19.18% | -22.40% | -20.60% | 991.2% | 688.4% |
| **Overall** | -0.01% | -0.01% | -0.01% | 100.0% | 99.3% | #DIV/0! | -16.54% | -19.17% | -21.17% | 1092.7% | 641.8% |
| Class D | -0.03% | -0.02% | -0.03% | 99.3% | 98.4% | #DIV/0! | -12.73% | -8.97% | -9.90% | 1030.3% | 649.7% |
| Class F | -0.01% | -0.01% | -0.01% | 97.5% | 96.2% | #DIV/0! | -30.27% | -33.90% | -34.11% | 639.3% | 644.2% |
| Class TGM | -0.01% | -0.01% | -0.01% | 99.8% | 99.1% | #DIV/0! | -43.26% | -48.85% | -48.12% | 544.2% | 654.9% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | | | | | | **Random Access Main 10** | | | | | |
|  | | | | **Over ECM-16.1** | | | | **Over VTM-11ecm16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 4.87% | 4.62% | 5.07% | 85.1% | 74.0% | #DIV/0! | -23.73% | -20.29% | -32.35% | 1010.2% | 948.4% |
| Class A2 | 5.75% | 5.74% | 5.95% | 85.7% | 67.8% | #DIV/0! | -26.50% | -29.96% | -35.41% | 965.8% | 1017.3% |
| Class B | 4.62% | 4.78% | 4.71% | 81.3% | 67.4% | #DIV/0! | -21.58% | -28.61% | -25.84% | 790.3% | 918.4% |
| Class C | 4.93% | 5.01% | 5.46% | 77.0% | 63.6% | #DIV/0! | -23.11% | -18.20% | -18.65% | 788.7% | 884.8% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 4.98% | 5.00% | 5.23% | 81.7% | 67.7% | #DIV/0! | -23.40% | -24.44% | -27.14% | 863.5% | 934.1% |
| Class D | 4.03% | 4.16% | 4.30% | 75.3% | 62.8% | #DIV/0! | -24.53% | -19.69% | -20.62% | 729.1% | 926.2% |
| Class F | 3.77% | 3.85% | 4.02% | 87.9% | 73.5% | #DIV/0! | -30.54% | -32.64% | -33.13% | 736.3% | 656.3% |
| Class TGM | 4.59% | 4.43% | 4.36% | 89.8% | 80.2% | #DIV/0! | -39.94% | -45.47% | -45.30% | 648.9% | 617.5% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | | | | | | **Low delay B Main10** | | | | | |
|  | | | | **Over ECM-16.1** | | | | **Over VTM-11ecm16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 5.89% | 6.28% | 6.05% | 68.6% | 58.3% | #DIV/0! | -17.48% | -31.87% | -28.17% | 672.1% | 666.5% |
| Class C | 5.74% | 5.52% | 6.35% | 68.6% | 54.1% | #DIV/0! | -20.16% | -20.72% | -21.71% | 634.7% | 620.4% |
| Class E | 6.28% | 7.27% | 7.10% | 73.3% | 67.3% | #DIV/0! | -16.82% | -21.31% | -20.74% | 692.4% | 558.8% |
| **Overall (Ref)** | 5.94% | 6.28% | 6.41% | 69.7% | 58.9% | #DIV/0! | -18.21% | -25.51% | -24.16% | 664.3% | 622.7% |
| Class D | 5.20% | 5.27% | 5.26% | 69.0% | 54.9% | #DIV/0! | -22.00% | -21.84% | -22.86% | 638.1% | 665.5% |
| Class F | 5.63% | 5.52% | 4.08% | 82.7% | 67.4% | #DIV/0! | -26.61% | -35.08% | -35.67% | 669.5% | 535.1% |
| Class TGM | 6.62% | 6.46% | 6.41% | 84.6% | 68.5% | #DIV/0! | -36.91% | -46.76% | -46.68% | 620.7% | 480.8% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | | | | | | **Low delay P Main10** | | | | | |
|  | | | | **Over ECM-16.1** | | | | **Over VTM-11ecm16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 4.13% | 4.83% | 4.92% | 78.6% | 61.9% | #DIV/0! | -16.62% | -42.19% | -39.25% | 662.1% | 645.8% |
| Class C | 3.99% | 3.73% | 4.96% | 77.8% | 53.6% | #DIV/0! | -19.39% | -31.33% | -31.88% | 598.4% | 579.8% |
| Class E | 4.98% | 4.16% | 4.10% | 84.8% | 70.7% | #DIV/0! | -16.46% | -32.21% | -32.65% | 681.6% | 524.5% |
| **Overall (Ref)** | 4.30% | 4.29% | 4.73% | 79.8% | 61.0% | #DIV/0! | -17.50% | -36.08% | -35.14% | 644.8% | 591.4% |
| Class D | 3.93% | 4.23% | 5.40% | 75.1% | 53.5% | #DIV/0! | -22.26% | -34.80% | -34.28% | 570.8% | 607.0% |
| Class F | 4.38% | 3.17% | 3.11% | 90.0% | 68.8% | #DIV/0! | -25.36% | -41.94% | -41.99% | 679.2% | 530.8% |
| Class TGM | #VALUE! | #VALUE! | #VALUE! | #NUM! | #NUM! | #DIV/0! | #VALUE! | #VALUE! | #VALUE! | #NUM! | #NUM! |

***Group 2 off***

Group 2 includes coding tools that interleave the (merge/skip/AMVP/subblock/IBC/etc) list derivation with the intra prediction/reconstruction process. The offgroup2.cfg was used in addition to ECM CTC settings.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | **All Intra Main10** | | | | | |
|  | | | | **Over ECM16** | | | | **Over VTM11ecm16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 0.15% | 0.46% | 0.45% | 94.4% | 96.5% | 100% | -14.46% | -15.33% | -26.43% | 1221.8% | 551.3% |
| Class A2 | 0.25% | 0.41% | 0.39% | 93.8% | 97.7% | 100% | -20.90% | -23.58% | -28.12% | 1137.3% | 579.1% |
| Class B | 0.20% | 0.49% | 0.51% | 92.1% | 95.8% | 96% | -14.54% | -22.02% | -19.93% | 1071.0% | 612.8% |
| Class C | 0.14% | 0.37% | 0.43% | 91.8% | 94.9% | 100% | -14.72% | -11.49% | -12.60% | 1038.8% | 571.3% |
| Class E | 0.31% | 0.47% | 0.56% | 93.4% | 96.5% | 99% | -18.91% | -22.04% | -20.14% | 1031.1% | 653.4% |
| **Overall** | 0.21% | 0.44% | 0.47% | 92.9% | 96.1% | 99% | -16.36% | -18.83% | -20.79% | 1091.4% | 593.5% |
| Class D | 0.08% | 0.42% | 0.51% | 90.6% | 91.6% | 100% | -12.63% | -8.58% | -9.41% | 1005.8% | 612.1% |
| Class F | 0.58% | 0.62% | 0.80% | 92.6% | 97.3% | 98% | -29.88% | -33.48% | -33.60% | 610.8% | 636.2% |
| Class TGM | 0.44% | 0.51% | 0.50% | 93.4% | 99.7% | 100% | -43.00% | -48.58% | -47.86% | 519.8% | 638.1% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | | | | | | **Random Access Main 10** | | | | | |
|  | | | | **Over ECM16** | | | | **Over VTM11ecm16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 2.36% | 1.28% | 2.05% | 88.8% | 98.3% | 100% | -25.59% | -22.60% | -34.48% | 1080.7% | 1168.3% |
| Class A2 | 1.39% | 1.11% | 1.64% | 88.0% | 98.2% | 100% | -29.52% | -32.96% | -38.02% | 1034.4% | 1470.1% |
| Class B | 1.45% | 0.90% | 1.20% | 88.3% | 97.5% | 99% | -23.98% | -31.28% | -28.28% | 911.9% | 1246.2% |
| Class C | 1.00% | 1.14% | 1.08% | 87.0% | 94.8% | 98% | -26.04% | -21.22% | -22.06% | 960.9% | 1311.5% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 1.50% | 1.08% | 1.42% | 88.0% | 97.1% | 99% | -25.96% | -27.20% | -29.81% | 981.1% | 1289.0% |
| Class D | 0.48% | 0.36% | 0.71% | 85.7% | 95.2% | 99% | -27.16% | -22.64% | -23.38% | 924.7% | 1530.4% |
| Class F | 1.96% | 2.25% | 1.64% | 90.3% | 95.2% | 99% | -31.85% | -33.83% | -34.69% | 818.7% | 804.9% |
| Class TGM | 3.39% | 5.38% | 5.56% | 92.2% | 99.6% | 99% | -40.76% | -45.32% | -45.05% | 732.5% | 711.4% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | | | | | | **Low delay B Main10** | | | | | |
|  | | | | **Over ECM16** | | | | **Over VTM11ecm16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 1.81% | 3.71% | 3.45% | 82.1% | 95.0% | 99% | -20.69% | -33.49% | -29.90% | 850.2% | 1043.4% |
| Class C | 1.58% | 2.63% | 3.64% | 82.8% | 90.7% | 99% | -23.36% | -22.92% | -23.73% | 823.0% | 1033.0% |
| Class E | 1.26% | 2.99% | 4.56% | 85.7% | 93.3% | 99% | -20.74% | -24.44% | -22.50% | 879.4% | 707.0% |
| **Overall (Ref)** | 1.60% | 3.17% | 3.79% | 83.2% | 93.1% | 99% | -21.59% | -27.70% | -26.00% | 848.2% | 943.5% |
| Class D | 0.85% | 2.78% | 3.68% | 78.9% | 92.1% | 98% | -25.22% | -23.65% | -23.90% | 823.1% | 1274.3% |
| Class F | 2.51% | 2.97% | 3.69% | 87.1% | 93.9% | 99% | -28.89% | -36.78% | -36.14% | 783.8% | 765.2% |
| Class TGM | 2.57% | 7.47% | 8.76% | 90.2% | 95.7% | 101% | -39.49% | -46.78% | -46.42% | 710.4% | 653.8% |

***Group 3 off***

Group 3 includes intra and IBC template matching (with search) related tools. The offgroup3.cfg was used in addition to ECM CTC settings.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | **All Intra Main10** | | | | | |
|  | | | | **Over ECM16** | | | | **Over VTM11ecm16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 1.14% | 3.90% | 6.19% | 72.7% | 90.4% | 100% | -13.61% | -12.68% | -22.69% | 923.7% | 508.9% |
| Class A2 | 2.46% | 6.29% | 6.16% | 71.3% | 79.9% | 100% | -19.11% | -19.44% | -24.43% | 857.9% | 482.3% |
| Class B | 2.46% | 5.08% | 5.34% | 69.4% | 79.4% | 100% | -12.64% | -18.82% | -16.34% | 783.7% | 504.5% |
| Class C | 2.20% | 2.80% | 3.16% | 68.9% | 79.0% | 100% | -13.01% | -9.44% | -10.32% | 756.3% | 476.0% |
| Class E | 3.46% | 4.93% | 4.57% | 70.7% | 78.8% | 100% | -16.37% | -18.71% | -17.00% | 756.9% | 525.0% |
| **Overall** | 2.35% | 4.55% | 5.00% | 70.4% | 81.0% | 100% | -14.58% | -15.80% | -17.52% | 806.6% | 498.3% |
| Class D | 1.44% | 2.31% | 2.62% | 69.4% | 79.9% | 100% | -11.45% | -6.88% | -7.52% | 738.1% | 524.6% |
| Class F | 6.31% | 7.16% | 7.45% | 72.0% | 70.4% | 99% | -26.06% | -29.54% | -29.53% | 486.3% | 436.5% |
| Class TGM | 11.70% | 13.57% | 13.98% | 76.4% | 57.8% | 100% | -36.77% | -42.07% | -41.07% | 433.3% | 368.2% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | | | | | | **Random Access Main 10** | | | | | |
|  | | | | **Over ECM16** | | | | **Over VTM11ecm16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 1.09% | 2.84% | 6.70% | 92.2% | 98.5% | 100% | -26.52% | -21.56% | -32.29% | 1065.5% | 1117.1% |
| Class A2 | 1.52% | 4.01% | 3.84% | 93.1% | 98.0% | 100% | -29.45% | -31.16% | -36.76% | 1037.0% | 1347.2% |
| Class B | 1.27% | 4.70% | 4.73% | 90.5% | 96.6% | 100% | -24.13% | -28.75% | -25.90% | 880.9% | 1180.7% |
| Class C | 0.92% | 1.42% | 1.89% | 93.1% | 95.1% | 100% | -26.08% | -20.98% | -21.38% | 949.2% | 1320.7% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 1.19% | 3.31% | 4.19% | 92.0% | 96.9% | 100% | -26.19% | -25.72% | -28.15% | 964.4% | 1235.3% |
| Class D | 0.78% | 2.09% | 2.21% | 94.3% | 101.5% | 100% | -26.96% | -21.30% | -22.22% | 891.4% | 1468.4% |
| Class F | 4.27% | 5.42% | 4.99% | 90.2% | 89.5% | 100% | -30.52% | -32.22% | -32.95% | 791.5% | 732.1% |
| Class TGM | 7.20% | 8.92% | 9.40% | 93.8% | 94.9% | 100% | -38.46% | -43.21% | -42.75% | 748.6% | 652.4% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | | | | | | **Low delay B Main10** | | | | | |
|  | | | | **Over ECM16** | | | | **Over VTM11ecm16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 0.49% | 1.62% | 1.99% | 93.9% | 100.9% | 100% | -21.73% | -34.84% | -31.00% | 903.3% | 1014.7% |
| Class C | 0.51% | 0.84% | 1.13% | 94.6% | 96.4% | 100% | -24.12% | -24.21% | -25.56% | 829.8% | 1060.0% |
| Class E | 0.86% | 2.72% | 4.22% | 95.7% | 94.1% | 100% | -21.05% | -24.60% | -22.67% | 901.1% | 663.1% |
| **Overall (Ref)** | 0.59% | 1.64% | 2.26% | 94.6% | 97.7% | 100% | -22.35% | -28.74% | -27.10% | 877.6% | 925.7% |
| Class D | 0.33% | 0.10% | 1.35% | 95.9% | 104.2% | 100% | -25.63% | -25.75% | -25.64% | 879.3% | 1203.6% |
| Class F | 3.49% | 5.01% | 5.06% | 92.0% | 97.9% | 100% | -28.32% | -35.78% | -35.55% | 818.3% | 744.6% |
| Class TGM | 4.94% | 5.94% | 6.54% | 91.9% | 96.7% | 100% | -38.00% | -47.35% | -47.05% | 742.7% | 617.5% |

***Group 4 off***

Group 4 includes tools that require more processing on the neighboring reconstructed samples than VVC.

The offgroup4.cfg was used in addition to ECM CTC settings.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | **All Intra Main10** | | | | | |
|  | | | | **Over ECM-16.1** | | | | **Over VTM-11-ECM16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 1.67% | 7.00% | 9.34% | 85.0% | 86.4% | 100% | -13.17% | -10.24% | -20.41% | 725.6% | 317.9% |
| Class A2 | 2.59% | 7.03% | 8.34% | 81.3% | 90.6% | 100% | -19.16% | -18.88% | -23.08% | 710.8% | 360.4% |
| Class B | 1.04% | 7.49% | 6.42% | 89.0% | 93.7% | 99% | -13.83% | -17.28% | -15.53% | 913.7% | 542.3% |
| Class C | 1.01% | 3.54% | 3.54% | 83.6% | 92.2% | 100% | -14.01% | -8.81% | -9.98% | 864.0% | 545.4% |
| Class E | 1.43% | 7.39% | 5.94% | 86.2% | 96.5% | 100% | -18.03% | -17.09% | -16.01% | 843.5% | 572.3% |
| **Overall** | 1.46% | 6.44% | 6.51% | 85.3% | 92.1% | 100% | -15.35% | -14.46% | -16.45% | 821.8% | 468.2% |
| Class D | 0.91% | 3.25% | 3.27% | 84.0% | 97.1% | 100% | -11.91% | -6.03% | -6.91% | 843.9% | 547.0% |
| Class F | 1.29% | 4.13% | 4.03% | 90.5% | 95.7% | 99% | -29.38% | -31.30% | -31.51% | 501.1% | 544.3% |
| Class TGM | 2.22% | 3.96% | 4.15% | 90.3% | 99.6% | 100% | -42.06% | -46.91% | -46.07% | 450.7% | 569.3% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | | | | | | **Random Access Main 10** | | | | | |
|  | | | | **Over ECM-16.1** | | | | **Over VTM-11-ECM16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 1.67% | 3.87% | 6.29% | 91.1% | 100.0% | 100% | -26.10% | -20.82% | -32.23% | 777.0% | 686.5% |
| Class A2 | 1.26% | 3.83% | 4.20% | 92.5% | 101.2% | 100% | -29.62% | -31.26% | -36.58% | 747.8% | 840.9% |
| Class B | 1.04% | 6.22% | 5.93% | 94.3% | 97.9% | 100% | -24.30% | -27.86% | -25.22% | 837.9% | 996.7% |
| Class C | 1.12% | 2.00% | 2.35% | 93.4% | 100.3% | 100% | -25.95% | -20.55% | -21.06% | 885.9% | 1179.5% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 1.23% | 4.15% | 4.70% | 93.1% | 99.6% | 100% | -26.16% | -25.18% | -27.79% | 818.9% | 935.2% |
| Class D | 0.88% | 2.60% | 2.05% | 93.0% | 95.0% | 100% | -26.86% | -20.98% | -22.42% | 855.7% | 1164.0% |
| Class F | 1.33% | 3.04% | 3.01% | 97.2% | 101.2% | 100% | -32.35% | -33.53% | -33.99% | 734.4% | 699.0% |
| Class TGM | 0.83% | 1.54% | 1.60% | 94.8% | 103.1% | 99% | -42.13% | -47.05% | -46.83% | 636.3% | 590.5% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | | | | | | **Low delay B Main10** | | | | | |
|  | | | | **Over ECM-16.1** | | | | **Over VTM-11-ECM16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 1.07% | 1.54% | 1.52% | 97.1% | 99.0% | 100% | -21.27% | -34.90% | -31.34% | 886.9% | 838.9% |
| Class C | 1.31% | 0.90% | 0.85% | 98.0% | 97.7% | 99% | -23.52% | -24.20% | -25.78% | 855.7% | 921.4% |
| Class E | 0.99% | 4.86% | 4.08% | 99.2% | 101.9% | 99% | -20.96% | -23.14% | -22.84% | 826.0% | 578.2% |
| **Overall (Ref)** | 1.13% | 2.16% | 1.93% | 97.9% | 99.3% | 100% | -21.94% | -28.40% | -27.36% | 861.0% | 788.6% |
| Class D | 0.95% | -0.18% | 0.12% | 98.6% | 98.7% | 99% | -25.12% | -25.94% | -26.62% | 842.9% | 1027.4% |
| Class F | 1.22% | 2.64% | 0.96% | 96.8% | 96.7% | 100% | -29.78% | -37.06% | -37.84% | 691.8% | 586.9% |
| Class TGM | 0.51% | 1.28% | 1.51% | 97.7% | 103.6% | 100% | -40.60% | -49.51% | -49.41% | 671.4% | 531.0% |

***Group 5 off***

Group 5 includes tools which need large memory access.

The offgroup5.cfg was used in addition to ECM CTC settings.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | **All Intra Main10** | | | | | |
|  | | | | **Over ECM-16.1** | | | | **Over VTM-11.0ecm16.0** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 4.43% | 5.07% | 4.83% | 79.0% | 82.8% | 90% | -10.76% | -11.45% | -23.26% | 806.3% | 401.5% |
| Class A2 | 3.60% | 3.45% | 4.04% | 81.0% | 87.7% | 90% | -18.24% | -21.35% | -25.68% | 809.6% | 473.0% |
| Class B | 4.19% | 4.18% | 4.69% | 80.5% | 86.6% | 79% | -11.13% | -19.28% | -16.65% | 773.0% | 494.8% |
| Class C | 6.04% | 4.42% | 5.17% | 79.9% | 88.7% | 91% | -9.86% | -8.05% | -8.68% | 766.9% | 493.2% |
| Class E | 6.01% | 5.43% | 4.20% | 81.0% | 86.9% | 87% | -14.31% | -18.31% | -17.28% | 729.5% | 528.3% |
| **Overall** | 4.84% | 4.47% | 4.63% | 80.3% | 86.6% | 87% | -12.50% | -15.66% | -17.59% | 775.6% | 479.2% |
| Class D | 4.90% | 4.63% | 5.41% | 78.7% | 87.8% | 97% | -8.43% | -4.72% | -4.97% | 731.5% | 514.8% |
| Class F | 4.19% | 2.63% | 3.40% | 87.6% | 87.2% | 88% | -27.16% | -31.86% | -31.64% | 566.6% | 522.3% |
| Class TGM | 0.54% | 0.63% | 0.60% | 88.2% | 88.9% | 81% | -42.95% | -48.53% | -47.83% | 473.5% | 555.8% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | | | | | | **Random Access Main 10** | | | | | |
|  | | | | **Over ECM-16.1** | | | | **Over VTM-11.0ecm16.0** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 3.88% | 3.35% | 4.32% | 92.8% | 91.0% | 97% | -24.50% | -21.05% | -33.27% | 1039.9% | 947.8% |
| Class A2 | 3.40% | 2.59% | 3.02% | 93.9% | 92.8% | 97% | -28.15% | -32.02% | -37.22% | 1021.1% | 1224.1% |
| Class B | 4.10% | 2.86% | 3.53% | 92.3% | 92.0% | 84% | -22.01% | -30.03% | -26.72% | 860.0% | 1076.6% |
| Class C | 5.30% | 3.55% | 4.26% | 95.6% | 93.8% | 91% | -22.86% | -19.38% | -19.65% | 926.6% | 1241.5% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 4.24% | 3.09% | 3.78% | 93.6% | 92.5% | 91% | -23.97% | -25.79% | -28.25% | 943.1% | 1118.5% |
| Class D | 4.60% | 3.95% | 4.37% | 93.2% | 93.9% | 96% | -24.14% | -19.87% | -20.58% | 841.1% | 1358.4% |
| Class F | 3.26% | 2.98% | 2.91% | 87.6% | 90.5% | 89% | -30.83% | -33.24% | -33.75% | 699.1% | 694.5% |
| Class TGM | 0.83% | 0.93% | 1.02% | 85.4% | 82.0% | 87% | -42.07% | -47.33% | -47.11% | 600.0% | 513.3% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | | | | | | **Low delay B Main10** | | | | | |
|  | | | | **Over ECM-16.1** | | | | **Over VTM-11.0ecm16.0** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 3.42% | 1.11% | 1.33% | 93.6% | 87.9% | 80% | -19.46% | -35.08% | -31.41% | 850.8% | 860.7% |
| Class C | 4.98% | 1.88% | 1.85% | 95.2% | 88.7% | 91% | -20.77% | -23.47% | -25.10% | 814.7% | 963.5% |
| Class E | 4.20% | 3.03% | 2.22% | 87.7% | 89.2% | 89% | -18.44% | -24.42% | -24.30% | 739.9% | 624.1% |
| **Overall (Ref)** | 4.13% | 1.85% | 1.73% | 92.6% | 88.5% | 86% | -19.64% | -28.54% | -27.53% | 809.8% | 824.7% |
| Class D | 4.33% | 2.09% | 1.40% | 94.9% | 90.4% | 96% | -22.64% | -24.13% | -25.42% | 814.6% | 1122.9% |
| Class F | 3.45% | 2.38% | 2.03% | 87.1% | 88.2% | 86% | -28.12% | -37.14% | -37.11% | 673.5% | 642.3% |
| Class TGM | 1.14% | 1.08% | 1.22% | 85.5% | 87.0% | 85% | -40.19% | -49.61% | -49.51% | 596.5% | 513.9% |

***Group 1-5 off***

In this test, all the tools in the group 1-5 are switched off. The offgroup1-5.cfg was used in addition to ECM CTC settings.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | | | | | | **All Intra Main10** | | | | | |
|  | | | | **Over ECM-16** | | | | **Over VTM-11-ECM16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 9.22% | 17.28% | 22.96% | 32.9% | 48.0% | 89% | -6.66% | -1.96% | -11.21% | 379.9% | 183.3% |
| Class A2 | 10.82% | 19.55% | 20.91% | 34.6% | 43.4% | 89% | -12.54% | -9.93% | -14.71% | 360.3% | 173.1% |
| Class B | 9.83% | 18.94% | 18.42% | 32.5% | 36.9% | 85% | -6.33% | -9.01% | -6.26% | 387.5% | 207.7% |
| Class C | 11.01% | 12.32% | 13.74% | 33.8% | 39.1% | 96% | -5.69% | -1.28% | -1.35% | 378.6% | 217.3% |
| Class E | 14.91% | 21.13% | 18.09% | 32.2% | 37.3% | 96% | -7.14% | -6.80% | -6.37% | 377.7% | 216.9% |
| **Overall** | 11.00% | 17.66% | 18.50% | 33.1% | 40.2% | 91% | -7.41% | -5.90% | -7.42% | 378.0% | 200.8% |
| Class D | 8.72% | 10.98% | 12.39% | 33.4% | 37.2% | 97% | -5.10% | 1.02% | 1.32% | 357.0% | 211.9% |
| Class F | 18.03% | 21.07% | 22.21% | 43.5% | 36.7% | 94% | -17.96% | -20.81% | -20.18% | 274.5% | 210.3% |
| Class TGM | 18.84% | 22.74% | 23.75% | 46.1% | 37.9% | 87% | -32.83% | -37.49% | -36.17% | 259.2% | 213.6% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | | | | | | **Random Access Main 10** | | | | | |
|  | | | | **Over ECM-16** | | | | **Over VTM-11-ECM16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 15.74% | 16.15% | 25.90% | 49.2% | 62.4% | 97% | -15.92% | -11.52% | -20.80% | 510.9% | 444.3% |
| Class A2 | 15.52% | 19.69% | 20.85% | 50.4% | 58.8% | 97% | -19.75% | -21.02% | -26.49% | 492.2% | 510.1% |
| Class B | 14.18% | 21.19% | 21.30% | 44.5% | 58.0% | 83% | -14.42% | -17.78% | -14.30% | 468.2% | 565.3% |
| Class C | 14.72% | 15.46% | 17.11% | 46.2% | 53.2% | 90% | -15.92% | -10.13% | -9.77% | 482.3% | 600.0% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 14.90% | 18.36% | 21.01% | 47.0% | 57.7% | 90% | -16.19% | -15.14% | -16.83% | 485.0% | 536.2% |
| Class D | 11.83% | 13.79% | 15.33% | 44.9% | 53.7% | 95% | -18.79% | -12.29% | -12.25% | 452.2% | 625.3% |
| Class F | 18.31% | 20.53% | 21.40% | 38.8% | 60.2% | 90% | -21.06% | -22.56% | -22.52% | 441.8% | 411.3% |
| Class TGM | 20.18% | 25.20% | 26.00% | 38.8% | 54.6% | 89% | -31.10% | -34.95% | -34.38% | 403.3% | 309.2% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | | | | | | **Low delay B Main10** | | | | | |
|  | | | | **Over ECM-16** | | | | **Over VTM-11-ECM16** | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 13.33% | 14.66% | 15.81% | 37.7% | 40.3% | 78% | -11.70% | -26.65% | -21.85% | 439.6% | 359.3% |
| Class C | 14.41% | 12.76% | 14.94% | 40.6% | 38.8% | 89% | -13.70% | -15.37% | -15.44% | 388.7% | 364.2% |
| Class E | 14.48% | 21.63% | 18.12% | 34.0% | 56.9% | 83% | -10.41% | -11.34% | -12.44% | 434.6% | 322.3% |
| **Overall (Ref)** | 13.98% | 15.77% | 16.10% | 37.6% | 43.4% | 83% | -12.04% | -19.06% | -17.36% | 420.8% | 351.3% |
| Class D | 12.22% | 13.02% | 15.45% | 37.5% | 39.8% | 94% | -16.75% | -16.17% | -15.36% | 362.4% | 424.6% |
| Class F | 17.98% | 18.45% | 19.91% | 35.9% | 48.6% | 87% | -18.17% | -27.74% | -26.53% | 390.4% | 303.2% |
| Class TGM | 18.98% | 26.46% | 28.74% | 38.5% | 50.8% | 84% | -29.74% | -37.41% | -36.71% | 444.1% | 262.1% |

***Summary***

The tool-off results on top of the recent ECM versions are summarized below for BD-PSNR-Y. Note that SCC results are not included.

**Issues**

***Resolved issues***

* #101, ECM 16.0 decoding, MD5sum mismatch with AHG7 group1 off
* #100, ECM 16.0 encoding crash with AHG7 group4 off
* #96, [Current master tip (dad860d2) encoding crash with AHG7 group1-5 off](https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/issues/96)

***Open issues***

* #91, MaxTU setting
* #87, ECM-15.0 decoder crashes when "InterLFNST=0"
* #80, Compilation Issue ECM14.0 when disabling GPM reordering
* #78, Encoder crash in RA with --LMChroma=0
* #77, Encoder crash in RA with --DepQuant=0 --NumSignPred=0
* #71, Encode/decode mismatch when using single tree
* #66, [Difference in encoding results of ECM-12.0 in AhG7 group 2 tool off test](https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/issues/66)
* #65, [Different encoding results of ECM12 in AHG7 group1-4 off tests](https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/issues/65)
* #64, [Encode/decode mismatch and decoder crash when inter-CCCM is disable](https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/issues/64)
* #53, Decoding mismatch was observed when AMVR is off

**Input contributions**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| [JVET-AL0083](https://jvet-experts.org/doc_end_user/current_document.php?id=15408) | m71879 | 2025-03-18 18:30:00 | 2025-03-19 17:13:13 | 2025-03-19 17:13:13 | AHG7: On Luma-Chroma Gain Rebalancing | [X. Li (Google)](mailto:xlxiangli@google.com), [Y. Wang](mailto:wangyang.cs@bytedance.com), K. Zhang, L. Zhang (Bytedance) |
| [JVET-AL0171](https://jvet-experts.org/doc_end_user/current_document.php?id=15496) | m71984 | 2025-03-19 13:31:57 | 2025-03-19 14:05:58 | 2025-03-19 14:05:58 | AHG7: Tools interaction analysis of ECM160 | [R. Ishimoto](mailto:ishimoto.ryo@mail.sharp), [Z. Fan](mailto:fan.zheming@mail.sharp), [T. Chujoh](mailto:chujoh.takeshi@mail.sharp), [T. Ikai (Sharp)](mailto:ikai.tomohiro@mail.sharp) |
| [JVET-AL0194](https://jvet-experts.org/doc_end_user/current_document.php?id=15519) | m72007 | 2025-03-19 17:14:06 | 2025-03-19 17:19:06 | 2025-03-19 17:19:06 | AHG7: Assessment Perspectives of Codec/Coding Tools | [X. Li (Google)](mailto:xlxiangli@google.com) |
| [JVET-AL0213](https://jvet-experts.org/doc_end_user/current_document.php?id=15540) | m72028 | 2025-03-19 22:00:11 | 2025-03-19 22:18:38 | 2025-03-20 00:06:39 | AHG7: On common test conditions for fixed-QP objective rate-distortion testing of "low delay" encoding | [G. J. Sullivan](mailto:g-j-sullivan@outlook.com), P. Yin, T. N. Canh (Dolby Labs) |
| [JVET-AL0242](https://jvet-experts.org/doc_end_user/current_document.php?id=15569) | m72065 | 2025-03-20 17:27:19 | 2025-03-20 18:49:47 | 2025-03-20 18:49:47 | [AHG7][AHG17] ECM performance under different MTT configurations | [S. Puri](mailto:saurabh.puri@interdigital.com), K. Naser, F. Le Léannec, E. François (InterDigital) |
| [JVET-AL0245](https://jvet-experts.org/doc_end_user/current_document.php?id=15572) | m72084 | 2025-03-21 12:48:25 | 2025-03-21 13:34:37 | 2025-03-21 13:34:37 | [AHG7][AHG17] Further consideration of common test condition | T. Ikai, K.-W. Liang (Sharp) |
| [JVET-AL0247](https://jvet-experts.org/doc_end_user/current_document.php?id=15574) | m72092 | 2025-03-21 15:44:06 | 2025-03-21 15:47:36 | 2025-03-21 15:47:36 | [AHG-7] On Max Transform Size in ECM | [K. Naser](mailto:karam.naser@interdigital.com), F. Le Léannec, S. Puri, C. Bonnineau, E. François (InterDigital) |

**Recommendations**

* Continue and improve tool assessment
* Resolve identified software issues related to the tool assessment

[JVET-AL0008](https://jvet-experts.org/doc_end_user/current_document.php?id=15391) JVET AHG report: Optimization of encoders and receiving systems for machine analysis of coded video content (AHG8) [S. Liu, J. Ström, S. Wang, M. Zhou (AHG chairs)]

***Software and Common Test Conditions***

AHG 8 related software and documents can be accessed at <https://vcgit.hhi.fraunhofer.de/jvet-ahg-ofm>. This repository contains two projects: common test conditions, reporting templates with anchor results, evaluation scripts and task networks are available in <https://vcgit.hhi.fraunhofer.de/jvet-ahg-ofm/ofm-ctc>, and software implementation examples are hosted in <https://vcgit.hhi.fraunhofer.de/jvet-ahg-ofm/vtm-ofm>.

For this meeting cycle, common test conditions remain unchanged as described in output document JVET-AI2031. Some software implementation examples are available in the repository:

|  |  |
| --- | --- |
| **Branch name** | **Description** |
| JVET-AB0275 | Region-of-Interest-based adaptive QP |
| JVET-AC0086 | Foreground/background separation |
| JVET-AD0122 | Temporal QP offsets |
| JVET-AE0143 | Spatial resampling (Experimental) |
| JVET-AG0212 | Post-processing filter (Removed\*) |
| JVET-AH0130 | Spatial resampling |
| JVET-AH0157 | Combined pre- and post-processing |
| JVET-AJ0178 | Lightweight post-processing |
| JVET-AJ0181 | Combined software JVET-AB0275, JVET-AC0086, JVET-AJ0178 |
| JVET-AJ0254 | Pre-analysis based temporal resampling |
| JVET-AK0094 | Combined software of adaptive temporal resampling, pre-processing, post-processing and ROI-based adaptive QP |

\* Note that the current description of the post-processing algorithm in CDTR A.3 is based on the lightweight design proposed in JVET-AJ0178. Consequently, the reference code for the previous post-processing algorithm, JVET-AG0212, has been removed from the software repository.

It was decided in the last meeting to upload the dense QP bitstreams corresponding to dense QP experiments and results reported in JVET-AK0122 to MPEG content server. They can now be accessed at [https://content.mpeg.expert/data/MPEG-05/AHG8/bitstreams\_for\_JVET-AK0122/](https://nam12.safelinks.protection.outlook.com/?url=https%3A%2F%2Fcontent.mpeg.expert%2Fdata%2FMPEG-05%2FAHG8%2Fbitstreams_for_JVET-AK0122%2F&data=05%7C02%7Cshanl%40global.tencent.com%7Ca858a079f3f24746af6908dd62f5a68a%7Ca32856f21731405cb53d480e26413adf%7C1%7C0%7C638775529450277029%7CUnknown%7CTWFpbGZsb3d8eyJFbXB0eU1hcGkiOnRydWUsIlYiOiIwLjAuMDAwMCIsIlAiOiJXaW4zMiIsIkFOIjoiTWFpbCIsIldUIjoyfQ%3D%3D%7C0%7C%7C%7C&sdata=W2nLtN%2BLFvBtWUsPvlSBd9J1%2FD%2BvzG6mIkS2bwFhUOs%3D&reserved=0).

***Technical Report***

The eight draft of the technical report (TR) JVET-AK2030 “Optimization of encoders and receiving systems for machine analysis of coded video content (draft 8)” was produced, including the following additions compared with draft 7:

* Text on Packed regions info SEI (to clause 10.5) JVET-AK0141
* Tool combination examples (to annex B) JVET-AK0122
* Tool combination examples (to annex B) JVET-AK0094

The following combined tool examples have been included in the draft TR, besides single tool implementation examples.

|  |  |  |  |
| --- | --- | --- | --- |
| Technology 1 | Technology 2 | Technology 3 | Technology 4 |
| Adaptive QP (Clause 8.1 and Annex A.1) | Temporal layer QP offset (Clause 8.2) |  |  |
| De-noising filter (Clause 7.5) | Temporal layer QP offset (Clause 8.2) |  |  |
| Pre-processing (Clause 7.2 and Annex A.2) | NNPF (Clause 9.3 and Annex A.3) |  |  |
| 4:4:4 coding (Clause 8) | Reduced resolution (Clauses 7.4 and 9.2) |  |  |
| Pre-processing (Clause 7.2 and Annex A.2) | NNPF (Clause 9.3 and Annex A.3) | Adaptive QP (Clause 8.1 and Annex A.1) |  |
| NNPF (Clause 9.3) | Adaptive QP (Clause 8.1 and Annex A.1) |  |  |
| NNPF (Clause 9.3) | Reduced resolution (Clauses 7.4 and 9.2) |  |  |
| Pre-processing (Clause 7.2 and Annex A.2) | NNPF (Clause 9.3 and Annex A.3) | Adaptive QP (Clause 8.1 and Annex A.1) | QP offset adjustment for higher temporal layers (Clause 8.1) |
| Pre-processing (Clause 7.2 and Annex A.2) | NNPF (Clause 9.3 and Annex A.3) | Adaptive QP (Clause 8.1 and Annex A.1) | Temporal resampling (Clause 9.1 and Annex A.4) |

**Input contributions**

There are 2 input contributions related to AHG 8 mandates (by the time this report is uploaded). They are listed below.

|  |  |  |
| --- | --- | --- |
| **Report** | | |
| JVET-AL0008 | JVET AHG report: Optimization of encoders and receiving systems for machine analysis of coded video content (AHG8) | S. Liu, J. Ström, S. Wang, M. Zhou (AHG chairs) |
| **Proposals** | | |
| JVET-AL0152 | AHG8: Dense QP coding results of combining adaptive temporal resampling, pre-processing, ROI-based adaptive QP, QP offset adjustment for higher temporal layers and post-processing algorithms for machine vision | S. Wang, J. Chen, Y. Ye, B. Li (Alibaba), S. Wang (CityUHK) |
| **Crosschecks** | | |
|  |  |  |

**Recommendations**

The AHG recommends to:

* Review all input contributions.
* Continue improving draft TR based on CDTR feedback and other inputs.
* Discuss and plan for finalization of TR (version 1).
* Continue investigating non-normative technologies and their uses for machine vision applications and machine consumptions.

It was agreed that software of the non-normative tools should be attached to the TR (as also requested in context of ballot)

It was clarified that the bitstreams described in JVET-AK0122 and JVET-AL0152 are not intended to be used by JVET (as they are going beyond the CTC document JVET-AI2031), but are delivered as a service to WG 4 such that they can exercise non-normative tools in their own CTC.

Break until 0845 UTC

[JVET-AL0009](https://jvet-experts.org/doc_end_user/current_document.php?id=15392) JVET AHG report: SEI message studies (AHG9) [S. McCarthy, Y.-K. Wang (co-chairs), J. Boyce, T. Chujoh, S. Deshpande, C. Fogg, M. M. Hannuksela, P. de Lagrange, G. J. Sullivan, H. Tan, A. Tourapis, S. Wenger, P. Wu (vice-chairs)]

A total of 73 contributions are identified relating to the mandates of AHG9. Some contributions relate to more than one mandate and/or SEI message. Some contributions also relate to the work of AHG13 and AHG16.

The following is a list of contributions related to the mandates of AHG9.

***Study the SEI messages in VSEI, VVC, HEVC and AVC***

**Additions for HEVC and AVC (6)**

[JVET-AL0057](https://jvet-experts.org/doc_end_user/current_document.php?id=15363) AHG9: Inclusion of the encoder optimization information SEI message in HEVC [M. M. Hannuksela, J. Boyce (Nokia)]

[JVET-AL0059](https://jvet-experts.org/doc_end_user/current_document.php?id=15365) AHG9: Inclusion of the packed regions information SEI message in HEVC [J. . Boyce, M. M. Hannuksela (Nokia)]

[JVET-AL0061](https://jvet-experts.org/doc_end_user/current_document.php?id=15367) AHG 9: Encoder optimization information for AVC and HEVC [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AL0062](https://jvet-experts.org/doc_end_user/current_document.php?id=15368) AHG 9: AI usage restrictions SEI message for AVC and HEVC [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AL0148](https://jvet-experts.org/doc_end_user/current_document.php?id=15473) AHG9: Generative face video and generative face video enhancement SEI messages for HEVC and AVC [J. Chen, B. Chen, Y. Ye (Alibaba), S. Gehlot, G.-M. Su, P. Yin, S. McCarthy (Dolby), A. Trioux, F. Yang (Xidian Univ.), Y.-K. Wang (Bytedance), H.-B. Teo, J.-Y. Thong, K. Abe (Panasonic), Y. Xu, K. Yang, Y. Li (SJTU)]

[JVET-AL0210](https://jvet-experts.org/doc_end_user/current_document.php?id=15535) AHG9: On SEI processing order SEI message for HEVC and AVC [Y. Sanchez, T. M. Borges, R. Skupin, C. Hellge, T. Schierl (Fraunhofer HHI)]

***Study JVET-AK2006 Additional SEI messages for VSEI version 4***

**Film grain characteristics SEI message *(*3*)***

[JVET-AL0086](https://jvet-experts.org/doc_end_user/current_document.php?id=15411) AHG9/AHG13: On Spatial Resolution for the Film Grain Characteristics (FGC) SEI message [J. Samuelsson-Allendes, S. Deshpande (Sharp)]

[JVET-AL0204](https://jvet-experts.org/doc_end_user/current_document.php?id=15529) AHG9: On picture width and height for the film grain characteristics SEI message [M. M. Hannuksela, J. Boyce (Nokia)]

[JVET-AL0211](https://jvet-experts.org/doc_end_user/current_document.php?id=15536) AHG9: Resolution nesting for FGC SEI message [R. Skupin, Y. Sanchez, A. Wieckowski, T. M. Borges, C. Hellge, T. Schierl (Fraunhofer HHI)]

*JVET- AL0211 also relates to clause 2.5 potential needs for additional SEI messages*

**NNPF SEI messages *(*4*)***

[JVET-AL0075](https://jvet-experts.org/doc_end_user/current_document.php?id=15381) AHG9: On nnpfa\_num\_input\_pic\_shift [M. M. Hannuksela (Nokia)]

[JVET-AL0076](https://jvet-experts.org/doc_end_user/current_document.php?id=15382) AHG9: On multi-purpose NNPFs [M. M. Hannuksela, F. Cricri (Nokia)]

[JVET-AL0096](https://jvet-experts.org/doc_end_user/current_document.php?id=15421) AHG9: On signalling of extension syntax elements in NNPFA SEI message[C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AL0159](https://jvet-experts.org/doc_end_user/current_document.php?id=15481) AHG9: On backbone and tail of NNPFs [F. Cricri, M. M. Hannuksela (Nokia)]

**SEI processing order and processing order nesting SEI messages (5)**

[JVET-AL0063](https://jvet-experts.org/doc_end_user/current_document.php?id=15369) AHG9: On SPO SEI message[Y. He, M. Karczewicz (Qualcomm)]

[JVET-AL0064](https://jvet-experts.org/doc_end_user/current_document.php?id=15370) AHG9: On SPO sub-chain signaling [Y. He, M. Karczewicz (Qualcomm)]

[JVET-AL0065](https://jvet-experts.org/doc_end_user/current_document.php?id=15371) AHG9: On PON SEI message [Y. He, M. Karczewicz (Qualcomm)]

[JVET-AL0178](https://jvet-experts.org/doc_end_user/current_document.php?id=15503) AHG9: Use cases for energy savings information in SPO SEI messages [C-H. Demarty, E. François, F. Aumont, O. Le Meur (InterDigital)]

[JVET-AL0208](https://jvet-experts.org/doc_end_user/current_document.php?id=15533) AHG9: On SPO root-process signaling constraint [T. M. Borges, Y. Sanchez, R. Skupin, C. Hellge, T. Schierl (Fraunhofer HHI)]

**Encoder optimization information SEI message *(*3*)***

[JVET-AL0056](https://jvet-experts.org/doc_end_user/current_document.php?id=15362) AHG9: On the encoder optimization information SEI message [M. M. Hannuksela (Nokia)]

[JVET-AL0123](https://jvet-experts.org/doc_end_user/current_document.php?id=15448) AHG9: On the encoder optimization information (EOI) SEI message [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AL0221](https://jvet-experts.org/doc_end_user/current_document.php?id=15548) AHG9: EOI SEI message with luma range adaptation for machine analysis [T. Partanen (Tuni), M. M. Hannuksela, H. Zhang, A. Aminlou (Nokia)]

**Source picture timing information SEI message *(*1*)***

[JVET-AL0130](https://jvet-experts.org/doc_end_user/current_document.php?id=15455) AHG9: Source picture timing for interlaced video with SPTI SEI message [J. Lee, H. Tan, J. Nam, C. Kim, J. Lim, S. Kim (LGE)]

**Object mask information SEI message *(*3*)***

[JVET-AL0066](https://jvet-experts.org/doc_end_user/current_document.php?id=15372) AHG9: Lossy compression with Object mask info SEI [J. Boyce, M. M. Hannuksela (Nokia)]

[JVET-AL0067](https://jvet-experts.org/doc_end_user/current_document.php?id=15373) AHG9: On the OMI SEI [J. Boyce, M. M. Hannuksela (Nokia)]

[JVET-AL0071](https://jvet-experts.org/doc_end_user/current_document.php?id=15377) AHG9: On OMI SEI message [Y. He, M. Karczewicz (Qualcomm)]

[JVET-AL0249](https://jvet-experts.org/doc_end_user/current_document.php?id=15576) AHG9: Proposed modifications to VSEI to address national body comments [J. Boyce (Nokia)]

*JVET- AL0249 also relates to the text description information SEI message*

**Text description information SEI message *(*1*)***

[JVET-AL0077](https://jvet-experts.org/doc_end_user/current_document.php?id=15383) AHG9: On the text description information SEI message [M. M. Hannuksela, J. Boyce (Nokia)]

[JVET-AL0249](https://jvet-experts.org/doc_end_user/current_document.php?id=15576) AHG9: Proposed modifications to VSEI to address national body comments [J. Boyce (Nokia)]

*JVET- AL0249 also relates to the object mask information SEI message*

**Generative face video SEI messages *(*3*)***

[JVET-AL0102](https://jvet-experts.org/doc_end_user/current_document.php?id=15427) AHG9/AHG16: SEI message and further experiments on QP-adaptive GFVC [W. Kang, L. Liu, C. Jung (Xidian Univ.)]

[JVET-AL0155](https://jvet-experts.org/doc_end_user/current_document.php?id=15480) AHG9: Further fixes and cleanup on GFV and GFVE SEI messages [J. Chen, B. Chen, Y. Ye (Alibaba)]

[JVET-AL0156](https://jvet-experts.org/doc_end_user/current_document.php?id=15481) AHG9/AHG16: Colour calibration for generative face video coding [J. Chen, B. Chen, Y. Ye (Alibaba), S. Yin, S. Wang (CityUHK)]

**Digitally signed content messages *(*11*)***

[JVET-AL0078](https://jvet-experts.org/doc_end_user/current_document.php?id=15403) AHG9: On Digital Signing [S. Deshpande (Sharp)]

[JVET-AL0103](https://jvet-experts.org/doc_end_user/current_document.php?id=15428) AHG9: Editorial changes for the three DSC SEI messages [Y.-K. Wang, J. Xu (Bytedance)]

[JVET-AL0115](https://jvet-experts.org/doc_end_user/current_document.php?id=15440) AHG9: Substream dependency signalling in the DSCI SEI message [Y.-K. Wang (Bytedance), Y. Li, K. Yang (SJTU), J. Xu (Bytedance) Y. Xu (SJTU)]

[JVET-AL0116](https://jvet-experts.org/doc_end_user/current_document.php?id=15441) AHG9: On DSCI content UUID [Y. Li (SJTU), J. Xu, Y.-K. Wang (Bytedance), K. Yang, Y. Xu (SJTU)]

[JVET-AL0117](https://jvet-experts.org/doc_end_user/current_document.php?id=15442) AHG9: On association of NAL units to DSC verification substreams [Y.-K. Wang, J. Xu, (Bytedance), Y. Li, K. Yang, Y. Xu (SJTU)]

[JVET-AL0118](https://jvet-experts.org/doc_end_user/current_document.php?id=15443) AHG9: Miscellaneous changes for the three DSC SEI messages [Y.-K. Wang, J. Xu (Bytedance), Y. Li, K. Yang, Y. Xu (SJTU)]

[JVET-AL0119](https://jvet-experts.org/doc_end_user/current_document.php?id=15444) AHG9: Support of low-delay DSC verification process [Y.-K. Wang, J. Xu (Bytedance), Y. Li, K. Yang, Y. Xu (SJTU)]

[JVET-AL0131](https://jvet-experts.org/doc_end_user/current_document.php?id=15456) AHG9: Proposed changes for miscellaneous aspects of SEIs in VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AL0131 also relates to the AI usage restrictions and packed regions SEI messages*

[JVET-AL0132](https://jvet-experts.org/doc_end_user/current_document.php?id=15457) AHG9: Editorial updates for VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AL0132 also relates to the packed regions and image format metadata SEI messages*

[JVET-AL0186](https://jvet-experts.org/doc_end_user/current_document.php?id=15511) AHG9: Subpicture support for digitally signed content SEI messages [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

[JVET-AL0222](https://jvet-experts.org/doc_end_user/current_document.php?id=15549) AHG9: On Digitally Signed Content SEI messages [K. Suehring, T. Hinz, Y. Sanchez, J. Pfaff, H. Schwarz, D. Marpe, T. Wiegand (Fraunhofer HHI)]

**AI usage restrictions SEI message *(*2*)***

[JVET-AL0058](https://jvet-experts.org/doc_end_user/current_document.php?id=15364) AHG9: On the AI usage restrictions SEI message [M. M. Hannuksela, L. Kondrad, K. Kammachi-Sreedhar, E. B. Aksu, J. Boyce (Nokia)]

[JVET-AL0131](https://jvet-experts.org/doc_end_user/current_document.php?id=15456) AHG9: Proposed changes for miscellaneous aspects of SEIs in VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AL0131 also relates to the digitally signed content and packed regions SEI messages*

**Packed regions information SEI message *(*8*)***

[JVET-AL0070](https://jvet-experts.org/doc_end_user/current_document.php?id=15376) AHG9: On packed regions information SEI message [T. Chujoh, Z. Fan, R. Ishimoto, T. Ikai (Sharp)]

[JVET-AL0072](https://jvet-experts.org/doc_end_user/current_document.php?id=15378) AHG9: On PRI SEI message [Y. He, M. Karczewicz (Qualcomm)]

[JVET-AL0098](https://jvet-experts.org/doc_end_user/current_document.php?id=15423) AHG9: On target picture in packed regions information SEI message [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

[JVET-AL0120](https://jvet-experts.org/doc_end_user/current_document.php?id=15445) AHG9: On the packed regions information SEI message - part 1 [Y.-K. Wang, J. Xu (Bytedance)]

[JVET-AL0122](https://jvet-experts.org/doc_end_user/current_document.php?id=15447) AHG9: On the packed regions information (PRI) SEI message - part 2 [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AL0129](https://jvet-experts.org/doc_end_user/current_document.php?id=15454) AHG9: On signaling of regions in PRI SEI message [J. Lee, H. Tan, J. Nam, C. Kim, J. Lim, S. Kim (LGE)]

[JVET-AL0131](https://jvet-experts.org/doc_end_user/current_document.php?id=15456) AHG9: Proposed changes for miscellaneous aspects of SEIs in VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AL0131 also relates to the digitally signed content and AI usage restrictions SEI messages*

[JVET-AL0132](https://jvet-experts.org/doc_end_user/current_document.php?id=15457) AHG9: Editorial updates for VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AL0132 also relates to the digitally signed content and image format metadata SEI messages*

**Image format metadata SEI message *(4)***

[JVET-AL0068](https://jvet-experts.org/doc_end_user/current_document.php?id=15374) AHG9: On image format metadata (IFM) SEI [J. Boyce, M. M. Hannuksela (Nokia)]

[JVET-AL0094](https://jvet-experts.org/doc_end_user/current_document.php?id=15419) AHG9: On payload length of image format metadata (IFM) SEI [A. T. Hinds, S. Wenger (Tencent)]

[JVET-AL0128](https://jvet-experts.org/doc_end_user/current_document.php?id=15453) AHG9: On image format metadata SEI message [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AL0132](https://jvet-experts.org/doc_end_user/current_document.php?id=15457) AHG9: Editorial updates for VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AL0132 also relates to the digitally signed content and packed regions SEI messages*

***Study JVET-AK2032 TuC for VSEI***

**General *(*1*)***

[JVET-AL0093](https://jvet-experts.org/doc_end_user/current_document.php?id=15418) AHG 9: On value range for syntax elements coded as u(v) [H. Tan, C. Kim, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

**NNPF SEI messages *(*3*)***

[JVET-AL0175](https://jvet-experts.org/doc_end_user/current_document.php?id=15500) AHG9: On Target Mastering Colour Volume Information in the NNPFC SEI message for Tone Mapping [C-H. Demarty, E. François, F. Aumont, O. Le Meur (InterDigital)]

[JVET-AL0177](https://jvet-experts.org/doc_end_user/current_document.php?id=15502) AHG9: On Signalling Tone Mapping Related Information in NNPFA [C-H. Demarty, E. François, F. Aumont, O. Le Meur (InterDigital)]

[JVET-AL0209](https://jvet-experts.org/doc_end_user/current_document.php?id=15534) AHG9: On providing robustness against layer dropping in multi-layer NNPF [T. M. Borges, Y. Sanchez, R. Skupin, C. Hellge, T. Schierl (Fraunhofer HHI)]

**Multiplane image information SEI message *(*1*)***

[JVET-AL0091](https://jvet-experts.org/doc_end_user/current_document.php?id=15416) AHG9: On the multiplane image information (MPII) SEI message [S. McCarthy, S. Oh, W. Husak (Dolby)]

**Constituent rectangle SEI messages (2*)***

[JVET-AL0095](https://jvet-experts.org/doc_end_user/current_document.php?id=15420) AHG 9: On constituent rectangles SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AL0139](https://jvet-experts.org/doc_end_user/current_document.php?id=15464) AHG9: On multilayer support for CR SEI [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

**Quality metrics SEI message *(*1*)***

[JVET-AL0140](https://jvet-experts.org/doc_end_user/current_document.php?id=15465) AHG9: Region-specific quality metrics for QM SEI [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

**Lens optical correction SEI messages *(*1*)***

[JVET-AL0216](https://jvet-experts.org/doc_end_user/current_document.php?id=15543) [AHG9] Lens Optical Correction SEI - floating point parameters representation [G. Teniou, S. Wenger, A. Hinds]

**Display rectangles SEI message *(*4*)***

[JVET-AL0097](https://jvet-experts.org/doc_end_user/current_document.php?id=15422) AHG 9: Gaussian blur filling method in display rectangles SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AL0099](https://jvet-experts.org/doc_end_user/current_document.php?id=15424) AHG9: On design of display rectangles SEI message [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

[JVET-AL0138](https://jvet-experts.org/doc_end_user/current_document.php?id=15463) AHG9: VVC interface for Display Rectangles SEI [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

[JVET-AL0141](https://jvet-experts.org/doc_end_user/current_document.php?id=15466) AHG9: Showcase on the implementation of display rectangles SEI [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

*JVET- AL0141 also relates to clause 2.4 software and showcase information*

**Picture segment information SEI message *(*1*)***

[JVET-AL0226](https://jvet-experts.org/doc_end_user/current_document.php?id=15553) AHG9: Proposed segmentation plane test sequences (AUX\_SEGMENT) [E. Thomas, E. Potetsianakis, E. Alexiou, M.-L. Champel (Xiaomi)]

***Collect software and showcase information for SEI messages (*1*)***

[JVET-AL0141](https://jvet-experts.org/doc_end_user/current_document.php?id=15466) AHG9: Showcase on the implementation of display rectangles SEI [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

*JVET-AL0141 also relates to clause 2.3 study of TuC for VSEI*

***Identify potential needs for additional SEI messages, including study of AVC and HEVC SEI messages for use in VVC (*8*)***

[JVET-AL0069](https://jvet-experts.org/doc_end_user/current_document.php?id=15375) AHG9/AHG18: Error recovery SEI message [J. Boyce, M. M. Hannuksela (Nokia)]

[JVET-AL0073](https://jvet-experts.org/doc_end_user/current_document.php?id=15379) AHG9/AHG18: Loss recovery information SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AL0092](https://jvet-experts.org/doc_end_user/current_document.php?id=15417) AHG9: Confidence information SEI message [J. Boyce, T. Biatek, M. M. Hannuksela (Nokia)]

[JVET-AL0127](https://jvet-experts.org/doc_end_user/current_document.php?id=15452) AHG9: Danmu information SEI message [J. Xu, Y.-K. Wang, L. Zhang (Bytedance)]

[JVET-AL0133](https://jvet-experts.org/doc_end_user/current_document.php?id=15458) AHG9: Signaling of thumbnail information [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AL0211 also relates to clause 2.2 study of VSEI v4*

[JVET-AL0212](https://jvet-experts.org/doc_end_user/current_document.php?id=15539) AHG9/AHG15: Depth-adaptive picture scaling information SEI [V. Zakharchenko, T. Biatek, J. Boyce (Nokia)]

[JVET-AL0219](https://jvet-experts.org/doc_end_user/current_document.php?id=15546) AHG9: Colour mapping information SEI [J. Boyce, T. Biatek, M. M. Hannuksela (Nokia)]

[JVET-AL0224](https://jvet-experts.org/doc_end_user/current_document.php?id=15551) AHG9: Auxiliary sampling alignment information SEI [V. Zakharchenko, J. Boyce, D. Rusanovskyy, M. M. Hannuksela (Nokia)]

**Activities**

The regular JVET e-mail reflector was used for discussions ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de)) with [AHG9] in message headers. No emails with [AHG9] were exchanged.

**Recommendations**

The AHG recommends to:

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

J. Arumurgan volunteered on checking whether the SPO/PON message implementation in software is matching with the current text (software was originally developed by Ittiam) – if not matching, a solution needs to be found who takes responsibility among experts from the companies wo proposed subsequent changes. Revisit.

[JVET-AL0010](https://jvet-experts.org/doc_end_user/current_document.php?id=15393) JVET AHG report: Encoding algorithm optimization (AHG10) [K. Andersson, P. de Lagrange, A. Duenas (co-chairs), T. Ikai, T. Solovyev, A. Tourapis (vice chairs)]

6 contributions and one cross-check document were identified relating to AHG10 and summarized in the following sections.

***JVET-AL0055: AhG10: On constrained encoder complexity configuration of VTM***

The document describes three alternative configurations for the VTM to achieve additional complexity performance trade-offs. A preferred variant shows an impact of 37%/46%/44%/43% to the encoder runtime with a bd rate impact of 4.47%/1.49%/4.17%/4.34% relatively to the default VTM 23.5 RA, AI, LDB, and LDP configurations respectively. The details of the preferred configuration are shown below:

**Less extensive partitioning search**:

--MaxMTTHierarchyDepth=1

--MaxMTTHierarchyDepthISliceL=2

--MaxMTTHierarchyDepthISliceC=2

**Implicit MTS instead of explicit one:**

--MTS=0

--MTSImplicit=1

**Lower number of merge candidates:**

--MaxNumMergeCand=5

A cross-check of this proposal is available in JVET-AL0263.

***JVET-AL0074: AHG10: Teleconference on encoder optimization***

The document summarizes discussions held during a teleconference on February 24, mainly related to multi-layer spatial scalability, but also to multi-layer multi-view, multi-layer content layering, and reduced complexity performance trade-offs.

***JVET-AL0114: AHG10: On intra mode selection***

The document proposes modifications to the intra mode selection of the ECM specifically to reduce the matrix-based position-dependent intra prediction (MPDIP) mode tests. The following results are currently included in this contribution.

All-Intra: {-0.01%, 0.04%, 0.02%, EncT: 99.3%, DecT: 99.8%}

Random-Access: {} (Note: currently missing)

***JVET-AL0207: AHG10/AHG17: On matching target bitrate for subjective quality evaluation***

The document proposes an alternative approach for matching the target bitrate for subjective evaluations. Instead of increasing the base QP by one at a given frame, which may give an abrupt change in quality after the QP change, it is proposed to start from the base QP closest to the target bitrate and to adjust the lambda to correspond to a fractional QP that is in-between the two closest QPs. In this way it is claimed that a more equal quality can be reached for all frames rather than having a change of quality for frames after a change of the base QP.

The document proposes to add this functionality in the VTM reference software and suggests using the method for matching a target bitrate in the context of subjective quality evaluation.

***JVET-AL0213: AHG7: On common test conditions for fixed-QP objective rate-distortion testing of "low delay" encoding***

The document requests JVET to consider modifying the method used for routine objective rate-distortion testing of “low-delay” configurations for high-resolution video content to combat with the encoding of a long series of frames in a sequential manner. The suggested alternative is to divide a test sequence into closed-GOP segments that are coded independently of each other and to measure only the bit rate and distortion for the non-intra frames. A hypothetical alternative approach of using temporal sublayers is also suggested to be a possible way to reduce encoding times. In such a scheme, the lowest temporal layer would be coded first, followed by parallel encoding of the higher temporal sublayers, with all frames using only forward temporal prediction.

The intent of this document is to stimulate the discussion and study of the potential approaches for reducing encoding times for such tests.

***JVET-AL0233: Information on low complexity encoding experiments***

The document claims that the ability of supporting a low complexity encoder with reasonable compression efficiency is an essential functionality for a next generation video coding specification design. Experiments related to the ECM have shown that changing the encoder’s configuration can have a large impact on the encoder complexity especially in later versions of the ECM. Some of the operating points seem to achieve a better RD-complexity trade offs than the ECM anchor points, and some operating points seem to might be able to reach the desired complexity in encoding time. The latest version of the ECM, ECM-16.0 seems unable to reach the desired complexity in both the encoder and the decoder. A significant modification of the design and the software may be required to reduce decoder complexity such that it can reach the desired decoder complexity.

***JVET-AL0245: [AHG7][AHG17] Further consideration of common test condition***

This document further explores constrained test conditions by analyzing experiment results on ECM-16.1 under various MTT depth settings. It recommends configuring the encoder setting during the development of the next standard to approximately 2x to 4.5x of the encoding time of the VTM, and by changing the MTT depth parameters to the following (about 3x faster with around 4% BD-rate loss):

--MaxMTTHierarchyDepth=2 --MaxMTTHierarchyDepthISliceL=2

--MaxMTTHierarchyDepthISliceC=2 --MaxMTTHierarchyDepthByTid=221111

1. **Recommendation**

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

[JVET-AL0011](https://jvet-experts.org/doc_end_user/current_document.php?id=15394) JVET AHG report: Neural network-based video coding (AHG11) [E. Alshina, F. Galpin, S. Liu, A. Segall (co-chairs), J. Li, Y. Li, R.-L. Liao, M. Santamaria, T. Shao, M. Wien, P. Wu (vice chairs)]

**Anchor Encoding**

Anchor for the NN-based video coding activity made available though the Git repository used for the AHG activity:

https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/nnvc-ctc/-/blob/master/Anchor%20performance/NNVC-10-VTM\_vs\_NNVC-12.xlsm

also distributed by AhG14 in JVET-AK0014.

***New training materials***

BVI-AOM training set was used in EE1-2 (NN-Inter) and EE1-3 (retraining NN-filters) categories. Results of training are analyzed in relevant EE1 contributions. So far, some promising performance improvement is observed for HOP NN-filter. It is suggested to conduct detailed discussion, opinion exchange and brainstorming on training using additional materials.

***Dataset access***

Training data generation and md5 sums for BVI-AOM been discussed during AhG11/AhG14 teleconference in scope of EE1-3 tests.

***Interaction with ECM***

Some version of neural network based Intra included into ECM already. Interface for NNVC in-loop filter testing in ECM has been added and some test results reported in incoming AhG11 contribution.

In random access configuration NN-based in-loop filter provides roughly 1%, 2% and 5% BD-rate gain on top of ECM with only 1%, 2% and 8% CPU encoding run-time increment for VLOP, LOP and HOP versions of filter correspondently.

|  |  |  |
| --- | --- | --- |
| [JVET-AL0230](https://jvet-experts.org/doc_end_user/current_document.php?id=15557) | AhG11/AhG12: Performance of the NNVC ILF in ECM | [D. Rusanovskyy](mailto:dmytro.rusanovskyy@nokia.com), K. Panusopone, S. Hong, L. Wang (Nokia) |
| [JVET-AL0228](https://jvet-experts.org/doc_end_user/current_document.php?id=15555) | EE2-related: NNLF interface in ECM | [T. Poirier](mailto:tangi.poirier@interdigital.com), [F. Galpin](mailto:franck.galpin@interdigital.com), G. Boisson (InterDigital) |

***EE Coordination***

The AHG finalized, conducted, and discussed the EE on NN based video coding. A summary report for the EE is available at this meeting as:

|  |  |  |
| --- | --- | --- |
| [JVET-AL0023](https://jvet-experts.org/doc_end_user/current_document.php?id=15401) | EE1: Summary report of exploration experiment on neural network-based video coding | E. Alshina, R. Chang, F. Galpin, Yue Li, Yun Li, M. Santamaria, J. Ström, Z. Xie (EE coordinators) |

***Teleconferences***

The AHG conducted two joint teleconferences with AHG14 and EE1 during the interim period. The teleconferences were held on February 05 and March 05, 2025. In those teleconferences, the following topics were discussed:

* New version of NN-based filter (LOP5) training report and LOP5 inference cross-check
* NNVC12.0 software integration status and anchors performance,
* EE1 description finalization
* Training on BVI-AOM

Combination of two proposals on LOP[JVET-AK0195](https://jvet-experts.org/doc_end_user/current_document.php?id=15166) (luma input to chroma processing at the later stage of NN filter) on top of [JVET-AK0150](https://jvet-experts.org/doc_end_user/current_document.php?id=15121) (attention mechanism) was verified by training cross-check and adoption from last meeting confirmed during teleconference.

|  |  |  |
| --- | --- | --- |
| [JVET-AL0043](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0043-v1.zip) | [AHG11] [AHG14] Teleconference on NNVC | E. Alshina, F. Galpin |

***Performance Evaluation***

The performance and complexity of NN-based tools available in NNVC SW is summarized in the table below. All test data provided by AhG14. Encoding and decoding run time is very dependent on cluster used for simulation. Run time data in this table are all from InterDigital.

In NNVC-12, LOP filter performance improved by 0.6% (in random access test). There is no performance change for other configuration, but there is some speed-up (due to SADL optimization).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test vs NNVC (configured as VTM)** | **Random Access cfg** | | | | | **kMAC/pxl** | | | | **Param (Mprm)** | | | |
| **Y** | U | V | Enc | Dec | **Total** | Filter | Intra | SR | **Total** | Filter | Intra | SR |
| NN-Intra & LOP filter (2 tools) | | | | | | | | | | | | | |
| NNVC-12.0 (LOP5) | **-8.2%** | **-15.3%** | **-13.5%** | **1.2** | **35** | **21.4** | **16.6** | **4.8** | **0** | **1.5** | **0.247** | **1.3** | **0** |
| NNVC-11.0 (LOP4) | **-7.6%** | -14.3% | -13.2% | 1.2 | 36 | **21.6** | 16.8 | 4.8 | 0 | **1.5** | 0.21 | 1.3 | 0 |
| NNVC-10.0 (LOP3) | **-7.4%** | -13.6% | -11.6% | 1.2 | 33 | **21.7** | 16.9 | 4.8 | 0 | **1.5** | 0.21 | 1.3 | 0 |
| NNVC-9.1(LOP3) | **-7.3%** | -13.1% | -11.3% | 1.2 | 81 | **24.8** | 16.9 | 7.9 | 0 | **1.7** | 0.21 | 1.5 | 0 |
| NNVC-8.0(LOP2) | **-6.9%** | -13.2% | -12.1% | 1.2 | 73 | **25.0** | 17.1 | 7.9 | 0 | **1.6** | 0.05 | 1.5 | 0 |
| NNVC-7.1(LOP2) | **-6.9%** | -13.2% | -12.1% | 1.3 | 86 | **25.0** | 17.1 | 7.9 | 0 | **1.6** | 0.05 | 1.5 | 0 |
| NNVC-9.1(LOP2CA) | **-8.2%** | -16.5% | -15.5% | 2.5 | 69 | **25.5** | 17.6 | 7.9 | 0 | **1.6** | 0.05 | 1.5 | 0 |
| NN-Intra & HOP filter (2 tools) | | | | | | | | | | | | | |
| NNVC-10.0 (HOP5) | **-14.2%** | -19.5% | -19.9% | 2.6 | 1135 | **471** | 466 | 4.8 | 0 | **2.7** | 1.4 | 1.3 | 0 |
| NNVC-9.1(HOP4) | **-14.1%** | -19.2% | -19.6% | 2.9 | 1447 | **484** | 476 | 7.9 | 0 | **3.0** | 1.44 | 1.5 | 0 |
| NNVC-8.0(HOP3) | **-13.7%** | -13.9% | -14.5% | 2.5 | 1092 | **474** | 466 | 7.9 | 0 | **2.9** | 1.40 | 1.5 | 0 |
| NNVC-7.0(HOP2) | **-13.6%** | -12.5% | -14.2% | 4.1 | 2071 | **485** | 477 | 7.9 | 0 | **3.0** | 1.50 | 1.5 | 0 |
| NN-Intra & VLOP filter (2 tools) | | | | | | | | | | | | | |
| NNVC-11.0 (VLOP3) | **-5.8%** | -6.6% | -5.7% | 1.2 | 7 | **9.9** | 5.10 | 4.8 | 0 | **1.3** | 0.07 | 1.3 | 0 |
| NNVC-10.0 (VLOP2) | **-5.6%** | -7.6% | -6.4% | 1.1 | 15 | **10** | 5.16 | 4.8 | 0 | **1.3** | 0.06 | 1.3 | 0 |
| NNVC-9.1(VLOP) | **-5.3%** | -5.4% | -5.2% | 1.2 | 40 | **13** | 5.12 | 7.9 | 0 | **1.5** | 0.02 | 1.5 | 0 |
| NN-Intra & LOP filter content adaptive (2 tools) | | | | | | | | | | | | | |
| NNVC-10.0 aLOP3 | **-8.2%** | -16.7% | -15.5% | 2.2 | 34 | **21.8** | 16.9 | 4.8 | 0 | **1.5** | 0.21 | 1.3 | 0 |
| NN-Intra & LOP filter & adaptive resolution coding (3 tools) | | | | | | | | | | | | | |
| NNVC-11.0 NNSR | **-8.5%** | -12.2% | -10.9% |  |  | **26.3** | 16.8 | 4.8 | 4.7 | **1.4** | 0.05 | 1.3 | 0.05 |
| NNVC-8.0 RPR | **-7.5%** | -10.9% | -9.7% |  |  | **25.0** | 17.1 | 7.9 | 0 | **1.6** | 0.05 | 1.5 | 0 |
| NNVC-8.0 NNSR | **-7.8%** | -11.8% | -10.5% |  |  | **45.3** | 17.1 | 7.9 | 20.3 | **1.8** | 0.21 | 1.5 | 0.1 |

More details and analysis for tools and tools combination is expected in AhG14 report.

***Architectural changes***

Following proposals from 36th and 37th meetings several companies propose framework for E2E AI coded reference picture insertion. Promising gain reported for this approach (4% and 1% in all intra and random-access configuration correspondingly).

In order to support this feature bit-exact reconstruction of E2E AI coded picture is required. One contribution discusses fundamental aspects of bit-exact reproducibility and potential implementation using different platforms (GPU, NPU, CPU, ASIC).

***NNVC algorithms description***

One contribution submitted to this meeting resolves mismatch between LOP5 implementation in NNVC SW and description.

**Input contributions**

There are 33 input contributions related to the AHG mandates. The list of input contributions is provided below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Reporting (**5**) | | | | | | |
| [JVET-AL0023](https://jvet-experts.org/doc_end_user/current_document.php?id=15401) | EE1: Summary report of exploration experiment on neural network-based video coding | | | | E. Alshina, R. Chang, F. Galpin, Yue Li, Yun Li, M. Santamaria, J. Ström, Z. Xie (EE coordinators) | |  |
| [JVET-AL0043](https://jvet-experts.org/doc_end_user/current_document.php?id=15348) | [AHG11] [AHG14] Teleconference on NNVC | | | | [E. Alshina](mailto:elena.alshina@huawei.com), [F. Galpin](mailto:franck.galpin@interdigital.com) | |
| [JVET-AL0230](https://jvet-experts.org/doc_end_user/current_document.php?id=15557) | AhG11/AhG12: Performance of the NNVC ILF in ECM | | | | [D. Rusanovskyy](mailto:dmytro.rusanovskyy@nokia.com), K. Panusopone, S. Hong, L. Wang (Nokia) | |
| [JVET-AL0228](https://jvet-experts.org/doc_end_user/current_document.php?id=15555) | EE2-related: NNLF interface in ECM | | | | [T. Poirier](mailto:tangi.poirier@interdigital.com), [F. Galpin](mailto:franck.galpin@interdigital.com), G. Boisson (InterDigital) | |
| [JVET-AL0291](https://jvet-experts.org/doc_end_user/current_document.php?id=15618) | EE1-related: Recommendations for resolving mismatches between LOP5 description and implementation | | | | [Nam Le](mailto:nam.le@nokia.com), [Francesco Cricri (Nokia)](mailto:francesco.cricri@nokia.com) | |
| Architectural change and implementation aspects (**4**) | | | | | | |
| [JVET-AL0080](https://jvet-experts.org/doc_end_user/current_document.php?id=15405) | AHG11: Bit-exact reconstruction for NN video tools | | | | [L. Kerofsky](mailto:kerofsky@qti.qualcomm.com), [Y. Li](mailto:yli30@qti.qualcomm.com), [M. Karczewicz (Qualcomm)](mailto:marta@qti.qualcomm.com) | |
| [JVET-AL0196](https://jvet-experts.org/doc_end_user/current_document.php?id=15521) | AHG 11: Neural Network Coded Reference Frame for Intra Coding with Residual Coding and Intra Blocks | | | | F. Brand, T. Solovyev, E. Alshina (Huawei) | |
| [JVET-AL0203](https://jvet-experts.org/doc_end_user/current_document.php?id=15528) | [AHG11] A Hybrid Framework Integrating End-to-End Learned Image Codec with Conventional Codec | | | | [N. Zou](mailto:nannan.zou@nokia.com), [A. Hallapuro](mailto:antti.hallapuro@nokia.com), [F. Cricri](mailto:francesco.cricri@nokia.com), [H. Zhang](mailto:honglei.1.zhang@nokia.com), [A. B. Koyuncu](mailto:burakhan.koyuncu@nokia.com), [J. Ahonen](mailto:jukka.1.ahonen@nokia.com), [M. M. Hannuksela (Nokia)](mailto:miska.hannuksela@nokia.com) | |
| [JVET-AL0243](https://jvet-experts.org/doc_end_user/current_document.php?id=15570) | [AHG11] Multilayer framework for supporting a hybrid codec using End-to-End Learned Image Codec and Conventional Video Codec | | | | [F. Urban](mailto:fabrice.urban@interdigital.com), [Y. Chen](mailto:ya.cheninterdigital.com), [F. Galpin](mailto:franck.galpininterdigital.com), [E. François (InterDigital)](mailto:edouard.francoisinterdigital.com) | |
| EE1 contributions (**11**) | | | | | | |
| [JVET-AL0084](https://jvet-experts.org/doc_end_user/current_document.php?id=15409) | EE1-1.2: LOP5 improvement with parallel 1x3/3x1 Backbone | [T. Shao](mailto:tong.shao@dolby.com), [P. Yin](mailto:pyin@dolby.com), S. McCarthy (Dolby), [J. N. Shingala](mailto:jay.shingala@ittiam.com), [A. Shyam](mailto:ajayshyam@ittiam.com), A. Suneja, S. P. Badya (Ittiam) | | | |
| [JVET-AL0085](https://jvet-experts.org/doc_end_user/current_document.php?id=15410) | EE1-3.1: NNVC-LOP5 retraining with additional BVI-AOM dataset | A. Suneja, [J. N. Shingala](mailto:jay.shingala@ittiam.com), [A. Shyam](mailto:ajayshyam@ittiam.com), S. P. Badya (Ittiam), [T. Shao](mailto:tong.shao@dolby.com), [P. Yin](mailto:pyin@dolby.com), S. McCarthy (Dolby) | | | |
| [JVET-AL0104](https://jvet-experts.org/doc_end_user/current_document.php?id=15429) | EE1-2.1: Lightweight Multiscale Reference Frame Generation for VVC Inter Coding | [P. Li](mailto:2415355621@qq.com), [C. Jung](mailto:zhengzk@xidian.edu.cn), [Q. Qin (Xidian Univ.)](mailto:kippqin@163.com) | | | |
| [JVET-AL0105](https://jvet-experts.org/doc_end_user/current_document.php?id=15430) | EE1-2.2: RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding | [Q. Qin](mailto:kippqin@163.com), [C. Jung (Xidian Univ.)](mailto:zhengzk@xidian.edu.cn) | | | |
| [JVET-AL0144](https://jvet-experts.org/doc_end_user/current_document.php?id=15469) | EE1-3.1: Retraining LOP4 and LOP5 using extended dataset from BVI-AOM | [D. Liu](mailto:du.liu@ericsson.com), [J. Ström](mailto:jacob.strom@ericsson.com), [M. Damghanian](mailto:mitra.damghanian@ericsson.com), [P. Wennersten (Ericsson)](mailto:per.wennersten@ericsson.com) | | | |
| [JVET-AL0145](https://jvet-experts.org/doc_end_user/current_document.php?id=15470) | EE1-1.4: Conditional loop-filter | [M. Santamaria](mailto:maria.santamaria_gomez@nokia.com), [F. Cricri (Nokia)](mailto:Francesco.cricri@nokia.com) | | | |
| [JVET-AL0164](https://jvet-experts.org/doc_end_user/current_document.php?id=15489) | EE1-1.1: Multiscale blocks in LOP5 and VLOP3 filters | [R. Yang](mailto:ruiying.yang@nokia.com), [M. Santamaria](mailto:maria.santamaria_gomez@nokia.com), [F. Cricri](mailto:francesco.cricri@nokia.com), [H. Zhang](mailto:honglei.1.zhang@nokia.com), [J.Lainema](mailto:jani.lainema@nokia.com), [M.M. Hannuksela (Nokia)](mailto:miska.hannuksela@nokia.com) | | | |
| [JVET-AL0169](https://jvet-experts.org/doc_end_user/current_document.php?id=15494) | EE1-1.3 Dimension-wise decomposed representation of multiplier for content-adaptive loop filtering | [Z. Xu](mailto:zhuowei.xu@tcl.com), [J. Konieczny](mailto:jacek.k@tcl.com), [A. Filippov](mailto:alexey.filippov@tcl.com), [C. Hollmann](mailto:christopher.hollmann@tcl.com), [V. Rufitskiy](mailto:vasily.rufitskiy@tcl.com), [T. Dong (TCL)](mailto:tianyu.dong@tcl.com) | | | |
| [JVET-AL0187](https://jvet-experts.org/doc_end_user/current_document.php?id=15512) | EE1-3.1: NNVC-LOP4 and LOP5 retraining with additional BVI-AOM dataset | [T. Dumas](mailto:thierry.dumas@interdigital.com), A. Monier, F. Galpin (InterDigital) | | | |
| [JVET-AL0189](https://jvet-experts.org/doc_end_user/current_document.php?id=15514) | EE1-3.2 – NNVC-HOP5 retraining adding BVI-AOM | [F. Galpin (InterDigital)](mailto:franck.galpin@interdigital.com) | | | |
| [JVET-AL0190](https://jvet-experts.org/doc_end_user/current_document.php?id=15515) | EE1-3.3 – NNVC-VLOP3 retraining adding BVI-AOM | [F. Galpin](mailto:franck.galpin@interdigital.com), Z. Ameur (InterDigital), R. Chang, L. Wang, X. Xu, S. Liu (Tencent) | | | |
| New NNVC tools in AhG11 or EE1 related contributions (**7**) | | | | | | |
| [JVET-AL0166](https://jvet-experts.org/doc_end_user/current_document.php?id=15491) | EE1 related: Improved VLOP with Attention | | [Y. Li](mailto:yli30@qti.qualcomm.com), [L. Kerofsky](mailto:kerofsky@qti.qualcomm.com), [M. Karczewicz (Qualcomm](mailto:martak@qti.qualcomm.com) | | | |
| [JVET-AL0167](https://jvet-experts.org/doc_end_user/current_document.php?id=15492) | EE1 related: Further simplification of VLOP with Attention | | [Y. Li](mailto:yli30@qti.qualcomm.com), [L. Kerofsky](mailto:kerofsky@qti.qualcomm.com), [M. Karczewicz (Qualcomm)](mailto:martak@qti.qualcomm.com) | | | |
| [JVET-AL0184](https://jvet-experts.org/doc_end_user/current_document.php?id=15509) | EE1-related: Deep Reference Frame Generation for Inter Prediction Enhancement | | [D. Ding](mailto:dingding@whu.edu.cn), [X. Chen](mailto:xinxinchen@whu.edu.cn), [Z. Chen (Wuhan Univ.)](mailto:zzchen@whu.edu.cn) | | | |
| [JVET-AL0121](https://jvet-experts.org/doc_end_user/current_document.php?id=15446) | AHG11: Sample-based adaptive blending weight selection for LOP | | [H. Kwon](mailto:hspeedkwon@hanyang.ac.kr), [H. Ko (HYU)](mailto:hyunsuk@hanyang.ac.kr) | | | |
| [JVET-AL0136](https://jvet-experts.org/doc_end_user/current_document.php?id=15461) | AHG11: Over-Parameterized LOP In-Loop Filter | | [J. Han](mailto:jiang16h@163.com), [C. Jung](mailto:zhengzk@xidian.edu.cn), [Q. Qin (Xidian Univ.)](mailto:kippqin@163.com) | | | |
| [JVET-AL0137](https://jvet-experts.org/doc_end_user/current_document.php?id=15462) | AHG11: Backbone Block Enhancement of LOP In-Loop Filter with Over-Parameterized Training and Variable Channels | | [J. Han](mailto:jiang16h@163.com), [C. Jung](mailto:zhengzk@xidian.edu.cn), [Q. Qin (Xidian Univ.)](mailto:kippqin@163.com) | | | |
| [JVET-AL0250](https://jvet-experts.org/doc_end_user/current_document.php?id=15577) | AHG11: Cross-component enhanced NNSR | | [T. Yang](mailto:y_tian@hust.edu.cn), [W.-X. He](mailto:wxhe@hust.edu.cn), [Y.-Q. Zhu](mailto:yiqingzhu@hust.edu.cn), [J.-D. Ye](mailto:ye_jd@hust.edu.cn), [X.-T. Xie](mailto:xiatian_xie@hust.edu.cn), [J.-S. Gong](mailto:jsgong@hust.edu.cn), [Q. Liu (HUST)](mailto:q.liu@hust.edu.cn), [Z.-Y. Lv (vivo)](mailto:zhuoyi.lv@vivo.com) | | | |
| Cross-checks (**6** some not yet uploaded at the time report was prepared) | | | | | | |  |
| [JVET-AL0173](https://jvet-experts.org/doc_end_user/current_document.php?id=15498) | Crosscheck of JVET-AL0164 (EE1-1.1: Multiscale blocks in LOP5 and VLOP3 filters) | | | [Y. Li (Qualcomm)](mailto:yli30@qti.qualcomm.com) | | |
| [JVET-AL0185](https://jvet-experts.org/doc_end_user/current_document.php?id=15510) | Crosscheck of JVET-AL0169 (EE1-1.3 Dimension-wise decomposed representation of multiplier for content-adaptive loop filtering) | | | [M. Santamaria (Nokia)](mailto:maria.santamaria_gomez@nokia.com) | | |
| [JVET-AL0246](https://jvet-experts.org/doc_end_user/current_document.php?id=15573) | Crosscheck of JVET-AL0084 (EE1-1.2: LOP5 improvement with parallel 1x3/3x1 Backbone) | | | [Y. Li (Bytedance)](mailto:yue.li@bytedance.com) | | |
| [JVET-AL0284](https://jvet-experts.org/doc_end_user/current_document.php?id=15611) | Crosscheck of JVET-AL0145 (EE1-1.4: Conditional loop-filter) | | | [J. Strom (Ericsson)](mailto:jacob.strom@ericsson.com) | | |
| [JVET-AL0297](https://jvet-experts.org/doc_end_user/current_document.php?id=15624) | Crosscheck of JVET-AL0104 (EE1-2.1: Lightweight Multiscale Reference Frame Generation for VVC Inter Coding) | | | [L. Murn (Nokia)](mailto:luka.murn@nokia.com) | | |
| [JVET-AL0298](https://jvet-experts.org/doc_end_user/current_document.php?id=15625) | Crosscheck of JVET-AL0105 (EE1-2.2: RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding) | | | [L. Murn (Nokia)](mailto:luka.murn@nokia.com) | | |

**Recommendations**

The AHG recommends:

* Review all input contributions.
* Continue investigating neural network-based video coding tools, including coding performance and complexity.
* Continue collecting training materials for neural network-based video coding tool development and investigate training stability.
* Conduct detailed discussion on training, exchange opinions and observations among interested parties (potential BoG)
* Add study of bit-exact reproducibility to the NNVC complexity assessment

Results indicate that adding BVI-AOM to training is not sufficient for optimizing inter prediction part of EE.

[JVET-AL0012](https://jvet-experts.org/doc_end_user/current_document.php?id=15395) JVET AHG report: Enhanced compression beyond VVC capability (AHG12) [M. Karczewicz, Y. Ye, L. Zhang (co-chairs), B. Bross, R. Chernyak, X. Li, K. Naser, Y. Yu (vice-chairs)]

The primary activity of the AHG was the “Exploration experiment on enhanced compression beyond VVC capability” (JVET-AK2024). The combined improvements of the ECM-16.1 over VTM-11.0ecm16.0 anchorfor AI, RA and LB configurations are:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | All Intra Main10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -14.59% | -15.70% | -26.79% | 1197.4% | 527.4% |
| Class A2 | -21.11% | -23.87% | -28.39% | 1175.6% | 576.4% |
| Class B | -14.71% | -22.37% | -20.35% | 1115.0% | 622.9% |
| Class C | -14.85% | -11.82% | -12.99% | 1050.3% | 586.3% |
| Class E | -19.17% | -22.39% | -20.59% | 1033.0% | 649.6% |
| Overall | -16.53% | -19.17% | -21.17% | 1109.1% | 594.2% |
| Class D | -12.71% | -8.95% | -9.88% | 1027.3% | 624.9% |
| Class F | -30.26% | -33.90% | -34.10% | 719.4% | 656.4% |
| Class TGM | -43.26% | -48.84% | -48.12% | 543.2% | 622.8% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Random Access Main 10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -27.30% | -23.64% | -35.77% | 1204.6% | 1070.0% |
| Class A2 | -30.50% | -33.70% | -39.05% | 1162.8% | 1307.0% |
| Class B | -25.08% | -31.91% | -29.21% | 999.8% | 1139.8% |
| Class C | -26.76% | -22.11% | -22.88% | 1053.2% | 1226.1% |
| Class E |  |  |  |  |  |
| Overall | -27.06% | -28.00% | -30.80% | 1084.5% | 1179.5% |
| Class D | -27.52% | -22.95% | -23.94% | 995.5% | 1342.6% |
| Class F | -33.16% | -35.27% | -35.81% | 918.3% | 851.5% |
| Class TGM | -42.58% | -47.84% | -47.64% | 742.3% | 613.8% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Low Delay B Main 10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -22.10% | -35.80% | -32.15% | 992.7% | 940.5% |
| Class C | -24.50% | -24.84% | -26.38% | 936.2% | 984.3% |
| Class E | -21.74% | -26.55% | -25.95% | 952.2% | 623.4% |
| Overall | -22.81% | -29.83% | -28.68% | 963.4% | 861.6% |
| Class D | -25.88% | -25.77% | -26.68% | 949.4% | 1139.8% |
| Class F | -30.60% | -38.50% | -38.39% | 846.9% | 748.6% |
| Class TGM | -40.89% | -50.16% | -50.14% | 737.2% | 550.1% |

The rate reduction for natural sequences over VTM in RA configuration for {Y, U, V} increased from ECM-15.0’s {-26.55%, -27.57%, -30.37%} to ECM-16.1’s {-27.06%, -28.00%, -30.80%}. For SCC sequences (class TGM) the rate reduction for RA configuration increased from ECM-15.0’s { -42.33%, -47.83%, -47.63%} to ECM-16.1’s { -42.58%, -47.84%, -47.66%}.

**Contributions**

In addition to 31 EE2 contributions, 30 (comparing to 35 last meeting) EE2-related and AHG12-related contributions were received. The EE2-related and AHG12-related contributions can be subdivided as follows:

***Intra (9)***

JVET-AL0174, "Non-EE2: TIMD fusion with neural network based intra prediction", Y.-H Lin, K.-W Liang, C.-Y Teng, Y.-C Yang (Sharp)

JVET-AL0179, "Non-EE2: Intra Merge Mode Enhancements", M. Blestel, P. Andrivon (Ofinno), Y. Chang, V. Seregin, M. Karczewicz (Qualcomm Inc.),

JVET-AL0183, "Non-EE2: Block Vector-based Intra Mode Derivation", J.-K Lee, D. Ruiz Coll, M. Blestel (Ofinno)

JVET-AL0192, "EE2-related: Harmonization of SGPM-BV and LIC", J. Huo, Y. Fei, L. Wang, Y. Ma, F. Yang (Xidian Univ.)

JVET-AL0195, "Non-EE2: TIMD-BV extension with enhanced IntraTMP merge list", J. Fu, J. Zhang, Y. Zhao, S. Ma (PKU), Y. Gao, C. Huang (ZTE), K. Naser, M. RadosavljeviÄ‡, T. Dumas (InterDigital), D. Ruiz Coll, J.-K Lee (Ofinno)

JVET-AL0202, "EE2-related: Adaptive picture-level vertical mirroring based on decimated video", D. Mieloch, M. Lorkiewicz, A. Dziembowski (PUT)

JVET-AL0231, "Non-EE2: On interpolation filter for TIMD", Y. Wang, W. Yin, K. Zhang, Z. Deng, N. Zhang, L. Zhao, M. Salehifar, L. Zhang (Bytedance)

JVET-AL0241, "Non-EE2: Intra TMP sub-modes depending on the template type information", T. Dumas, K. Naser, M. Radosavljević, F. Le Léannec (Interdigital)

JVET-AL0290, "[AHG12] Combination of JVET-AL0174, JVET-AL0195 and JVET-AL0241 on Enhanced TIMD with NNIP and Optimized Block Vector Derivation", K. Naser, S. Puri, T. Dumas, M. Radosavljević, F. Le Léannec, E. François (InterDigital), J. Fu, Y. Zhao, J. Zhang, S. Ma (PKU), C. Huang (ZTE), D. Ruiz Coll, J.-K. Lee (Ofinno), Y-H. Lin, C.-Y. Teng, K.-W. Liang, Y.-C. Yang (Sharp Corporation)

***Inter (6)***

JVET-AL0082, "AHG12: Modifications to regression-based GPM with intra and inter prediction", R. Yu, V. Seregin, M. Karczewicz (Qualcomm)

JVET-AL0111, "Non-EE2: Matrix-based position dependent intra prediction for GPM/CIIP", Z. Sun, Y. Yu, L. Xu, H. Yu, D. Wang (OPPO)

JVET-AL0193, "Non-EE2: Extension of Template Types in Regression-Based GPM", Y. Yao, J. Huo, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang (Hisense)

JVET-AL0234, "EE2-related: affine bilateral matching merge mode", H. Huang, V. Seregin, M. Karczewicz (Qualcomm)

JVET-AL0248, "AHG12: On Motion Vector Prediction", D. Bugdayci Sansli, P. Astola, J. Lainema (Nokia)

JVET-AL0287, "AHG12: Generated Merge Candidates", D. Bugdayci Sansli, P. Astola, J. Lainema (Nokia)

***Entropy and Coefficient Coding (5)***

JVET-AL0087, "AHG12: Predictive transform coefficient coding", T. N. Canh, F. Pu, P. Yin, S. McCarthy (Dolby)

JVET-AL0109, "EE2-related: On binarization of a coefficient level in TSRC", Y. Yu, L. Xu, J. Gan, H. Yu, D. Wang (OPPO)

JVET-AL0113, "AHG12: Directional sign prediction", L. Xu, Y. Yu, Z. Sun, L. Zhang, H. Yu, D. Wang (OPPO)

JVET-AL0150, "Non-EE2: CABAC context switch of sig\_coeff\_flag and abs\_level\_gtx\_flag for LFNST/NSPT", T. Kusakabe, K. Abe, T. Sugio, T. Nishi (Panasonic)

JVET-AL0198, "Non-EE2: Optimization of probability estimation in CABAC", D. Karwowski, D. Mieloch, M. Lorkiewicz, J. Stankowski (PUT)

***In Loop Filters (9)***

JVET-AL0110, "EE2-related: On ALF-CCCM", N. Song, L. Xu, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AL0163, "Non-EE2: Look-up table based loop filtering for ECM", Y. Du, J. Chen, A. Li, J. Liu, C. Zhu, L. Luo, H. Guo (UESTC), Y. Huo, L. Liu (Transsion)

JVET-AL0182, "AhG-12: On TALF reference picture extensions", P. Onno, B. Galmiche, G. Laroche (Canon)

JVET-AL0220, "AHG12: Reuse of ALF control information", N. Hu, H. Wang, M. Karczewicz, V. Seregin (Qualcomm)

JVET-AL0225, "EE2-related: On In-Loop Filtering in ECM", D. Rusanovskyy, M. Santamaria, N. Le, F. Cricri, K. Panusopone, S. Hong, L. Wang, J. Lainema (Nokia)

JVET-AL0228, "EE2-related: NNLF interface in ECM", T. Poirier, F. Galpin, G. Boisson (InterDigital)

JVET-AL0230, "AhG11/AhG12: Performance of the NNVC ILF in ECM", D. Rusanovskyy, K. Panusopone, S. Hong, L. Wang (Nokia)

JVET-AL0232, "Non-EE2: on TALF input extension", C. Ma, X. Xiu, X. Wang (Kwai)

JVET-AL0275, "Non-EE2: Non-linear clipping for CCALF", N. Song, L. Xu, Y. Yu, H. Yu, D. Wang (OPPO)

Recommendations

The AHG recommends to:

* To review all the related contributions.

[JVET-AL0013](https://jvet-experts.org/doc_end_user/current_document.php?id=15396) JVET AHG report: Film grain technologies (AHG13) [W. Husak, P. de Lagrange (co-chairs), A. Duenas, X. Meng, A. Segall, G. Teniou, A. Tourapis (vice-chairs)]

This period was slow with no meetings or discussions held.

From the previous meetings, the following five items should be in the second edition:

* Updated TR text to fix errors and clumsy wording
* Updated tools for the TR
* Video test sequences specific to film grain to be added to the TR
* Metrics – discussion and/or survey of available techniques or metrics
* Subjective testing of Film Grain

The following are worthy of discussion for the second edition:

* Conformance – this is interesting due to being an SEI
* Analysis – preprocessing analysis (parameter estimation)

These are additional topics for consideration and discussion:

* EG/RP (?) – What would be useful information for guiding usage? (guidance document)
* Future parameters and signaling – not a v2 topic

**Related contributions**

Six contributions related to AHG13 were identified as of 03/25/2025.

* One contribution was the AHG report:
  + JVET-AL0013 JVET AHG report: Film grain technologies (AHG13)
* Five other contributions were uploaded at the time of the report drafting:
  + JVET-AL0086 AHG9/AHG13: On Spatial Resolution for the Film Grain Characteristics (FGC) SEI message
  + JVET-AL0204 AHG9: On picture width and height for the film grain characteristics SEI message
  + JVET-AL0211 AHG9: Resolution nesting for FGC SEI message
  + JVET-AL0282 AHG13: Film grain analysis improvement
  + JVET-AL0288 AHG2, AHG9, AHG13: on FGC SEI reference picture size

***Contributions***

There were five contributions registered other than the AHG report. Three were uploaded as of 03/25/25.

**JVET-AL0086 AHG9/AHG13: On Spatial Resolution for the Film Grain Characteristics (FGC) SEI message**

This contribution relates to the Film Grain Characteristics (FGC) SEI message. It is proposed to add signalling of width and height as extension of the FGC SEI message. It is asserted that this signalling allows for encoders and decoders to properly handle the combination of resolution changes and Film Grain Synthesis (FGS). The proposed solution is claimed to have the following advantages:

1. It is backwards compatible in the sense that no change is expected from existing encoders and decoders with support for the FGC SEI message.
2. It does not reinterpret/overload existing syntax elements with properties they were not intended for.
3. It applies not only to VVC and RPR, but also to general Adaptive Bit Rate (ABR) streaming with VVC, HEVC, and AVC.

The same change is proposed for VSEI, HEVC and AVC.

**JVET-AL0204 AHG9: On picture width and height for the film grain characteristics SEI message**

The following aspects are proposed for the film grain characteristics (FGC) SEI message in this contribution:

1. Addition of fg\_pic\_width\_in\_luma\_samples and fg\_pic\_height\_in\_luma\_samples to an extension of the FGC SEI message. When present, they indicate the width and the height of the picture for which the film grain modelling information is indicated in units of luma samples. When fg\_pic\_width\_in\_luma\_samples and fg\_pic\_height\_in\_luma\_samples are not present, there is no change to the existing specifications on picture width and height for the FGC SEI message.

Clarifications how the input image Î to which the film grain model applies is derived.

**JVET-AL0211 AHG9: Resolution nesting for FGC SEI message**

This proposal addresses the issue of applying FGS at a resolution different than the coded resolution reported in *JVET-AK0197 and also addressed in JVET-AK0339. The document asserts that the solutions proposed at the last meeting are not well suited for adaptive streaming environments,* have backward-compatibility issues and are unclear regarding conformance window cropping*. A solution based on nesting is proposed by adding a new resolution nesting SEI message to VSEI to carry so-called resolution-nested SEI messages to be applied to a resampled decoded picture. Interface text for VVC is provided.*

**JVET-AL0282 AHG13: Film grain analysis improvement**

Not uploaded.

**JVET-AL0288 AHG2, AHG9, AHG13: on FGC SEI reference picture size**

This contribution is a continuation of JVET-AK0197; it proposes to amend the VSEI specification and VVC interface text to refer to SPS instead of PPS to define reference picture resolution for the interpretation of the film grain characteristics SEI message, the intent being to describe film grain characteristics at source picture resolution independently of encoder decisions to perform reduced-resolution coding.

An experiment is reported to showcase the effect of grain synthesis at either SPS max resolution, or coded resolution when using RPR functionality testing of the VTM, switching between full and half resolution.

It is also proposed to indicate that unspecified cropping and padding can be applied as needed.

**Recommendations**

The AHG recommends:

* Continue editing the second edition for the TR;
* the related input contributions are reviewed;
* any liaisons are reviewed;
* testing of FGS be discussed;
* continued conformance discussion;
* SEI message extensions;
* discussion topics for an EG/RP; and
* continue the study of film grain technologies in JVET.

It was announced that JVET-AL2020 will be made available during the current meeting.

[JVET-AL0014](https://jvet-experts.org/doc_end_user/current_document.php?id=15349) JVET AHG report: NNVC software development (AHG14) [F. Galpin (chair), R. Chang, Yue Li, Yun Li, M. Santamaria, J. N. Shingala, Z. Xie (vice-chairs)]

1. **Software development**

***Location***

NNVC repository is located at <https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/VVCSoftware_VTM>

NNVC software is based on VTM-11.0 with enabled MCTF including the update from JVET-V0056, GOP32, enabling deblocking in the RDO, JVET-AH0054 with improved MCTF, JVET-AI0124 for reference picture alignment.

NNVC-12.0 anchor at https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/nnvc-ctc is used for NNVC performance evaluation.

***Software changes***

***NNVC-12.0***

Several commits were merged in the NNVC repository. The following changes were integrated:

|  |  |  |
| --- | --- | --- |
| **Contribution** | **MR** | **description** |
| AK0093 | MR 290 | EE1-1.5.2 (off in ctc) : Adaptive skip of LOP filtering based on boundary strength partitions |
| AK0150 | MR 289 | AK0150 attention module (LOP only) |
| AK0311 | MR 288/291 | [JVET-AK0311 - AHG11/AHG14: Content-adaptive LOP4 filter](https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/VVCSoftware_VTM/-/merge_requests/288) |
|  | MR 144 | [Feature: backtrack layers to run from used output](https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/sadl/-/issues/54) |
|  | MR 293 | merge new SADL in NNVC |
|  | MR 294 | update to SADL v12 |
|  | MR 295 | correction for HOP5 training |
| AK0195 | MR296 | [LOP5(JVET-AK0150 & JVET-AK0195)](https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/VVCSoftware_VTM/-/merge_requests/296) |
|  | MR297 | [Nnvc 6.1 aom dataset assets](https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/VVCSoftware_VTM/-/merge_requests/298) |

In SADL, the following changes were integrated:

|  |  |  |
| --- | --- | --- |
| **Contribution** | **MR** | **description** |
|  | MR 147 SADL | [SIMD add implementation](https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/sadl/-/merge_requests/132) |
|  | MR 133 SADL | [Simd mul](https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/sadl/-/merge_requests/133) |
|  | MR 134 SADL | [Simd relu](https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/sadl/-/merge_requests/134) |
| AK0257 | MR 138 SADL | Extend the Resize operator to support 2x upsampling in Bicubic mode |
| AK0257 | MR 139 SADL | [Extend the GridSample operator to support Bicubic mode](https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/sadl/-/merge_requests/139) |
| AK0151 | MR 141 SADL | [Explicit full SIMD for 1x3, 3x1, and 3x3 DW convolution](https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/sadl/-/merge_requests/141) |
|  | MR 142 SADL | Fix #53: Resize input width and height in count\_mac only when the input has 3 or more dimensions |

A new branch allowing dataset extension has been created to ease the process of dataset creation ( see <https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/VVCSoftware_VTM/-/tree/NNVC-6.1_aom_dataset?ref_type=heads> )

***Software version***

NNVC-12 was tagged February 6th, 2024 (containing final LOP5 model)

NNVC-12rc1 was tagged February 5th, 2024 (containing new intermediate LOP5 model)

NNVC-11.0 was tagged December 10th, 2024 (bit accurate with 11rc)

NNVC-11.0rc was tagged December 3rd, 2024

NNVC-10.0 was tagged August 9th, 2024

NNVC-9.1 was tagged May 28th, 2024

NNVC-9.0 was tagged May 13th, 2024

NNVC-8.0 was tagged February 20th, 2024

NNVC-8.0rc3 was tagged February 20th, 2024.

NNVC-7.1 was tagged November 29th, 2023.

NNVC-7.0 was tagged November 3rd, 2023.

NNVC-6.1 was tagged September 25th, 2023 (fix).

NNVC-6.0 was tagged September 6th, 2023.

NNVC-5.1 was tagged July 19th, 2023.

NNVC-5.0 was tagged May 11th, 2023.

NNVC-3.0 (a.k.a VTM-11.0\_nnvc3.0) was tagged December 1st, 2022.

NCS-1.0 (a.k.a NNVC-3.0wip2) was tagged September 4th, 2022 (first release containing the FilterSets, using NNVC 2.0 as a base).

VTM-11.0\_nnvc-2.0 was tagged August 4th, 2022 (add deblocking in RDO).

VTM-11.0\_nnvc-1.0 was tagged May 6th, 2021 (VTM-11.0 base with MCTF enabled).

1. **CTC performance**

See configurations section for naming convention.

***Comparison to VTM***

**NNVC-11.0 VTM vs NNVC-12.0 VTM**

VTM configuration of NNVC is not changed between version 10.0 and 12.0.

Note: 1 redundant bit in SPS is removed between the 2 versions (see MR 265). In practice NNVC-10 VTM is used as anchor.

**NNVC-12.0 VTM vs NNVC-12.0 anchor**

The NNVC-12.0 anchor includes LOP.5 filter and Intra Prediction tools activated.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-10.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -9.44% | -13.81% | -15.06% | -9.67% | -16.12% | -17.77% | 119% | 3756% |
| Class A2 | -8.43% | -15.41% | -9.80% | -8.75% | -16.06% | -9.98% | 117% | 3619% |
| Class B | -7.83% | -16.23% | -14.70% | -8.16% | -18.57% | -17.48% | 116% | 3610% |
| Class C | -7.63% | -14.80% | -13.61% | -8.03% | -15.73% | -15.29% | 110% | 3133% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -8.22% | -15.20% | -13.50% | -8.54% | -16.82% | -15.45% | 115% | 3505% |
| Class D | -8.11% | -13.77% | -12.49% | -7.36% | -15.21% | -13.59% | 105% | 2816% |
| Class F | -4.44% | -8.80% | -7.54% | -5.54% | -12.17% | -11.56% | 117% | 1542% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-10.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | -6.00% | -11.62% | -10.75% | -6.57% | -11.47% | -13.05% | 107% | 3324% |
| Class C | -6.12% | -12.78% | -10.34% | -6.96% | -12.06% | -8.63% | 102% | 3116% |
| Class E | -6.62% | -7.98% | -5.71% | -7.97% | -6.80% | -6.13% | 109% | 2797% |
| **Overall** | -6.19% | -11.10% | -9.35% | -7.05% | -10.50% | -9.85% | 106% | 3116% |
| Class D | -6.98% | -9.73% | -6.65% | -7.15% | -7.63% | -4.39% | 98% | 3028% |
| Class F | -3.58% | -5.89% | -5.19% | -5.78% | -6.59% | -8.53% | 108% | 1687% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | |
|  | **BD-rate Over NNVC-10.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | -6.59% | -13.84% | -12.80% | -6.85% | -14.83% | -15.94% | 109% | 3302% |
| Class C | -6.59% | -15.10% | -12.65% | -7.04% | -14.89% | -13.26% | 104% | 3035% |
| Class E | -7.63% | -9.40% | -7.19% | -9.23% | -9.21% | -9.18% | 116% | 3306% |
| **Overall** | -6.85% | -13.15% | -11.35% | -7.51% | -13.44% | -13.35% | 109% | 3212% |
| Class D | -7.42% | -11.49% | -9.48% | -7.53% | -9.29% | -8.74% | 99% | 2777% |
| Class F | -3.99% | -7.42% | -6.72% | -5.92% | -9.50% | -12.42% | 108% | 1657% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-10.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -10.04% | -15.76% | -15.86% | -9.90% | -18.72% | -18.73% | 161% | 2722% |
| Class A2 | -8.39% | -15.93% | -12.29% | -8.97% | -16.56% | -12.16% | 166% | 2401% |
| Class B | -8.35% | -15.94% | -16.39% | -8.69% | -18.44% | -18.75% | 172% | 2437% |
| Class C | -8.31% | -14.16% | -14.18% | -8.99% | -17.53% | -17.83% | 149% | 1758% |
| Class E | -11.85% | -17.56% | -18.40% | -12.46% | -17.80% | -19.96% | 162% | 2511% |
| **Overall** | -9.21% | -15.78% | -15.46% | -9.63% | -17.87% | -17.64% | 162% | 2314% |
| Class D | -8.20% | -11.93% | -12.73% | -8.35% | -16.84% | -17.48% | 139% | 1556% |
| Class F | -5.77% | -10.64% | -9.99% | -6.21% | -13.77% | -13.81% | 130% | 1898% |

Note: Results from Interdigital, crosschecked by Qualcomm (AI/RA) and Nokia.

**NNVC-11.0 VTM mode vs NNVC-11.0 HOP.5**

The NNVC-12.0 had not change the HOP5 model. Performance is the same as NNVC-11.0 with a slight decoding time increase.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -15.60% | -13.69% | -21.60% | -17.26% | -19.06% | -23.79% | 305% | 155418% |
| Class A2 | -15.13% | -20.72% | -26.68% | -14.49% | -20.24% | -23.74% | 283% | 135823% |
| Class B | -13.10% | -24.21% | -17.36% | -11.95% | -22.58% | -16.70% | 294% | 146069% |
| Class C | -13.92% | -17.30% | -16.86% | -12.52% | -14.58% | -14.20% | 229% | 111863% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -14.22% | -19.57% | -19.94% | -13.67% | -19.28% | -18.86% | 275% | 135747% |
| Class D | -14.83% | -17.41% | -17.34% | -11.03% | -12.96% | -11.40% | 226% | 112306% |
| Class F | -8.99% | -11.35% | -10.48% | -9.24% | -12.20% | -10.80% | 412% | 59637% |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -13.53% | -10.72% | -17.20% | -15.00% | -16.58% | -19.47% | 360% | 105630% |
| Class A2 | -13.56% | -17.53% | -21.27% | -14.30% | -18.54% | -18.26% | 265% | 84182% |
| Class B | -12.13% | -16.96% | -14.32% | -12.03% | -17.06% | -14.79% | 259% | 80684% |
| Class C | -13.07% | -14.27% | -16.16% | -12.79% | -13.89% | -15.46% | 194% | 52806% |
| Class E | -16.66% | -19.95% | -18.84% | -16.38% | -18.82% | -19.54% | 271% | 89903% |
| **Overall** | -13.56% | -15.91% | -17.12% | -13.80% | -16.81% | -17.09% | 259% | 78755% |
| Class D | -12.19% | -12.68% | -15.79% | -11.24% | -12.70% | -14.68% | 178% | 49898% |
| Class F | -9.96% | -12.44% | -10.41% | -9.68% | -12.47% | -10.99% | 168% | 65233% |

Note: Results from InterDigital, crosschecked by xxx.

**NNVC-12.0 VTM mode vs NNVC-12.0 VLOP**

The NNVC-12.0 had not change the VLOP3 model. Performance is the same as NNVC-11.0 with a slight decoding time decrease.

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|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-10.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -7.18% | -5.57% | -5.74% | -7.66% | -6.78% | -6.23% | 107% | 1606% |
| Class A2 | -5.92% | -6.40% | -4.16% | -6.51% | -7.01% | -3.96% | 109% | 1481% |
| Class B | -5.45% | -7.56% | -6.50% | -6.25% | -8.21% | -7.34% | 110% | 1516% |
| Class C | -4.95% | -6.49% | -5.83% | -6.01% | -7.79% | -6.45% | 110% | 1382% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -5.75% | -6.65% | -5.70% | -6.52% | -7.57% | -6.20% | 109% | 1489% |
| Class D | -4.87% | -5.48% | -4.91% | -5.46% | -6.03% | -5.38% | 108% | 1307% |
| Class F | -2.93% | -3.49% | -3.22% | -3.87% | -5.61% | -4.54% | 112% | 726% |

|  |  |  |  |  |  |  |  |  |
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|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-10.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -8.24% | -8.99% | -8.35% | -8.36% | -10.77% | -9.22% | 150% | 1248% |
| Class A2 | -6.80% | -8.35% | -6.85% | -7.16% | -8.55% | -6.21% | 151% | 1154% |
| Class B | -6.73% | -8.80% | -8.72% | -7.11% | -9.70% | -9.50% | 154% | 1176% |
| Class C | -6.25% | -7.86% | -7.59% | -7.16% | -9.37% | -8.65% | 143% | 966% |
| Class E | -9.34% | -10.06% | -9.98% | -10.08% | -9.77% | -9.18% | 153% | 1223% |
| **Overall** | -7.32% | -8.76% | -8.30% | -7.83% | -9.63% | -8.67% | 150% | 1141% |
| Class D | -6.10% | -6.89% | -6.85% | -6.61% | -8.78% | -8.50% | 136% | 911% |
| Class F | -4.31% | -5.60% | -5.58% | -4.75% | -7.00% | -6.89% | 122% | 861% |

Note: Results from Interdigital, crosschecked by Qualcomm (RA/AI) and Nokia.

**NNVC-12.0 VTM vs NNVC-12.0 NNSR**

The NNVC-12.0 had not change the NNSR model. Performance is the same as NNVC-11.0 (performance on NNVC-11 for reference).

Note: only class A sequences are changed, LDx configuration are thus omitted.

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|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -12.07% | -10.17% | -10.56% | -19.18% | -21.21% | -20.88% |  |  |
| Class A2 | -8.86% | -6.49% | -1.95% | -17.40% | -15.13% | -14.57% |  |  |
| Class B | -7.29% | -15.44% | -14.36% | -7.96% | -17.45% | -16.84% |  |  |
| Class C | -6.91% | -13.77% | -13.51% | -7.78% | -14.78% | -15.09% |  |  |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -8.46% | -12.15% | -10.89% | -12.04% | -17.02% | -16.73% |  |  |
| Class D | -7.13% | -13.31% | -12.30% | -6.87% | -14.56% | -13.06% |  |  |
| Class F | -4.02% | -8.28% | -7.29% | -5.03% | -10.94% | -10.87% |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -10.98% | -9.96% | -11.73% | -13.82% | -13.69% | -13.78% |  |  |
| Class A2 | -11.00% | -4.54% | -1.25% | -17.09% | -6.78% | -2.52% |  |  |
| Class B | -7.86% | -15.36% | -16.39% | -8.27% | -17.73% | -18.36% |  |  |
| Class C | -7.71% | -14.17% | -14.72% | -8.57% | -17.34% | -17.80% |  |  |
| Class E | -11.22% | -17.07% | -18.08% | -11.90% | -17.26% | -19.04% |  |  |
| **Overall** | -9.43% | -12.68% | -13.00% | -11.34% | -15.07% | -14.95% |  |  |
| Class D | -7.61% | -12.34% | -13.39% | -7.97% | -16.35% | -17.00% |  |  |
| Class F | -5.39% | -9.85% | -9.70% | -5.81% | -12.75% | -13.41% |  |  |

Note: Results from HUTS, crosschecked by xxx.

***Comparison to NNVC-12.0 anchor***

**NNVC-11 anchor vs NNVC-12.0 anchor**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-11** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -0.62% | -0.96% | -0.90% | -0.26% | -1.79% | -2.13% | 100% | 97% |
| Class A2 | -0.59% | -1.31% | -0.13% | -0.42% | -1.23% | -0.52% | 100% | 99% |
| Class B | -0.58% | -1.01% | -0.41% | -0.21% | -1.51% | -0.82% | 97% | 96% |
| Class C | -0.77% | -1.21% | -0.10% | -0.28% | -1.19% | -0.25% | 94% | 94% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -0.64% | -1.11% | -0.37% | -0.28% | -1.42% | -0.87% | 97% | 96% |
| Class D | -1.07% | -0.54% | -0.22% | -0.52% | -0.93% | -0.37% | 93% | 92% |
| Class F | -0.44% | -0.65% | -0.32% | -0.54% | -1.57% | -0.88% | 95% | 90% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-11** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | -0.16% | -0.11% | 0.32% | 0.41% | 0.38% | 0.21% | 99% | 90% |
| Class C | -0.55% | -1.30% | 0.50% | 0.05% | -2.00% | 0.59% | 100% | 98% |
| Class E | -0.11% | -3.78% | 2.22% | 0.56% | -4.88% | 0.39% | 101% | 78% |
| **Overall** | -0.28% | -1.42% | 0.85% | 0.33% | -1.73% | 0.39% | 100% | 89% |
| Class D | -0.69% | -0.89% | 1.37% | -0.07% | -3.36% | 2.04% | 100% | 101% |
| Class F | -0.26% | -0.49% | 0.52% | -0.28% | -1.35% | -1.18% | 101% | 93% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | |
|  | **BD-rate Over NNVC-11** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | -0.29% | 0.60% | 0.65% | 0.54% | 1.82% | 1.30% | 98% | 91% |
| Class C | -0.64% | -1.62% | 0.09% | 0.16% | -2.29% | -0.01% | 101% | 100% |
| Class E | -0.29% | -3.94% | 1.87% | 0.29% | -4.75% | -0.93% | 103% | 90% |
| **Overall** | -0.41% | -1.27% | 0.77% | 0.35% | -1.19% | 0.31% | 100% | 94% |
| Class D | -0.87% | -0.59% | -0.21% | -0.12% | -1.97% | -0.07% | 100% | 100% |
| Class F | -0.36% | -0.51% | 0.17% | -0.46% | -1.46% | -0.58% | 100% | 99% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-11** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -0.95% | -0.18% | 1.04% | -0.57% | -0.40% | -0.78% | 94% | 96% |
| Class A2 | -0.47% | -0.66% | -0.09% | -0.47% | -0.63% | -0.32% | 97% | 97% |
| Class B | -0.53% | -0.73% | 0.01% | -0.46% | -0.95% | -0.50% | 100% | 100% |
| Class C | -0.65% | -0.02% | 0.64% | -0.45% | -0.30% | -0.09% | 97% | 94% |
| Class E | -0.71% | -0.59% | -0.41% | -0.62% | -0.70% | -1.20% | 98% | 96% |
| **Overall** | -0.65% | -0.45% | 0.24% | -0.50% | -0.62% | -0.54% | 97% | 97% |
| Class D | -0.64% | 0.41% | 0.73% | -0.42% | -0.69% | -0.77% | 95% | 93% |
| Class F | -0.41% | -0.95% | -0.36% | -0.42% | -1.31% | -0.53% | 96% | 97% |

Note: Results from InterDigital, crosschecked by Nokia.

1. **Contributions**

We have 2 contributions for AhG14 and 1 telco report.

|  |  |  |  |
| --- | --- | --- | --- |
| [JVET-AL0043](https://jvet-experts.org/doc_end_user/current_document.php?id=15348) | m71759 | [AHG11] [AHG14] Teleconference on NNVC | E. Alshina, F. Galpin |
| [JVET-AL0100](https://jvet-experts.org/doc_end_user/current_document.php?id=15425) | m71900 | AHG14: The extension of SADL library | W. Ma, N. Fu, W. Bao, Z. Chen (Wuhan Univ.) |
| [JVET-AL0265](https://jvet-experts.org/doc_end_user/current_document.php?id=15592) | m72339 | AhG14: SADL update | [F. Galpin (InterDigital)](mailto:franck.galpin@interdigital.com) |

Another contribution of interest for the software development in AhG11 was also available:

|  |  |  |  |
| --- | --- | --- | --- |
| [JVET-AL0080](https://jvet-experts.org/doc_end_user/current_document.php?id=15405) | m71875 | AHG11: Bit-exact reconstruction for NN video tools | L. Kerofsky, Y. Li, M. Karczewicz (Qualcomm) |

1. **Configurations**

The following configurations is used to generate the different NNVC results.

The column “tested” is read as follow:

* Y: the configuration has been tested using the new NNVC software
* P: the results are the ones from previous NNVC software basis
* N: not tested.

The column “xcheck” is read as follow:

* Y: the test has been cross-checked
* P: no cross-checked performed but results are consistent with previous version on NNVC
* N: no cross-check available

|  |  |  |
| --- | --- | --- |
| Name | Tools | Configuration |
| NNVC VTM mode | None | encoder\_xxx\_vtm.cfg |
| NNVC Anchor/EE1 | Intra Pred + LOP.5 | encoder\_xxx\_nnvc.cfg |
| NNVC. HOP | Intra Pred + HOP.5 | encoder\_xxx\_nnvc.cfg + nn-based/HOP5.cfg |
| NNVC. VLOP | Intra Pred + VLOP.3 | encoder\_xxx\_vtm.cfg + nn-based/vlop3.cfg |
| SR | Super-resolution | nn-based/nnsr.cfg + nn-based/nnsr\_classAx.cfg |
| PF | Adaptive post-filters | nn-based/nnpf/nnpf\_xxx.cfg |
| ALOP | Intra pred+adaptive LOP | encoder\_xxx\_vtm.cfg +nn-based/intra.cfg+xxx |

Deprecated options:

|  |  |  |
| --- | --- | --- |
| set0 | Loop filter set #0 | encoder\_xxx\_vtm.cfg + nn-based/NnlfOption\_1.cfg |
| set1 | Loop filter set #1 | encoder\_xxx\_vtm.cfg + nn-based/NnlfOption\_2.cfg |
| set0+rdo | Loop filter set #0 + Rdo | nn-based/NnlfOption\_1.cfg + --EncNnlfOpt=1 |
| set1+rdo+intra+temporal filter | Loop filter set #1 + Temporal filter | nn-based/NnlfOption\_2.cfg  + --NnlfSet1Multiframe=1 |

1. **Recommendations**

The AHG recommends to:

* Continue to develop NNVC software.
* Improve the software documentation.
* Encourage people to report all (potential) bugs that they are finding using GitLab Issues functionality <https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/VVCSoftware_VTM/-/issues>

Encourage people to submit merge requests fixing identified bugs.

[JVET-AL0015](https://jvet-experts.org/doc_end_user/current_document.php?id=15397) JVET AHG report: Gaming content compression (AHG15) [S. Puri, J. Sauer (co-chairs), R. Chernyak, A. Duenas, L. Wang, V. Zakharchenko (vice chairs)]

Software developed by AHG15 consists of forks of VTM/ECM that have support for reading auxiliary data that is provided for sequences of classes G1/G3. A third repository contains scripts for the verification of the auxiliary information. The repositories can be found at <https://vcgit.hhi.fraunhofer.de/jvet-ahg-gcc>.

1. **Test results**

Test results were obtained according to JVET-AJ2027. The list of sequences/classes is copied for convenience below:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Class** | **Sequence name** | **Frame count** | **Low delay frame count** | **Frame rate** | **Bit depth** | **Intra** | **Random access** | **Low-delay** |
| G1 (SDR) | Level1\_SDR | 600 | 300 | 60 | 10 | M | M | M |
| Darktree\_SDR | 600 | 300 | 60 | 10 | M | M | M |
| ARPG2\_SDR | 600 | 300 | 60 | 10 | M | M | M |
| DesertTown3\_SDR | 600 | 300 | 60 | 10 | M | M | M |
| SunTemple3\_SDR | 600 | 300 | 60 | 10 | M | M | M |
| G2 | GTAV | 600 | 300 | 60 | 8 | M | M | M |
| Minecraft | 600 | 300 | 60 | 8 | M | M | M |
| JianlingTemple | 600 | 300 | 60 | 8 | M | M | M |
| BaoleiYard | 300 | - | 60 | 8 | M | M | - |
| G3 (HDR) | Level1\_HDR | 600 | 300 | 60 | 10 | O | O | O |
| Darktree\_HDR | 600 | 300 | 60 | 10 | O | O | O |
| ARPG2\_HDR | 600 | 300 | 60 | 10 | O | O | O |
| DesertTown3\_HDR | 600 | 300 | 60 | 10 | O | O | O |
| SunTemple3\_HDR | 600 | 300 | 60 | 10 | O | O | O |

For class G3 the HDR versions of Level1 and Darktree are still missing.

***VTM-11.0ecm16.0 vs ECM-16.0***

**SDR**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | |
|  | **Over Anchor** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class G1 | -11.59% | -23.99% | -18.80% | 1153.56% | 617.35% | #REF! |
| Class G2 | -18.38% | -22.87% | -27.01% | 1216.37% | 694.86% | #REF! |
| **Overall** | -14.61% | -23.49% | -22.45% | 1181.07% | 650.67% | #REF! |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access Main 10** | | | | | |
|  | **Over Anchor** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class G1 | -27.49% | -42.71% | -34.63% | 921.82% | 1545.85% | #REF! |
| Class G2\* | -24.45% | -36.52% | -37.83% | 907.19% | 1517.11% | #REF! |
| **Overall** | -26.35% | -40.39% | -35.83% | 916.31% | 1535.01% | #REF! |

\* ECM crashed for BaoleiYard. Results are averaged without BaoleiYard

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay B Main 10** | | | | | |
|  | **Over Anchor** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class G1 | -20.75% | -51.68% | -41.07% | 869.00% | 1318.26% | #REF! |
| Class G2 | -18.03% | -47.02% | -46.82% | 907.92% | 1380.22% | #REF! |
| **Overall** | -19.73% | -49.94% | -43.22% | 879.94% | 1335.67% | #REF! |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay P Main 10** | | | | | |
|  | **Over Anchor** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class G1 | -19.03% | -57.76% | -49.24% | 807.46% | 1077.85% | #REF! |
| Class G2 | -15.86% | -54.20% | -54.39% | 831.03% | 1183.64% | #REF! |
| **Overall** | -17.84% | -56.43% | -51.17% | 816.22% | 1116.37% | #REF! |

**HDR**

There are still no HDR versions for Level1 and Darktree.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | | | | | |
|  | **Over VTM11.0ecm16.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class G3 | -24.71% | -12.14% | -11.47% | -43.01% | -39.88% | -11.45% | -43.19% | -39.59% | 1475% | 592% |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access** | | | | | | | | | |
|  | **Over VTM11.0ecm16.0** | | | | | | | | | |
|  |  |  | **wPSNR** |  |  | **PSNR** |  |  |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class G3 | -40.68% | -26.92% | -28.06% | -58.09% | -56.31% | -28.28% | -58.58% | -56.50% | 1018% | 1413% |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low Delay B** | | | | | | | | | |
|  | **Over VTM11.0ecm16.0** | | | | | | | | | |
|  |  |  | **wPSNR** |  |  | **PSNR** |  |  |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class G3 | -36.74% | -20.79% | -19.98% | -61.91% | -57.96% | -20.26% | -62.59% | -57.91% | 823% | 1132% |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low Delay P** | | | | | | | | | |
|  | **Over VTM11.0ecm16.0** | | | | | | | | | |
|  |  |  | **wPSNR** |  |  | **PSNR** |  |  |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class G3 | -36.46% | -20.41% | -19.68% | -61.93% | -56.74% | -19.94% | -62.57% | -56.64% | 953% | 1028% |

1. **Input contributions**

* AHG9/AHG15: Depth-adaptive picture scaling information SEI (JVET-AL0212)

1. **Recommendations**

The AHG recommends to:

* Review input documents on gaming content compression
* Identify if/how auxiliary information can be used for coding of gaming content

[JVET-AL0016](https://jvet-experts.org/doc_end_user/current_document.php?id=15398) JVET AHG report: Generative face video compression (AHG16) [Y. Ye (chair), H.-B. Teo, Z. Lyu, S. McCarthy, S. Wang (vice chairs)]

Regarding the mandate on developing and maintaining the GFVC software, the AHG16 GFVC software tool and accompanying usage instructions and exemplar configurations for experimentation are maintained in the GIT repository at <https://vcgit.hhi.fraunhofer.de/jvet-ahg-gfvc>. During this AHG period, the GFVE pupil position model and its interface as provided in JVET-AK0164 were integrated into the AHG16 software repository. At this meeting, 4 contributions have been received on potential updates to the AHG16 software tool, including applying the generator as post-processing (JVET-AL0101), QP-adaptive GFVC (JVET-AL0102), updating the parameter translators (JVET-AL0147), and adding a color calibration process (JVET-AL0156) as post-processing.

Regarding coordination with AHG9 to develop the GFV SEI message, 4 contributions related to the GFV and GFVE SEI messages have been received. One of these contributions (JVET-AL0148) suggests to add support for GFV and GFVE SEI messages to HEVC and AVC. Other contributions suggest further enhancements and/or fixes to the GFV & GFVE SEI messages.

**Related contributions**

The following input contributions to this meeting are related to the activities of AHG16:

1. [JVET-AL0101](https://jvet-experts.org/doc_end_user/current_document.php?id=15426), AHG16: Further experiments on VVC GFVC [L. Liu, C. Jung (Xidian Univ.)]
2. [JVET-AL0102](https://jvet-experts.org/doc_end_user/current_document.php?id=15427), AHG9/AHG16: SEI message and further experiments on QP-adaptive GFVC [W. Kang, L. Liu, C. Jung (Xidian Univ.)]
3. [JVET-AL0147](https://jvet-experts.org/doc_end_user/current_document.php?id=15472), AHG16: Refined parameter translator of generative face video coding [S. Yin, S. Wang, Z. Zhang (CityUHK), B. Chen, Y. Ye, R.-L. Liao, J. Chen (Alibaba)]
4. [JVET-AL0156](https://jvet-experts.org/doc_end_user/current_document.php?id=15481), AHG9/AHG16: Colour calibration for generative face video coding [J. Chen, B. Chen, Y. Ye (Alibaba), S. Yin, S. Wang (CityUHK)]

Additionally, the following input contributions are related to the high-level syntax aspects of the generative face video (GFV) and/or generative face video enhancement (GFVE) SEI messages:

1. [JVET-AL0148](https://jvet-experts.org/doc_end_user/current_document.php?id=15473), AHG9: Generative face video and generative face video enhancement SEI messages for HEVC and AVC [J. Chen, B. Chen, Y. Ye (Alibaba), S. Gehlot, G.-M. Su, P. Yin, S. McCarthy (Dolby), A. Trioux, F. Yang (Xidian Univ.), Y.-K. Wang (Bytedance), H.-B. Teo, J.-Y. Thong, K. Abe (Panasonic), Y. Xu, K. Yang, Y. Li (SJTU)]
2. [JVET-AL01](https://jvet-experts.org/doc_end_user/current_document.php?id=15480)55, AHG9: Further fixes and cleanup on GFV and GFVE SEI messages [J. Chen, B. Chen, Y. Ye (Alibaba)]

**Recommendations**

The AHG recommends to:

* Review all related contributions, including those on the high-level syntax aspects of the GFV and GFVE SEI messages;
* Continue AHG16 to study GFVC-related topics.

Contributions to AHG9 can be reviewed separately in HLS track.

[JVET-AL0017](https://jvet-experts.org/doc_end_user/current_document.php?id=15399) JVET AHG report: Testing of video coding technology beyond CTC (AHG17) [M. Wien (chair), E. Alshina, V. Baroncini, P. de Lagrange, Y. Ye (vice chairs)]

Two online AHG calls were held on 2025-02-06 and 2025-03-05, respectively. Furthermore, a hybrid AHG meeting was held at RWTH Aachen University between 2025-03-10 and 03-12. The reports of these meetings are available in JVET-AL0041.

***Identification of test*** sequences ***and preparation of bitstreams***

The set of sequences explored at the previous JVET meeting as well as newly proposed test sequences were encoded and the corresponding RD data and bitstreams were collected in a significant preparatory effort by the volunteers. The test sequences and proposed QP values for the ECM and the VTM were assessed during the hybrid AHG meeting in a number of subjective test sessions.

The discussion and the results of this activity are reported in JVET-AL0041.

Documents JVET-AL0041, JVET-AL0042, JVET-AL0045, JVET-AL0046, JVET-AL0047, JVET-AL0048, JVET-AL0049, and JVET-AL0050 have been initially reviewed in the hybrid AHG meeting. Documents JVET-AL0053 and JVET-AL0054 reflect the results of the testing activity at this meeting.

**Related** contributions

|  |  |  |
| --- | --- | --- |
| [JVET-AL0017](https://jvet-experts.org/doc_end_user/current_document.php?id=15399) | JVET AHG report: Testing of video coding technology beyond CTC (AHG17) | M. Wien (chair), E. Alshina, V. Baroncini, P. de Lagrange, Y. Ye (vice chairs) |
| [JVET-AL0041](https://jvet-experts.org/doc_end_user/current_document.php?id=15346) | AHG17: AhG meeting notes | [M. Wien](mailto:wien@lfb.rwth-aachen.de) |
| [JVET-AL0042](https://jvet-experts.org/doc_end_user/current_document.php?id=15347) | AHG4/AHG17: Additional cropped HDR sequences for non-CTC testing | [A. Filippov](mailto:alexey.filippov@tcl.com), [J. Konieczny](mailto:jacek.k@tcl.com), [Z. Zhi](mailto:zhou.zhi@tcl.com), [V. Rufitskiy](mailto:vasily.rufitskiy@tcl.com), [H. Qin](mailto:hongdong.qin@tcl.com), [T. Dong](mailto:tianyu.dong@tcl.com), [X. Tang (TCL)](mailto:xiaoyong.tang@tcl.com), [S. Shen](mailto:s.shen@nercdtv.org), [Y. Qin](mailto:yf.qin@nercdtv.org), [Y. Wang](mailto:y.wang@nercdtv.org), [X. Wang](mailto:xs.wang@nercdtv.org), [Y. Guan (NERC-DTV)](mailto:yf.guan@nercdtv.org) |
| [JVET-AL0045](https://jvet-experts.org/doc_end_user/current_document.php?id=15351) | [AHG17] Proposal of 6 candidates SDR HD clips | [E. François](mailto:edouard.francois@interdigital.com), [P. de Lagrange](mailto:philippe.delagrange@interdigital.com), [C. Salmon-Legagneur (InterDigital)](mailto:charles.salmon-legagneur@interdigital.com) |
| [JVET-AL0046](https://jvet-experts.org/doc_end_user/current_document.php?id=15352) | [AHG17] UGC test sequences from vivo | [Z. Lyu](mailto:zhuoyi.lv@vivo.com), Y. Li, C. Zhou, G. Wang (vivo) |
| [JVET-AL0047](https://jvet-experts.org/doc_end_user/current_document.php?id=15353) | Proposed draft text: Call for Evidence on video compression with capability beyond existing standards | J.-R. Ohm, M. Wien |
| [JVET-AL0048](https://jvet-experts.org/doc_end_user/current_document.php?id=15354) | [AHG17] Proposal of new sequences in UHD-SDR-RA category | [M. Abdoli](mailto:mabdoli@xiaomi.com), A. Tissier, R. G. Youvalari, F. Plowman, M.-L. Champel (Xiaomi) |
| [JVET-AL0049](https://jvet-experts.org/doc_end_user/current_document.php?id=15355) | [AHG17] Proposal of 4 sequence candidates for the SDR-LD-HD category | [R.-L. Liao](mailto:ruling.lrl@alibaba-inc.com), [Y. Ye (Alibaba)](mailto:yan.ye@alibaba-inc.com) |
| [JVET-AL0050](https://jvet-experts.org/doc_end_user/current_document.php?id=15356) | AHG17: UGC test sequences from Huawei | [J. Pardo](mailto:johan.esprit.pardo1@huawei.com), [Y. Zhao](mailto:yin.zhao@huawei.com), Y. Sun, P. Liu, Y. Lu, C. Wang (Huawei) |
| [JVET-AL0051](https://jvet-experts.org/doc_end_user/current_document.php?id=15357) | [AHG17] Proposed CfE language regarding ultra low delay and error resilience | [S. Wenger (Tencent)](mailto:stewe@stewe.org) |
| [JVET-AL0052](https://jvet-experts.org/doc_end_user/current_document.php?id=15358) | AhG17: Comments on proposed draft text: Call for Evidence on video compression with capability beyond existing standards | [E. Alshina](mailto:elena.alshina@huawei.com), [T. Solovyev (Huawei)](mailto:solovyev.timofey@huawei.com) |
| [JVET-AL0053](https://jvet-experts.org/doc_end_user/current_document.php?id=15359) | AHG17: Results of expert viewing of non-CTC sequences | [M. Wien](mailto:wien@lfb.rwth-aachen.de), [A. Wieckowski](mailto:adam.wieckowski@hhi.fraunhofer.de), [K. Andersson](mailto:kenneth.r.andersson@ericsson.com) |
| [JVET-AL0054](https://jvet-experts.org/doc_end_user/current_document.php?id=15360) | AHG17: adjusted QPs for non-CTC sequences | [E. François (InterDigital)](mailto:edouard.francois@interdigital.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com), [P. Nikitin (Qualcomm)](mailto:pnikitin@qti.qualcomm.com) |
| [JVET-AL0154](https://jvet-experts.org/doc_end_user/current_document.php?id=15479) | AHG17: Resampling test for large resolution sequences | [G. Clare (bcom)](mailto:gordon.clare@b-com.com), [F. Henry (Orange)](mailto:felix.henry@orange.com), [M. Tarchouli (Ateme)](mailto:m.tarchouli@ateme.com), [M. Riviere (Ateme)](mailto:m.riviere@ateme.com) |
| [JVET-AL0207](https://jvet-experts.org/doc_end_user/current_document.php?id=15532) | AHG10/AHG17: On matching target bitrate for subjective quality evaluation | [K. Andersson](mailto:kenneth.r.andersson@ericsson.com), [P. Wennersten (Ericsson)](mailto:per.wennersten@ericsson.com) |
| [JVET-AL0239](https://jvet-experts.org/doc_end_user/current_document.php?id=15566) | [AHG17] Proposal of a new sequence in HD-SDR-LB category | [A. Tissier](mailto:alexandret@xiaomi.com), M. Abdoli, R. G. Youvalari, F. Plowman, M. -L. Champel (Xiaomi) |
| [JVET-AL0242](https://jvet-experts.org/doc_end_user/current_document.php?id=15569) | [AHG7][AHG17] ECM performance under different MTT configurations | [S. Puri](mailto:saurabh.puri@interdigital.com), K. Naser, F. Le Léannec, E. François (InterDigital) |
| [JVET-AL0245](https://jvet-experts.org/doc_end_user/current_document.php?id=15572) | [AHG7][AHG17] Further consideration of common test condition | T. Ikai, K.-W. Liang (Sharp) |

**Recommendations**

The AHG recommends:

* To review the remaining input contributions related to AHG17 during the meeting.
* To review the documents JVET-AL0053 and JVET-AL0054 and take their results into consideration for the development of an enhanced draft CfE document.
* To progress the draft CfE document with a proposed set of test categories with respective test sequences.

[JVET-AL0018](https://jvet-experts.org/doc_end_user/current_document.php?id=15400) JVET AHG report: Ultra-low latency and packet loss resilience (AHG18) [S. Ikonin, S. Wenger, V. Zakharchenko (co-chairs), S. Deshpande, S. Fößel, C. Kim, X. Ma, S. Puri, J. Ström (vice-chairs)]

The repository for AHG related simulation software was established, and can be accessed at: [https://vcgit.hhi.fraunhofer.de/jvet-ahg-ull/VVCSoftware\_VTM](https://vcgit.hhi.fraunhofer.de/jvet-ahg-ull/VVCSoftware_VTM/-/tree/ull-master).

***Teleconferences***

Two teleconferences were held on February 19th and March 14th, with 51 and 26 participant correspondingly.

The following topics were discussed:

* VTM + network model simulation software introduction.
* Network bandwidth simulation point introduction.
* Transmission latency derivation logic based on end-to-end latency.
* ULL metrics calculation example and correspondent excel template.
* Scalable transmission scenario simulation example.
* No-feedback IPPI-based transmission scenario example.
* Latency calculation consistency fix, and list of other modifications.

The meeting minutes, presented materials and video demonstrations are available in [JVET-AL0044](https://jvet-experts.org/doc_end_user/current_document.php?id=15350).

1. **Related contributions**

A total of 8 contributions are identified relating to the mandates of AHG18. They are listed below. Some contributions also relate to the work of AHG17 and AHG9.

|  |  |  |
| --- | --- | --- |
| **Report** | | |
| [JVET-AL0018](https://jvet-experts.org/doc_end_user/current_document.php?id=15400) | JVET AHG report: Ultra-low latency and packet loss resilience (AHG18) | S. Ikonin, S. Wenger, V. Zakharchenko (co-chairs), S. Deshpande, S. Fößel, C. Kim, X. Ma, S. Puri, J. Ström (vice-chairs) |
| [JVET-AL0044](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0044-v2.zip) | AHG18: Teleconference on ultra-low latency and packet loss resilience | [S. Ikonin](mailto:sergey.ikonin@huawei.com), [S. Wenger](mailto:swenger@global.tencent.com), V. Zakharchenko (co-chairs), S. Deshpande, J. Ström, X. Ma, C. Kim, S. Puri, S. Fößel (vice-chairs) |
| **Test condition and evaluation methodology** | | |
| [JVET-AL0051](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0051-v1.zip) | [AHG17] Proposed CfE language regarding ultra low delay and error resilience | [S. Wenger (Tencent)](mailto:stewe@stewe.org) |
| [JVET-AL0176](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0176-v1.zip) | AHG18: Proposed methodology and test conditions for ultra-low latency and error resilience performance evaluation | [S. Ikonin](mailto:sergey.ikonin@huawei.com), [X. Ma](mailto:maxiang6@huawei.com), [I. Gribushin](mailto:gribushin.ivan@huawei.com), [M. Sychev](mailto:Sychev.Maxim@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| **Proposals** | | |
| [JVET-AL0069](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0069-v1.zip) | AHG9/AHG18: Error recovery SEI message | [J. Boyce](mailto:jill.boyce@nokia.com), [M. M. Hannuksela (Nokia)](mailto:miska.hannuksela@nokia.com) |
| [JVET-AL0073](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0073-v1.zip) | AHG9/AHG18: Loss recovery information SEI message | [C. Kim](mailto:chulkeun.kim@lge.com), [H. Tan](mailto:dr.hendry@lge.com), [J. Nam](mailto:junghak.nam@lge.com), [J. Lee](mailto:jangw.lee@lge.com), [J. Lim](mailto:jaehyun.lim@lge.com),  [S. Kim (LGE)](mailto:seunghwan3.kim@lge.com) |
| [JVET-AL0200](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0200-v1.zip) | AHG18: Simulation software description | [S. Ikonin](mailto:sergey.ikonin@huawei.com), [V. Khamidullin](mailto:vyacheslav.khamidullin1@huawei.com), [R. Shabaev](mailto:shabaev.roman@h-partners.com),  [I. Gribushin](mailto:gribushin.ivan@huawei.com), [M. Sychev](mailto:Sychev.Maxim@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AL0201](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0201-v1.zip) | AHG18: Performance evaluation of VTM under proposed ULL test conditions and proposed software modifications | [S. Ikonin](mailto:sergey.ikonin@huawei.com), [V. Khamidullin](mailto:vyacheslav.khamidullin1@huawei.com), [R. Shabaev](mailto:shabaev.roman@h-partners.com),  [I. Gribushin](mailto:gribushin.ivan@huawei.com), [M. Sychev](mailto:Sychev.Maxim@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |

1. **Recommendations**

The AHG recommends:

* Review all input contributions.
* Discuss test conditions and evaluation methodology.
* Collect test cases and specific requirements.
* Continue development of simulation software.
* Continue the study of ultra-low latency and packet loss resilience technologies in JVET.

It was suggested to make the software available to all JVET experts.

# Project development (41)

## AHG1: Development, deployment and advertisement of standards (4)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0020](https://jvet-experts.org/doc_end_user/current_document.php?id=15537) Deployment status of the HEVC standard [G. J. Sullivan]

[JVET-AL0021](https://jvet-experts.org/doc_end_user/current_document.php?id=15538) Deployment status of the VVC standard [G. J. Sullivan]

[JVET-AL0235](https://jvet-experts.org/doc_end_user/current_document.php?id=15562) On the immersive requirements for the next generation video codec [B. Kroon, C. Varekamp (Philips)]

For discussion in joint meeting with parent bodies.

[JVET-AL0278](https://jvet-experts.org/doc_end_user/current_document.php?id=15605) Huawei comments on use case and requirements for NextGenVideoCodec [T. Solovyev, S. Ikonin, E. Alshina (Huawei)] [late]

For discussion in joint meeting with parent bodies.

## AHG2: Text development and errata reporting (2)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0223](https://jvet-experts.org/doc_end_user/current_document.php?id=15550) AHG2: Corrections and clarifications for profile-related aspects of the draft text for HEVC [G. J. Sullivan (Dolby Labs)]

[JVET-AL0288](https://jvet-experts.org/doc_end_user/current_document.php?id=15615) AHG2, AHG9, AHG13: on FGC SEI reference picture size [P. de Lagrange (InterDigital)] [late]

See section 4.2

## AHG3: Software development (0)

This section is kept as a template for future use.

## AHG3: Test conditions (3)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0197](https://jvet-experts.org/doc_end_user/current_document.php?id=15522) AHG3: Intra period for random access set in configuration files [A. Dziembowski, D. Mieloch (PUT)]

TBD

[JVET-AL0213](https://jvet-experts.org/doc_end_user/current_document.php?id=15540) AHG7: On common test conditions for fixed-QP objective rate-distortion testing of "low delay" encoding [G. J. Sullivan, P. Yin, T. N. Canh (Dolby Labs)]

TBD

[JVET-AL0245](https://jvet-experts.org/doc_end_user/current_document.php?id=15572) [AHG7][AHG17] Further consideration of common test condition [T. Ikai, K.-W. Liang (Sharp)] [late]

To be discussed in BoG for CfE

[JVET-AL0304](https://jvet-experts.org/doc_end_user/current_document.php?id=15631) Crosscheck of JVET-AL0245 ([AHG7][AHG17] Further consideration of common test condition) [J. Pardo (Huawei)] [late]

## AHG4: Subjective quality testing and verification testing (1)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0289](https://jvet-experts.org/doc_end_user/current_document.php?id=15616) AHG4: potential updates for VVC multi-layer verification test plan [P. de Lagrange (InterDigital)] [late]

## AHG4: Test and training material (0)

This section is kept as a template for future use.

Proposals on new test materials are also included in 4.16 and 5.1.4.

## AHG5: Conformance test development (0)

This section is kept as a template for future use.

## AHG7: ECM tool assessment (5+2)

Contributions in this area were discussed during 1555–1735 on Friday 28 March 2025 (chaired by JRO).

[JVET-AL0083](https://jvet-experts.org/doc_end_user/current_document.php?id=15408) AHG7: On Luma-Chroma Gain Rebalancing [X. Li (Google), Y. Wang, K. Zhang, L. Zhang (Bytedance)]

In this contribution, the luma-chroma exchange efficiency of the luma-chroma gain rebalancing is studied by analyzing the data of the recent luma-chroma rebalancing activity in JVET-AH0117. It is reported that the luma-chroma exchange rate is highly content and prediction structure dependent. It is proposed to further study luma-chroma rebalancing methods in terms of both objective and subjective benefits.

It was reported that by sequence-adaptive adaptation of chroma/luma balance, better luma BD gain might be achieved for some sequences. A visual inspection did not show much difference when a more radical shift from chroma to luma was done.

It was asked if the same would be found if a combined YUV gain would be computed.

It was commented that the definition of luma/chroma relation in CTC is not done for the purpose of visual optimization. Also, the BD rate of chroma is often misleading.

It was commented that in CTC sequence-adaptive fine-tuning should usually be avoided. It might be considered potentially when defining the CfE formulation (which already includes a generic statement that sequence-adaptive tuning should be avoided, in particular manually – check if that is sufficient).

It was also commented that also the gain by cross-component tools is usually different per sequence (which may be coherent with the findings of this contribution).

Further study encouraged – no immediate point for action.

[JVET-AL0171](https://jvet-experts.org/doc_end_user/current_document.php?id=15496) AHG7: Tools interaction analysis of ECM16.0 R. Ishimoto, [Z. Fan, T. Chujoh, T. Ikai (Sharp)]

This report analyzes the interactions between tools in ECM-16.0 and identifies how tools may interfere with one another, e.g., whether there are negative effects between the tools. It is observed that the gains of tools usually overlap between tools, i.e., off-test gain is less than on test-gain. However, in some cases, there are synergistic effects, i.e., off-test gain is more than on-test gain. The experiment was conducted by turning off and on target tools and observing the difference between the one tool being off vs. CTC anchor, or where major tools are off but one tool remains on vs. major tool off anchor. In the report, classes B and C in the RA are utilized.

It was commented that it might be interesting to think about strategies how to use the data collected, e.g. identifying combinations of tools that would give most benefit in compression while keeping encoding/decoding run time as low as possible.

Further study recommended how that could be used in the work of AHG.

[JVET-AL0194](https://jvet-experts.org/doc_end_user/current_document.php?id=15519) AHG7: Assessment Perspectives of Codec/Coding Tools [X. Li (Google)]

In this contribution, assessment perspectives of codec/coding tools are proposed. It is well known that codec/coding tool assessment is a multi-dimensional problem. In this contribution, assessment perspectives including quality, architecture, hardware and software are proposed. Many of them have been used in the development of earlier video coding standards.

It was commented that for entropy coding, also number of contexts, max number of context-coded bins plays a role.

It was commented that in terms of reference software implementation, excessive usage of macros might better be avoided, as it might simplify the part of code to be merged, but makes the software more difficult to maintain.

The items formulated around hardware should be worked out more precisely, needs a case by case study how the assessment of certain criteria could be quantified.

It was asked why CTU size impacts parallel processing? This reduces the potential number of parallel threads in wavefront processing. However, an encoder could select a smaller CTU size.

Further study in the context of AHG7 (conference call), also identifying for which aspects more concrete criteria already exist.

This would not yet be needed for CfE, but would be relevant for a potential CfP and standard development.

It might also be considered if everything that is relevant for NN (also taking into account GPU hardware) is covered.

[JVET-AL0213](https://jvet-experts.org/doc_end_user/current_document.php?id=15540) AHG7: On common test conditions for fixed-QP objective rate-distortion testing of "low delay" encoding [G. J. Sullivan, P. Yin, T. N. Canh (Dolby Labs)]

See also section 4.4

[JVET-AL0242](https://jvet-experts.org/doc_end_user/current_document.php?id=15569) [AHG7][AHG17] ECM performance under different MTT configurations [S. Puri, K. Naser, F. Le Léannec, E. François (InterDigital)] [late]

To be discussed in BoG for CfE

[JVET-AL0245](https://jvet-experts.org/doc_end_user/current_document.php?id=15572) [AHG7][AHG17] Further consideration of common test condition [T. Ikai, K.-W. Liang (Sharp)] [late]

to be discussed in BoG for CfE

[JVET-AL0247](https://jvet-experts.org/doc_end_user/current_document.php?id=15574) [AHG-7] On Max Transform Size in ECM [K. Naser, F. Le Léannec, S. Puri, C. Bonnineau, E. François (InterDigital)] [late]

TBD

[JVET-AL0266](https://jvet-experts.org/doc_end_user/current_document.php?id=15593) Crosscheck of JVET-AL0247 On Max Transform Size in ECM [X. Li (Google)] [late] [miss]

## AHG8: Optimization of encoders and receiving systems for machine analysis of coded video content (1)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0152](https://jvet-experts.org/doc_end_user/current_document.php?id=15477) AHG8: Dense QP coding results of combining adaptive temporal resampling, pre-processing, ROI-based adaptive QP, QP offset adjustment for higher temporal layers and post-processing algorithms for machine vision [S. Wang, J. Chen, Y. Ye, B. Li (Alibaba), S. Wang (CityUHK)]

## AHG10: Encoding algorithm optimization (3+1)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0074](https://jvet-experts.org/doc_end_user/current_document.php?id=15380) AHG10: Teleconference on encoder optimization [P. de Lagrange]

[JVET-AL0055](https://jvet-experts.org/doc_end_user/current_document.php?id=15361) AhG10: On constrained encoder complexity configuration of VTM [T. Solovyev, J. Sauer, J. E. F. Pardo, E. Alshina (Huawei)]

[JVET-AL0263](https://jvet-experts.org/doc_end_user/current_document.php?id=15590) Crosscheck of JVET-AL0055 (AhG10: On constrained encoder configuration of VTM) [H. Le Lais, P. de Lagrange (InterDigital)] [late]

[JVET-AL0114](https://jvet-experts.org/doc_end_user/current_document.php?id=15439) AHG 10: On intra mode selection [Y. Yu, L. Zhang, Z. Sun, J. Gan, F. Wang, H. Yu, D. Wang (OPPO)]

[JVET-AL0323](https://jvet-experts.org/doc_end_user/current_document.php?id=15650) Cross-check of JVET-AL0114 (AHG 10: On intra mode selection) [P. Bordes (InterDigital)] [late]

[JVET-AL0207](https://jvet-experts.org/doc_end_user/current_document.php?id=15532) AHG10/AHG17: On matching target bitrate for subjective quality evaluation [K. Andersson, P. Wennersten (Ericsson)]

TBD

## AHG13: Film grain synthesis (1+2)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0086](https://jvet-experts.org/doc_end_user/current_document.php?id=15411) AHG9/AHG13: On Spatial Resolution for the Film Grain Characteristics (FGC) SEI message [J. Samuelsson-Allendes, S. Deshpande (Sharp)]

[JVET-AL0282](https://jvet-experts.org/doc_end_user/current_document.php?id=15609) AHG13: Film grain analysis improvement [M. Radosavljević, F. Lefebvre, Z. Ameur, P. de Lagrange (InterDigital] [late]

[JVET-AL0288](https://jvet-experts.org/doc_end_user/current_document.php?id=15615) AHG2, AHG9, AHG13: on FGC SEI reference picture size [P. de Lagrange (InterDigital)] [late]

See section 4.2

Refer +204, 211, should all be discussed together

## Implementation studies (0)

This section is kept as a template for future use.

## Profile/tier/level specification (0)

This section is kept as a template for future use.

## AHG15: Gaming content compression (0)

This section is kept as a template for future use.

## AHG16: Generative face video (2+2)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

Also refer to section 6.1.4.

[JVET-AL0101](https://jvet-experts.org/doc_end_user/current_document.php?id=15426) AHG16: Further experiments on VVC GFVC [L. Liu, C. Jung (Xidian Univ.)]

[JVET-AL0102](https://jvet-experts.org/doc_end_user/current_document.php?id=15427) AHG9/AHG16: SEI message and further experiments on QP-adaptive GFVC [W. Kang, L. Liu, C. Jung (Xidian Univ.)]

See also section 6.2.6

[JVET-AL0147](https://jvet-experts.org/doc_end_user/current_document.php?id=15472) AHG16: Refined parameter translator of generative face video coding [S. Yin, S. Wang, Z. Zhang (CityUHK), B. Chen, Y. Ye, R.-L. Liao, J. Chen (Alibaba)]

[JVET-AL0156](https://jvet-experts.org/doc_end_user/current_document.php?id=15481) AHG9/AHG16: Colour calibration for generative face video coding [J. Chen, B. Chen, Y. Ye (Alibaba), S. Yin, S. Wang (CityUHK)]

See also section 6.2.6

## AHG17: CfE preparation (14+4)

Contributions in this area were discussed during 1405–1505 and 1525–1725 on Wednesday 26 March 2025 and during 1300–1550 on Friday 28 March 2025 (chaired by JRO).

Some aspects discussed under section 4.4 could also be relevant here.

[JVET-AL0041](https://jvet-experts.org/doc_end_user/current_document.php?id=15346) AHG17: AhG meeting notes [M. Wien]

An overview on the activities was given, and the viewing methodology was explained (results in JVET-AL0053)

* ACR MOS for some sequences was available from Geneva, for additional sequences was acquired in Aachen
* Direct comparison of quality of successive rate points per sequence
* DCR MOS was acquired for some selected sequences (including UGC)

It was generally concluded that a suitable set of non-CTC sequences would be available in the 7 categories for a Call for Evidence.

[JVET-AL0042](https://jvet-experts.org/doc_end_user/current_document.php?id=15347) AHG4/AHG17: Additional cropped HDR sequences for non-CTC testing [A. Filippov, J. Konieczny, Z. Zhi, V. Rufitskiy, H. Qin, T. Dong, X. Tang (TCL), S. Shen, Y. Qin, Y. Wang, X. Wang, Y. Guan (NERC-DTV)]

Was presented in AHG meeting, and sequences included in viewing

[JVET-AL0045](https://jvet-experts.org/doc_end_user/current_document.php?id=15351) [AHG17] Proposal of 6 candidates SDR HD clips [E. François, P. de Lagrange, C. Salmon-Legagneur (InterDigital)]

Was presented in AHG meeting, and sequences included in viewing

[JVET-AL0046](https://jvet-experts.org/doc_end_user/current_document.php?id=15352) [AHG17] UGC test sequences from vivo [Z. Lyu, Y. Li, C. Zhou, G. Wang (vivo)]

Was presented in AHG meeting, and sequences included in viewing

[JVET-AL0047](https://jvet-experts.org/doc_end_user/current_document.php?id=15353) Proposed draft text: Call for Evidence on video compression with capability beyond existing standards [J.-R. Ohm, M. Wien]

V2 (modified version from AHG17 meeting) was presented 1625 UTC on Wednesday 26 March.

Concern was raised about the idea which came up in the AHG17 meeting, such that ECM would be a “submission” to the CfE. It was argued that ECM does not provide a reasonable “evidence” in terms of complexity tradeoff, and it might be strange if JVET responds to its own CfE. On the other hand, ECM could be seen as a reasonable comparison point in terms of compression benefit, where good evidence could be provided by proposals which achieve something comparable in compression at lower complexity.

It was therefore agreed that ECM should be retained as an anchor (as in v1 of JVET-AL0047), it could also be a reasonable comparison point for judging the compression/complexity tradeoff of other submissions.

It could anyway not be avoided that some submission uses ECM or part of it as a basis.

In principle, JVET would be prepared to define testing conditions for the purpose of investigating compression benefit (section 3 of JVET-AL0047), whereas more discussion is needed about how to investigate the complexity aspects (section 4 of JVET-AL0047), e.g. based on JVET-AL0052, to be further conducted during the meeting.

It is asserted be useful in any case to perform a “dry run” for the CfE by the next meeting, which should include rate-matched VTM and ECM anchors, and potentially other configuration e.g. from the investigations of AHG7/AHG10. It would be useful to have this as an output document (title tbd), also to allow companies knowing about the purpose to have enough time for preparing submissions for the actual CfE.

Continuation of review of other documents in this category on Friday; meeting with parent bodies should be conducted on Monday.

[JVET-AL0048](https://jvet-experts.org/doc_end_user/current_document.php?id=15354) [AHG17] Proposal of new sequences in UHD-SDR-RA category [M. Abdoli, A. Tissier, R. G. Youvalari, F. Plowman, M.-L. Champel (Xiaomi)]

Was presented in AHG meeting, and sequences included in viewing[JVET-AL0049](https://jvet-experts.org/doc_end_user/current_document.php?id=15355) [AHG17] Proposal of 4 sequence candidates for the SDR-LD-HD category [R.-L. Liao, Y. Ye (Alibaba)]

Was presented in AHG meeting, and sequences included in viewing

[JVET-AL0050](https://jvet-experts.org/doc_end_user/current_document.php?id=15356) AHG17: UGC test sequences from Huawei [J. Pardo, Y. Zhao, Y. Sun, P. Liu, Y. Lu, C. Wang (Huawei)]

Was presented in AHG meeting, and sequences included in viewing

[JVET-AL0051](https://jvet-experts.org/doc_end_user/current_document.php?id=15357) [AHG17] Proposed CfE language regarding ultra low delay and error resilience [S. Wenger (Tencent)]

TBD

[JVET-AL0052](https://jvet-experts.org/doc_end_user/current_document.php?id=15358) AhG17: Comments on proposed draft text: Call for Evidence on video compression with capability beyond existing standards [E. Alshina, T. Solovyev (Huawei)]

This document suggests testing procedures for potential Call for Evidence on compression with capability beyond existing standards. The major focus is to address requirements of providing coding solution efficient in constrained encoder configuration.

Difficulties in designing constrained encoder test conditions:

* It is impossible to realistically emulate ‘real time’ encoding during standard development
* Encoder constrains are highly dependent on platform, use case, device.
* Standard development shall not become a competition of product level optimized encoders
* Run time cross-check for both encoder and decoder will be required

Cross-check for both ***encoder*** and decoder.

* Decoder executables are submitted as always
* Encoder executables are submitted as part of responses in ‘constrained encoder category’
* Encoder cross-check is slow? Check just few cases (for example, the lowest and the highest rate for several selected sequences)
* Useful to submit executables generated with same settings /optimization level for anchor

Different variants are presented, where variant 4 is most flexible, and also uses the same VTM anchor (only one) as in the “compression benefit” testing

It was commented that for the fast encoding capability it might not be desirable to impose decoder constraints. It would also not be desirable to make submissions of too many complexity points mandatory, and to impose too many restrictions in general. It is valuable for the CfE if additional information about the capability of fast encoding is provided with a submission. One purpose is also to possibly improve conditions for a subsequent CfP, and learn which might be reasonable constraints to impose there.

It was commented that it would be desirable to have multiple VTM configurations, if possible including some which go down to HM speed. Another expert suggested to investigate a range which goes up to 4.5x encoding runtime of VTM for submissions. It should however be observed that this might not be working with current rate 1, and more effort to generate anchors.

Diverging opinions on whether also decoder complexity should be limited.

It should be clear that in a CfE not such an amount of detail can be achieved in assessment as in a rigid standards development.

It was agreed that the approach of variant 4 is a reasonable step, and that towards the next meeting a “dry run” should be prepared, using VTM anchor(s) and configurations of ECM/NNVC etc. to exercise the methodology. To be further worked out in a BoG (E. Alshina, F. Bossen) with mandate to

* identify the test cases to be prepared for the next meeting in the testing for fast encoding basede on VTM, ECM and NNVC
* discuss the open questions above
* review contributions related to testing conditions targeting reduction of run time.
* after meeting with parent bodies, and if the plan to execute such a test is agreed, to discuss a first draft of section 4 in JVET-AL0047

[JVET-AL0053](https://jvet-experts.org/doc_end_user/current_document.php?id=15359) AHG17: Results of expert viewing of non-CTC sequences [M. Wien, A. Wieckowski, K. Andersson]

DCR results which had not yet been readily evaluated during the AHG meeting were presented.

For some UGC sequences, MOS for original is available, which are usually slightly higher than the VTM or ECM at highest rate point (not for all done ). This might be useful to get information in particular if the original has already visible compression artifacts.

Generally, it can be concluded that the DCR test also could work well for UGC content (where however in most cases the “original” quality was quite high)

It was suggested to conduct a comparison of DCR-MOS vs. ACR-MOS.

It was requested to generate a document which includes snapshots of the selected sequences (as per JVET-AL0041), results in terms of MOS, and suggested rate points from JVET-AL0054.

[JVET-AL0054](https://jvet-experts.org/doc_end_user/current_document.php?id=15360) AHG17: adjusted QPs for non-CTC sequences [E. François (InterDigital), E. Alshina (Huawei), P. Nikitin (Qualcomm)]

This contribution comprises an updated spreadsheet from JVET-AL0053 with proposed adjusted QPs based on results of viewing performed during interim Ahg17 meeting (March 10-12, 2025). The target of QPs adjustment was to provide recommendations for target rates per sequence, covering a quality range from very bad to very good, with four well distinguishable (during viewing) intermediate steps.

In v1, the QPs adjustment was made for the sequences initially considered for CfE before the interim meeting.

During this interim meeting, new sequences have been considered and the set of CfE candidate sequences has been updated. In v2 of the current document, the QPs adjustment has been completed for all the candidate sequences selected for CfE during the interim meeting.

Based on the adjustment of QPs, recommendations for target rates for each CfE candidate sequence are provided.

It was suggested to make the “quantization” of rates more coarse for highest bit rate points.

It was further suggested to perform the combination with the MOS results (DCR, or ACR when DCR not available) from JVET-AL0053 and check if the proposed rates are also useful in terms of quality ranges of ECM.

It was commented that correction seems necessary for Gregory Cactus (highest rate may be too high, lowest too low).

It was requested to generate plots where

* When DCR results are available, mark the position of the suggested rates compared to the available rates
* When ACR results are available (only for lowest and highest rate points, and only for ECM), to generate plots where the suggested rates are marked in comparison with the rates used in the test

The rates should be adjusted such that likely ECM quality at lowest rate is around MOS 3, but not approaching MOS 2, and at highest rate not higher than MOS 8. Side activity (M. Wien, E. Francois, K. Andersson, A. Wieckowski, E. Alshina, P. Nikitin) Revisit.

It is generally agreed that for most sequences the suggested rates are already more or less appropriate for a CfE, which is also meant as a “dry run” for a later CfP (if successful).

[JVET-AL0154](https://jvet-experts.org/doc_end_user/current_document.php?id=15479) AHG17: Resampling test for large resolution sequences [G. Clare (bcom), F. Henry (Orange), M. Tarchouli (Ateme), M. Riviere (Ateme)]

We tested SDR UHD candidate sequences by comparing two rate-distortion curves. The first curve corresponds to VTM coding of the original UHD sequence. The second curve consists in downsampling the UHD to HD using Lanczos, encoding-decoding with VTM, and finally upsampling to the original resolution. For some sequences the two curves are very close, indicating that it is possible to transmit these sequences at HD resolution without significant rate-distortion penalty. We suggest that this test is used to inform the group on the relevance of adding certain sequences to our Common testing Conditions.

The analysis could indicate that for certain sequences upsampled HD is sufficient. It was commented that a similar approach had been taken in AG 5 using visual testing. It was also commented that a test based on PSNR might not detect if only a certain region is true 4K resolution.

To be taken into consideration in the side activity under JVET-AL0054 and possible removal of sequences, or using downsampled versions of 4K in an HD category. Also for the CfE where it is explicitly said that no downsampling should be used, it might not be overly important.

[JVET-AL0207](https://jvet-experts.org/doc_end_user/current_document.php?id=15532) AHG10/AHG17: On matching target bitrate for subjective quality evaluation [K. Andersson, P. Wennersten (Ericsson)]

See section 4.10

[JVET-AL0233](https://jvet-experts.org/doc_end_user/current_document.php?id=15560) Information on low complexity encoding experiments [L. Li, M. W. Park, M. Park, Y. Kim, K. P. Choi (Samsung)]

This contribution provides trade off between coding efficiency and complexity for the constraint encoder test case described in the latest draft text of CfE.

It was reported that around 40 percentage of media consumption is user-generated content, including smart phone and camera generated videos. Compared to non real time encoding, the real time encoding has become the one of the biggest challenges in industry. Therefore, low complexity encoder with reasonable compression efficiency is an essential functionality in next generation video codec.

Experiments have shown following:

* Changing configuration has large impact on encoder complexity especially in later versions of ECM. When encoder spends more effort than ECM anchor points (triangle), the trade off is worse.
* Some points have better trade off than ECM anchor points, and some might reach the desired complexity in encoding time.
* The latest version of ECM, ECM-16.0 seems unable to reach the desired complexity in both encoder and decoder.
* Significant modification is required to reduce decoder complexity such that it can reach the desired decoder complexity.

The contribution suggests to put significant effort in reducing both encoder and decoder complexity such that practical implementation could be achieved for the next generation of video coding standard.

Examples of different ECM configuration by enabling/disabling tools show that the encoding time can be significantly modified relative to the CTC setting, but the decoding times stay almost constant.

It is commented that ECM has never been designed for the purpose of fast encoding, and is likely not the starting point of a next generation standard. In a rigid development stage, such optimization would be done.

It was requested to share the configurations used (if possible), such that they could potentially also be considered in the BoG.

[JVET-AL0239](https://jvet-experts.org/doc_end_user/current_document.php?id=15566) [AHG17] Proposal of a new sequence in HD-SDR-LB category [A. Tissier, M. Abdoli, R. G. Youvalari, F. Plowman (Xiaomi)] [late]

This contribution proposes one new sequence for inclusion in the SDR-HD-LD category of AHG17 in preparation for the next generation codec Call for Evidence (CfE). Below, detailed information is provided about the signal characteristics as well as the Bitrate-PSNR performance conforming the recommended settings in AHG17 [1].

It was commented that the rate is extremely low. Its unique feature would be that it is relatively dark.

For possible consideration in the side activity under JVET-AL0054.

[JVET-AL0242](https://jvet-experts.org/doc_end_user/current_document.php?id=15569) [AHG7][AHG17] ECM performance under different MTT configurations [S. Puri, K. Naser, F. Le Léannec, E. François (InterDigital)] [late]

to be discussed in BoG for CfE

[JVET-AL0245](https://jvet-experts.org/doc_end_user/current_document.php?id=15572) [AHG7][AHG17] Further consideration of common test condition [T. Ikai, K.-W. Liang (Sharp)] [late]

See also section 4.4

At the last meeting, JVET-AK0232 proposed the development of constraint test conditions and suggested that a better balance between coding efficiency and encoding time should be considered for CTC as well. This document further explores this notion by analyzing experiment results on ECM-16.1 under various MTT depth settings. It is recommended to configure the encoder setting at the next standard to approximately 2x to 4.5x encoding time compared to VTM.

It is proposed to use MTT depth below for ECM CTC.

--MaxMTTHierarchyDepth=2 --MaxMTTHierarchyDepthISliceL=2

--MaxMTTHierarchyDepthISliceC=2 --MaxMTTHierarchyDepthByTid=221111

Was already presented in JVET on Mar. 28 - to be further discussed in BoG for CfE

[JVET-AL0322](https://jvet-experts.org/doc_end_user/current_document.php?id=15649) AhG17: CfE draft: Sequences selection illustration [J. Pardo (Huawei] [late]

For Information – illustration of sequences planned for CfE as had been requested before

## AHG18 Ultra-low latency and packet loss resilience (3+3)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0044](https://jvet-experts.org/doc_end_user/current_document.php?id=15350) AHG18: Teleconference on ultra-low latency and packet loss resilience [S. Ikonin, S. Wenger, V. Zakharchenko (co-chairs), S. Deshpande, J. Ström, X. Ma, C. Kim, S. Puri, S. Fößel (vice-chairs)]

[JVET-AL0069](https://jvet-experts.org/doc_end_user/current_document.php?id=15375) AHG9/AHG18: Error recovery SEI message [J. Boyce, M. M. Hannuksela (Nokia)]

[JVET-AL0073](https://jvet-experts.org/doc_end_user/current_document.php?id=15379) AHG9/AHG18: Loss recovery information SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AL0176](https://jvet-experts.org/doc_end_user/current_document.php?id=15501) AHG18: Proposed methodology and test conditions for ultra-low latency and error resilience performance evaluation [S. Ikonin, X. Ma, I. Gribushin, M. Sychev, E. Alshina (Huawei)]

[JVET-AL0200](https://jvet-experts.org/doc_end_user/current_document.php?id=15525) AHG18: Simulation software description [S. Ikonin, V. Khamidullin, R. Shabaev, I. Gribushin, M. Sychev, E. Alshina (Huawei)]

[JVET-AL0201](https://jvet-experts.org/doc_end_user/current_document.php?id=15526) AHG18: Performance evaluation of VTM under proposed ULL test conditions and proposed software modifications [S. Ikonin, V. Khamidullin, R. Shabaev, I. Gribushin, M. Sychev, E. Alshina (Huawei)]

## CICP (4)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0217](https://jvet-experts.org/doc_end_user/current_document.php?id=15544) CICP support for monochrome content [J. Boyce, T. Biatek, M. M. Hannuksela (Nokia)]

[JVET-AL0218](https://jvet-experts.org/doc_end_user/current_document.php?id=15545) CICP support for colour mapping [J. Boyce, T. Biatek, M. M. Hannuksela (Nokia)]

[JVET-AL0320](https://jvet-experts.org/doc_end_user/current_document.php?id=15647) CICP TuC progress on monochrome [Y. Guyon (Google)] [late]

[JVET-AL0321](https://jvet-experts.org/doc_end_user/current_document.php?id=15648) XYB color representation support in CICP [J. Alakuijala, S. Boukortt (Google)] [late]

# Low-level tool technology proposals (104)

## AHG11/AHG14: Neural network-based video coding (27)

### Summary and BoG reports (2)

Contributions in this area were discussed during 0510–0710 and 0730–0815 on Thursday 27 March 2025 (chaired by JRO).

[JVET-AL0023](https://jvet-experts.org/doc_end_user/current_document.php?id=15401) EE1: Summary report of exploration experiment on neural network-based video coding [E. Alshina, R. Chang, F. Galpin, Yue Li, Yun Li, M. Santamaria, J. Ström, Z. Xie (EE coordinators)]

This report summarizes the activities of the Exploration Experiment 1 (EE1) performed between the 37th and 38th JVET meetings to evaluate **Neural Network-based Video Coding** (NNVC) technologies, analyze their performance, evaluate their complexity aspects, and clarify training procedure. Two teleconferences have been conducted during this meeting circle.

NNVC has three major operation points with NN-intra always enabled and NN-based in-loop filters with different level of complexity: High Operational Point (HOP, 471kMAC/pixel), Low Operational Point (LOP, 21.4kMAC/pixel) and Very Low Operational Point (VLOP, 9.9kMAC/pixel). Compared with VTM, NNVC HOP5 provides {14.2%, 19.5%, 19.9%}, NNVC LOP4 provides {8.2%, 15.3%, 13.5%} and NNVC VLOP3 provides {5.8%, 6.6%, 5.7%} bitrate saving for {Y, Cb, Cr} channels in the RA configuration. Observed run time increase relatively to VVC is ×2.5, ×1.2, ×1.1 (encoding) and ×1135, ×35, ×15 (decoding) for HOP, LOP and VLOP configurations respectively. EE1 tests were targeting improving the performance complexity trade-off of all three operation points of neural-network based filter and investigation NN-based Inter tool. One of the test categories was devoted to re-training using additional data set (BVI AOM).

1. **Introduction**

Code base for the EE1 tests was NNVC12.0, anchor is default configuration of **NNVC-12.0** (NN-Intra and **LOP5** filter enabled). NNVC common test conditions [1], results and complexity reporting template were be used.

For proposals in all categories, proponents used **AhG11 training set** [1], which consists of DIV2K [2], BVI-DVC [3], TVD [4] and BVI-AOM [5]. Comparison is done between tests which use the same sub-set of training data.

For tests competing with technologies in NNVC it was agreed to configure the proposed solution targeting close to existing NNVC tool complexity, but not exceeding it**:**

1. kMAC/pxl of EE1 test ≤ kMAC/pxl NNVC (*must*),
2. the number of channels (both input and output) in neural network modules which are modified **must be keep multiple of 16**,
3. Number of Parameters EE1 test ≤ Number of Parameters NNVC (*if possible*).

If it is not possible to respect both constrains 1) and 2) at the same time then two sub tests need to be performed: first test respecting the constrain 1) only – in order to prove the value of the proposed change, and the second test respecting constrain 2) with minor violation of 1) - in order to provide software and hardware friendly design.

Only tests with results provided to quantized (int 16) model are considered for adoption to NNVC, float point model results are provided just for information.

Exact parameters settings were announced by proponents by 2nd AhG11/14 teleconference on March 5 [3].

Inference cross-check is required for all EE1 tests. Candidates for adoption to NNVC are required to undergo training cross-check, implementation must be compatible with SADL.

*Table 1 Performance relatively to VTM anchor of NNVC tools combinations which serve as comparison point for corresponding tests in EE1*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test | Random Access | | | | | All Intra | | | | | Total kMAC/pxl | Total Param (Mprm) | |
| Y | U | V | Enc | Dec | Y | U | V | Enc | Dec |  |
| NNIntra+LOP | **-8.2%** | -15.3% | -13.5% | 1.2 | 35 | **-9.2%** | -15.8% | -15.5% | 1.6 | 26 | 21.4 | 1.5 |
| NNIntra+HOP | **-14.2%** | -19.6% | -20.0% | 2.5 | 1135 | **-13.7%** | -15.9% | -17.1% | 2.5 | 769 | 471 | 2.7 |
| NNIntra+VLOP | **-5.8%** | -6.6% | -5.7% | 1.1 | 15 | **-7.3%** | -8.8% | -8.3% | 1.7 | 13 | 9.9 | 1.4 |
| NNIntra+CALOP4 | **-8.5%** | -18.0% | -17.1% | 2.3 | 36 | NA | NA | NA | NA | NA | 21.6 | 1.5 |

1. **List of tests**

This round of EE1 tests includes:

* **EE1-1: LOP and VLOP in-loop filter**
  + EE1-1.1 – Multiscale blocks in LOP5 and VLOP3 filters [[JVET-AL0164](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0164-v1.zip)](https://jvet-experts.org/doc_end_user/current_document.php?id=15090)
    - Tester: Nokia, cross-check: Qualcomm [JVET-AL0173](https://jvet-experts.org/doc_end_user/current_document.php?id=15498) (inference only)
  + EE1-1.2 – LOP5 improvement with parallel 1x3/3x1 Backbone [JVET-AL0084](https://jvet-experts.org/doc_end_user/current_document.php?id=15409)
    - Tester: Dolby/Ittiam, cross-check: Bytedance [JVET-AL0246](https://jvet-experts.org/doc_end_user/current_document.php?id=15573) (training in progress, inference verified)
  + EE1-1.3 – Dimension-wise decomposed multiplier for content-adaptive loop-filter [JVET-AL0169](https://jvet-experts.org/doc_end_user/current_document.php?id=15494)
    - Tester: TCL, cross-check: Nokia [JVET-AL0185](https://jvet-experts.org/doc_end_user/current_document.php?id=15510) (still running)
  + EE1-1.4 - Conditional loop-filter [JVET-AL0145](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0145-v1.zip)
    - Tester: Nokia, cross-check: Ericsson (perfect match reported)
  + EE1-1.5 – Partial convolution and over-parametrization ***withdrawn***
* **EE1-2: NN-inter prediction**
  + E1-2.1 Lightweight Multiscale Reference Frame Generation for VVC Inter Coding [[JVET-AL0104](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0104-v1.zip)](https://jvet-experts.org/doc_end_user/current_document.php?id=15042)
  + Tester: Xidian Uni, cross-check: Nokia ([JVET-AL0297](https://jvet-experts.org/doc_end_user/current_document.php?id=15624))
  + EE1-2.2 RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding [JVET-AL0105](https://jvet-experts.org/doc_end_user/current_document.php?id=15430)
    - Tester: Xidian Uni, cross-check: Nokia [JVET-AL0298](https://jvet-experts.org/doc_end_user/current_document.php?id=15625), comparison point: NNVC-12 default
* **EE1-3: NNVC tools re-training**
  + EE1-3.1 –Retraining LOP4 and LOP5 using extended dataset from BVI-AOM [JVET-AL0085](https://jvet-experts.org/doc_end_user/current_document.php?id=15410), [JVET-AL0144](https://jvet-experts.org/doc_end_user/current_document.php?id=15469), [JVET-AL0187](https://jvet-experts.org/doc_end_user/current_document.php?id=15512)
    - Volunteers: Dolby/Ittiam, Ericsson, InterDigital, comparison point: NNVC-12 default
  + EE1-3.2 – NNVC-HOP5 retraining adding BVI-AOM [[JVET-AL0189](https://jvet-experts.org/doc_end_user/current_document.php?id=15514)](https://jvet-experts.org/doc_end_user/current_document.php?id=15244)
    - Volunteers: InterDigital, comparison point: NNVC-12 HOP5
  + EE1-3.3 – NNVC-VLOP retraining adding BVI-AOM [JVET-AL0190](https://jvet-experts.org/doc_end_user/current_document.php?id=15515)
    - Volunteers: InterDigital, Tencent comparison point: NNVC-12 VLOP3

1. **Test results summary**

Details of each test can be found in attached presentation.

***EE1.1- LOP and VLOP filter modifications***

NNVC-12 LOP5 filter is are depicted in the diagrams below (JVET-AK0150 and JVET-AK0195).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| d1 | | d2 | | d3 | | d4 | | d5 | |  |
| 16 | | 8 | | 4 | | 2 | | 2 | |  |
| C | | CY1 | | CUV1 | | CY | | CUV | | Ca | |
| 32 | | 176 | | 144 | | 32 | | 32 | | 32 | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *RecExtY*  [1,144,144 ] | | |  | *RecExtUV*  [2,72,72] | | | |  | *PredExtY*  [1,144,144 ] | | | | |  | *PredExtUV*  [2,72,72] | | | | | |  | | | *BS*  [1, 144, 144] | | | | |  | | | | | *QPbase*  [1, 144, 144] | | |  | | *QPblock*  [1, 144, 144] | |  | *IPB*  [1, 144, 144] | | |
| [DCT](#_DCT) | | |  |  |  | | | | [DCT](#_DCT) | | | | |  |  | |  | | | | | 2↓ | | | | | | |  | | | | | 2↓ | | |  | | 2↓ | |  | 2↓ | | |
| [6,72,72 ] | | |  |  |  | | | | [6,72,72 ] | | | | |  |  | |  | | | | | [1,72,72 ] | | | | | | |  | | | | | [1,72,72 ] | | |  | | [1,72,72 ] | |  | [1,72,72 ] | | |
| [CONV](#_convolution_layer) 3×3, 6, d1, 2↓ | | | | | |  | | | | [CONV](#_convolution_layer) 3×3, 6, d2, 2↓ | | | | | | |  | | | | [CONV](#_convolution_layer) 1×1, 1, d3, 2↓ | | | | | | |  | | | | | [CONV](#_convolution_layer) 1×1, 1, d4, 2↓ | | |  | | [CONV](#_convolution_layer) 1×1,  1, d4,2↓ | |  | [CONV](#_convolution_layer) 1×1,  1, d5,2↓ | | |
|  |  | | |  | |  | | | | |  |  | | |  | | | |  | | | | | | |  | | | | |  | |  | | | |  |  | | |  |  |
| [CONCAT](#_concatenation_of_tensors) (d1, d2, d3, d4, d4, d5) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [ d1+ d2+ d3+ d4+ d4+ d5+ d7+ d8= d6,72,72 ] | | | | | | | | | | | | | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 1×1, d6, C | | | | | | | | | | | | | | | | | | | | | | | | | |
| [PReLU](#_Parametric_rectified_linear) | | | | | | | | | | | | | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 1×3, C, C, 2↓ | | | | | | | | | | | | | | | | | | | | | | | | | |
| [ C,72,36 ] | | | | | | | | | | | | | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 3×1, C, C, 2↓ | | | | | | | | | | | | | | | | | | | | | | | | | |
| [ C,36,36 ] | | | | | | | | | | | | | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 1×1, C, C | | | | | | | | | | | | | | | | | | | | | | | | | |
| [PReLU](#_Parametric_rectified_linear) | | | | | | | | | | | | | | | | | | | | | | | | | |
| [ C,36,36 ] | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | | | | | |  | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 1×1, C, CY1 | | | | | | | | | | | | | | | | | | | |  | | | | | | [CONV](#_convolution_layer), 1×1, C, CUV1 | | | | | | | | | | | | | | | | | | |
| [BBBlock](#BBBLOP4) (1), CY1 | | | | | | | | | | | | | | | | | | | |  | | | | | | [BBBlock\_uv](#BBBLOP4_uv) (1), CUV1 | | | | | | | | | | | | | | | | | | |
| [ CY1,34,34 ] | | | | | | | | | | | | | | | | | | | |  | | | | | | [ CUV1,34,34 ] | | | | | | | | | | | | | | | | | | |
| [BBBlock](#BBBLOP4) (1), CY1 | | | | | | | | | | | | | | | | | | | |  | | | | | | [BBBlock](#BBBLOP4)\_uv (1), CUV1 | | | | | | | | | | | | | | | | | | |
| [ CY1,32,32 ] | | | | | | | | | | | | | | | | | | | |  | | | | | | [ CUV1,32,32 ] | | | | | | | | | | | | | | | | | | |
| [TwinBlock](#TwinBlockAK0150) (0), CY1 | | | | | | | | | | | | | | | | | | | |  | | | | | | [BBBlock\_uv](#BBBLOP4_uv) (0), CUV1 | | | | | | | | | | | | | | | | | | |
| [TwinBlock](#TwinBlockAK0150) (0), CY1 | | | | | | | | | | | | | | | | | | | |  | | | | | | [BBBlock\_uv](#BBBLOP4_uv) (0), CUV1 | | | | | | | | | | | | | | | | | | |
| [TwinBlock](#TwinBlockAK0150) (0), CY1 | | | | | | | | | | | | | | | | | | | |  | | | | | | [BBBlock\_uv](#BBBLOP4_uv) (0), CUV1 | | | | | | | | | | | | | | | | | | |
| TripleBlock(0), CY1 | | | | | | | | | | | | | | | | | | | |  | | | | | | | | | | | |  | | | | | | | | | | | | |
|  | | | | | | | | | | |  | | | | | | | | |  | | | | | | | | | | | | |
|  | | | | | | | | | | |  | | | |  | | | | |
|  | | | | | | |  | | | | | | [add](#_per_element_addition) | | | | | | | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 1×1, CY1, CY | | | | | | | | | | | | | | | | | | |  | | | | | | [CONV](#_convolution_layer), 1×1, CUV1, CUV | | | | | | | | | | | | | | | | | | | |
| [dwCONV](#_depthwise_separable_convolution), 1×3, CY, CY | | | | | | | | | | | | | | | | | | |  | | | | | | [CONV](#_convolution_layer), 1×3, CUV, CUV | | | | | | | | | | | | | | | | | | | |
| [dwCONV](#_depthwise_separable_convolution), 3×1, CY, CY | | | | | | | | | | | | | | | | | | |  | | | | | | [CONV](#_convolution_layer), 3×1, CUV, CUV | | | | | | | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 1×1, CY, CY | | | | | | | | | | | | | | | | | | |  | | | | | | [CONV](#_convolution_layer), 1×1, CUV, CUV | | | | | | | | | | | | | | | | | | | |
| [PReLU](#_Parametric_rectified_linear) | | | | | | | | | | | | | | | | | | |  | | | | | | [PReLU](#_Parametric_rectified_linear) | | | | | | | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 1×1, CY, 16 | | | | | | | | | | | | | | | | | | |  | | | | | | [CONV](#_convolution_layer), 1×1, CUV, 8 | | | | | | | | | | | | | | | | | | | |
| [ 16,32,32 ] | | | | | | | | | | | | | | | | | | |  | | | | | | [ 8,32,32 ] | | | | | | | | | | | | | | | | | | | |
| [Shuffle](#_shuffle_layer)(2) | | | | | | | | | | | | | | | | | | |  | | | | | |  | | | | | |  | | | | | | |
| [ 4,64,64 ] | | | | | | | | | | | | | | | | | | |  | | | | | |
| [IDCT](#_IDCT) | | | | | | | | | | | | | | | | | | |  | | | | | | [IDCT](#_IDCT) | | | | | | | | | | | | |
| [ 1,128,128 ] | | | | | | | | | | | | | | | | | | |  | | | | | | [ 2,64,64 ] | | | | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BBBlock** (x)   |  |  |  |  |  | | --- | --- | --- | --- | --- | | [ C1,h,w ] | | | | | | [PReLU](#_Parametric_rectified_linear) | | |  | | | [CONV](#_convolution_layer), 1×1, C1, C | | |  | | | [dwCONV](#_depthwise_separable_convolution), 1×3, C, C | | |  | [crop](#_cropping_layer)(2x) | | | [dwCONV](#_depthwise_separable_convolution), 3×1, C, C | | |  |  | | [crop](#_cropping_layer)(2x) | | |  | | | [CONV](#_convolution_layer), 1×1, C, C1 | | |  | | | [add](#_per_element_addition) | | | | | [ C1,h-((x==1)?2:0),w-((x==1)?2:0)] | | | | | | **BBBlock\_uv** (x)   |  |  |  |  |  | | --- | --- | --- | --- | --- | | [ CUV1,h,w ] | | | | | | [PReLU](#_Parametric_rectified_linear) | | |  | | | [CONV](#_convolution_layer), 1×1, CUV1, C | | | | [dwCONV](#_depthwise_separable_convolution), 3×3, C, C | | |  | [crop](#_cropping_layer)(2x) | | | [crop](#_cropping_layer)(2x) | | |  | | | [CONV](#_convolution_layer), 1×1, C CUV1 | | | | [add](#_per_element_addition) | | | | | [ CUV1,h-((x==1)?2:0),w-((x==1)?2:0)] | | | | | |
| **Twin Block** (x)   |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | [ C1,h,w ] | | | | | | | | | | | [PReLU](#_Parametric_rectified_linear) | | | |  |  | | | | | | [CONV](#_convolution_layer), 1×1, C1, C | | | |  |  | | | | | | [dwCONV](#_depthwise_separable_convolution), 1×3, C, C | | | |  |  | | | | | | [dwCONV](#_depthwise_separable_convolution), 3×1, C, C | | | |  |  | | | | | | [CONV](#_convolution_layer), 1×1, C C1 | | | |  |  | | | | | | [add](#_per_element_addition) | | | | | |  | | | [ C1,h,w] | | | | | | | |  | | [PReLU](#_Parametric_rectified_linear) | | | |  |  | | | | | | [CONV](#_convolution_layer), 1×1, C1, C | | | |  |  | | | | | | [dwCONV](#_depthwise_separable_convolution), 1×3, C, C | | | |  |  | | | |  | | [dwCONV](#_depthwise_separable_convolution), 3×1, C, C | | | |  |  | | | | | | [CONV](#_convolution_layer), 1×1, C C1 | | | |  |  |  |  | | | | [add](#_per_element_addition) | | | | | |  | | | [ C1,h,w] | | | | | | | |  | | [PReLU](#_Parametric_rectified_linear) | | | | | |  | | | [add](#_per_element_addition) | | | | | | | | **[Attention](#AttentionAk0150)** | | | | | | | | [ C1,h,w] | | | | | | | | | **Attention**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | [ C1,h,w ] | | | | | | | | | | | | | | [CONV](#_convolution_layer), 1×1, C1, Ca | | | | | | | |  | |  | | | | | [PReLU](#_Parametric_rectified_linear) | | | | | | | |  | |  | | | | |  | |  | | | | | |  | | |  | | | | | [MaxPool](#MaxPool), 2×2, 2↓ | | | | | |  | [CONV](#_convolution_layer), 1×1, Ca, Ca | | | | | |  | | | **[DW Block](#DWBlockAK0150)** | | | | | | [PReLU](#_Parametric_rectified_linear) | | | | | |  | | | [BiLinear](#Bilinear_Interpolation), 2×2, 2↑ | | | | | |  | | | |  | | |  | | | [add](#_per_element_addition) | | | | | | | |  | | | | [Conv](#_convolution_layer_1), 1x1, Ca, C1 | | | | | | | |  | | | | [HardSigmoid](#HardSigmoid) | | | | | | | |  | | | | [mult](#_per_element_multiplication) | | | | | | | | | | | | [ C1,h,w ] | | | | | | | | |   **DW Block** (x)   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | [ Ca,h,w ] | | | | | | | [dwCONV](#_depthwise_separable_convolution), 3×3, Ca, Ca | | |  |  | | [CONV](#_convolution_layer), 1×1, Ca, Ca | | |  | | | [PReLU](#_Parametric_rectified_linear) | | | | [add](#_per_element_addition) | | | | | [ Ca,h,w ] | | | | | | |

*Figure 1 NNVC 12 LOP5 architecture.*

Note: The TripleBlock is the same as the TwinBlock but with three BBBlocks in sequence.

The complexity for LOP filter is 16.606 kMAC/pxl (including MaxPool and HardSigmoid), 247 K parameters.

Results of tests in this category are summarized in the

*Table 2* ***EE1-1: LOP in-loop filter modifications***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Random Access | | | | | All Intra | | | | | kMAC/pxl | | | Num Param, M | | |
| Y | U | V | EncT | DecT | Y | U | V | EncT | DecT | Total | Filter | Intra | Total | Filter | Intra |
| NNVC-LOP5 | **0.0%** | **0.0%** | **0.0%** | **100%** | **100%** | **0.0%** | **0.0%** | **0.0%** | **100%** | **100%** | **21.4** | **16.6** | **4.8** | **1.5** | **0.247** | **1.3** |
| EE1-1.1.1 | 0.1% | 1.3% | 1.1% | 100% | 99% | -0.0% | 1.2% | 1.5% | 100% | 101% | 21.3 | 16.5 | 4.8 | 1.5 | 0.247 | 1.3 |
| EE1-1.1.2 | 0.1% | -0.0% | 0.3% | 101% | 102% | 0.1% | -0.3% | -0.2% | 100% | 102% | 21.3 | 16.5 | 4.8 | 1.5 | 0.247 | 1.3 |
| EE1-1.2 | 0.1% | -0.1% | -0.3% |  | 99% | 0.1% | -0.1% | -0.6% |  | 100% | 21.4 | 16.6 | 4.8 | 1.5 | 0.247 | 1.3 |
| EE1-1.4 | 0.0% | 0.0% | 0.1% | 100% | 123% | 0.0% | 0.0% | 0.0% | 100% | 101% | 21.4 | 16.6 | 4.8 | 1.5 | 0.247 | 1.3 |

*Table 3* ***EE1-1: content adaptive LOP in-loop filter modifications***

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Random Access | | | | | kMAC/pxl | | | Num Param, M | | |
| Y | U | V | EncT | DecT | Total | Filter | Intra | Total | Filter | Intra |
| NNVC-CALOP4 | **0.0%** | **0.0%** | **0.0%** | **100%** | **100%** | **21.4** | **16.6** | **4.8** | **1.5** | **0.247** | **1.3** |
| EE1-1.3 | -0.2% | -0.4% | -0.5% |  |  | 21.4 | 16.6 | 4.8 | 1.5 | 0.247 | 1.3 |

*Table 4* ***EE1-1: content adaptive VLOP in-loop filter modifications***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Random Access | | | | | All Intra | | | | | kMAC/pxl | | | Num Param, M | | |
| Y | U | V | EncT | DecT | Y | U | V | EncT | DecT | Total | Filter | Intra | Total | Filter | Intra |
| NNVC-VLOP3 | **0.0%** | **0.0%** | **0.0%** | **100%** | **100%** | **0.0%** | **0.0%** | **0.0%** | **100%** | **100%** | **9.9** | **5.1** | **4.8** | **1.4** | **0.067** | **1.3** |
| EE1-1.1.1 (float) | 0.1% | -0.1% | 0.2% | 119% | 123% |  |  |  |  |  | 9.9 | 5.1 | 4.8 | 1.4 | 0.070 | 1.3 |
| EE1-1.4 | 0.1% | 0.0% | 0.0% | 100% | 101% | 0.0% | -0.1% | 0.0% | 100% | 102% | 9.9 | 5.1 | 4.8 | 1.4 | 0.067 | 1.3 |

EE1-1.1 – (by Nokia) introduces multiscale blocks in LOP5 and VLOP3 filters[.](https://jvet-experts.org/doc_end_user/current_document.php?id=15090) Expected effect – BD-rate gain in Chroma.

EE1-1.2 – (by Dolby/Ittiam) improves LOP5 with parallel 1x3/3x1 Backbone. Expected effect – reduction for number of sequential convolution (lower latency with proper implementation).

EE1-1.3 – (by TCL) improves content adaptivity of CALOP. Expected effect – BD-rate gain.

EE1-1.4 - Conditional loop-filter. Expected effect – BD-rate gain in chroma or at least reduction (in average) for number of filtered samples.

***EE1.2- NN-Inter***

EE1-2.1 – (by Xidian Uni) Lightweight Multiscale Reference Frame Generation for VVC Inter Coding

More complex variant: 547 k/pixel, 25M model parameters. If trained on Vimeo-90K (89800 video scenes) then 6-7% gain was reported. Training with BVI-DVC and BVI-AOM (278 video scenes)resulted in significant lower gain.

EE1-2.2 – (by Xidian Uni) RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding

Less complex variant: 487 k/pixel, 2.75M model parameters. If trained on Vimeo-90K (89800 video scenes) then 5-7% gain was reported. Training with BVI-DVC and BVI-AOM (278 video scenes) resulted in significant lower gain 1% in average. Training on just BVI-DVC provides better performance. Proponent explains this by similarity of motion characteristics between BVI-DVC and JVET test set.

***EE1.3- NNVC filters re-training using BVI-AOM***

Most trainings are still ongoing.

Current NNVC training set: BVI-DVC & TVD & DIV2K.

Extended NNVC training set: BVI-DVC & TVD & DIV2K &BVI-AOM

EE1-3.1 – retraining LOP5

by Dolby/Ittiam: Current training set 0.1% (drop in RA cfg), new training set -0.1% (gain in RA cfg)

by Ericsson: new training set gain in Chroma, drop or no gain in Luma.

by Interdigital: new training set (all intra cfg) gain in Chroma, drop in Luma.

EE1-3.2 – retraining HOP5

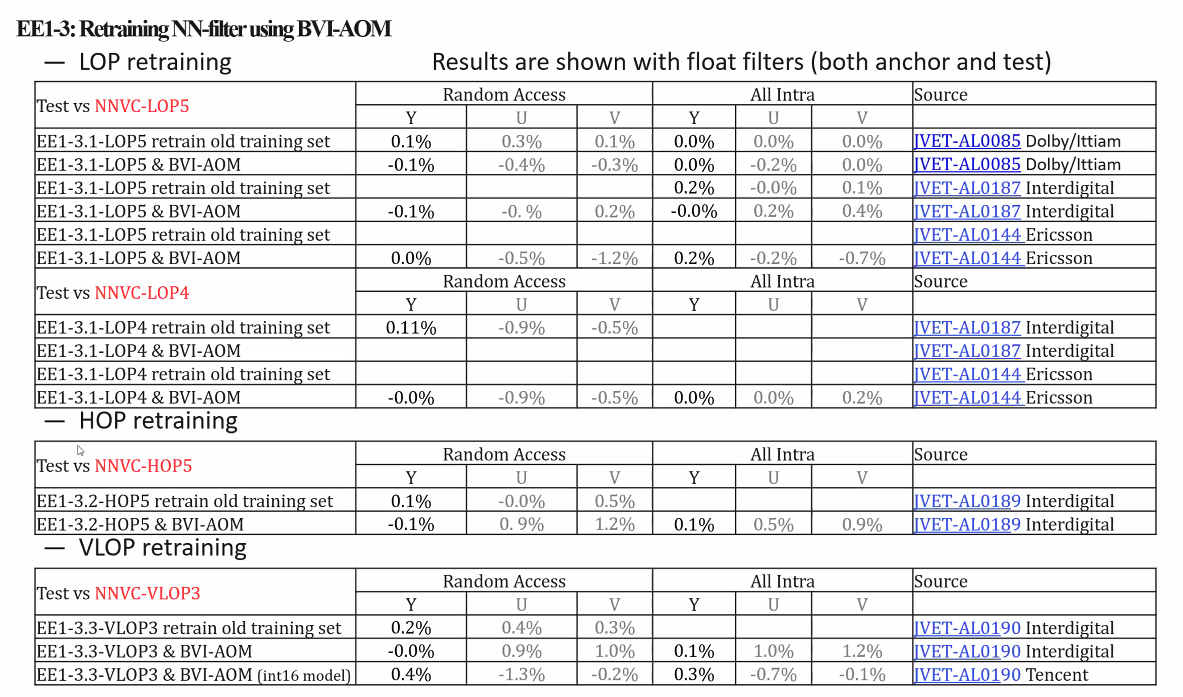
by Interdigital: new training set (RA cfg) gain in Chroma, drop in Luma.

EE1-3.3 – retraining VLOP3

by Interdigital: new training set drop or no gain (in RA cfg and all intra cfg).

by Tencent: new training set gain in Chroma, drop in Luma (in RA cfg and all intra cfg).

Analysis for this phenomenon is needed, likely training strategy requires modification.



For EE1-1.1 (multiscale blocks), less gain was found than expected for chroma, and some small loss for luma, when implemented on top of LOP5. Further investigation is necessary why this might be the case – there is some related contribution.

EE1-1.2 has small loss in luma, some gain in chroma and is asserted to be simpler due to possibility of oerforming convolutions in parallel. Training crosscheck expected to be finalized next week. Revisit.

EE1-1.3 (decomposed multiplier in overfitting of content-adaptive filter) provides gain, but the overfitting run time is increased significantly. Due to proponents, this is caused by the GPU time used. It should be confirmed by cross-checkers if that is the case. It should also be confirmed by cross-checkers that the number of multipliers is not increased compared to the current adaptive filter. Revisit.

EE1-1.4 uses separate enabling/disabling of luma and chroma filtering at frame level (instead of jointly on/off at block level) for LOP, and for VLOP separate both at frame and block level. It was reported that by tendency, chroma is filtered less frequently, but luma is filtered more frequently by this. This is having almost no impact for AI and RA, but in LD configurations has 1-2% gain in chroma, but luma drop of 0.1..0.2%/0.6..0.7% in VLOP/LOP is observed. It was commented that the complete removal of block-level control may be inappropriate in LOP, and was also not part of the original proposal in the last meeting, where a more significant chroma gain was observed in LOP4 (where however some other mechanism was used by inputting different QP into luma and chroma filters which had the disadvantage of increased decoder complexity, and also LOP5 may take away some chroma gain). It is asserted that the results indicate separate handling of luma/chroma filter enabling is useful, but the current results are not considered sufficiently attractive. Also, the worst case complexity is not reduced. It was asked if it would be possible to implement the separate luma/chroma control only at frame level, as the loss in luma for VLOP is probably caused by the additional separate block-level flags. Further study (if possible in EE).

For EE1-2.x (inter prediction) it was found that extending the training set by BVI-AOM did not provide advantage decreased the benefit. According to proponents, this may be caused that the amount of rigid motion is higher in BVI-AOM. With Vimeo-90K (which has 300x more video clips than the BVI sets) performance would be much better (as shown in JVET-AL0104). It was also commented that higher losses with BVI-AOM seem to occur for classes B, C and D. It was further commented that some of the drop may also be caused by the model used in JVET-AL0105 is different from JVET-AK0077 of the last meeting and JVET-AJ0099). It was also commented that the training parameters are different than those used before.It can be concluded that BVI sets are definitely not sufficient for training a decent model for inter prediction.

From current results, the model of JVET-AL0105 is most attractive in complexity/performance tradeoff, but results with training on Vimeo are not available. It was concluded to investigate this further in EE, and if possible, also get a training cross-check by a party that has access to the Vimeo database. Further investigation on integerization would also be necessary.

In EE1-3.x, same training scripts were used by participants, but hyperparameters such as number of epochs, learning rate might be different.

Generally, the performance does not seem to be much different, regardless if BVI-AOM is added to training or not (sometimes slightly worse, sometimes better). Likely, the characteristics are not too much different for the two parts of BVI.

It was discussed if the results might indicate that an overfitting of filters to the CTC set could already have occurred, but no clear indication of this.

Most experts commented that the results would not give justification to extend the training dataset for loop filters by the BVI-AOM part of the set.

It was discussed if training could target better performance for high resolution classes by adding more data of that type, but some experts commented that they did not have such findings in own experiments.

It was discussed if it might make sense also trying re-training from scratch (all stages), but previous reports on benefit of this seemed not to give much benefit (<0.5%), and it would be a big effort. Another option would be just re-training stage 4 (generating distorted data with current version of the filters), which however would be quite some effort and might not be useful for filters that are still under changes. Not of priority at this moment. It could potentially be interesting studying this for HOP which has not undergone changes over several meeting cycles, just to know how much gain it might give. This could better be done as AHG study rather than EE.

For consistency, it is agreed at this moment that it is appropriate to stay with BVI-DVC for training of loop filters.

[JVET-AL0043](https://jvet-experts.org/doc_end_user/current_document.php?id=15348) [AHG11] [AHG14] Teleconference on NNVC [E. Alshina, F. Galpin]

No need for presentation

### EE1 contributions: Neural network-based video coding (11)

Contributions in this area were discussed in the context of the EE summary report JVET-AL0023.

[JVET-AL0084](https://jvet-experts.org/doc_end_user/current_document.php?id=15409) EE1-1.2: LOP5 improvement with parallel 1x3/3x1 Backbone [T. Shao, P. Yin, S. McCarthy (Dolby), J. N. Shingala, A. Shyam, A. Suneja, S. P. Badya (Ittiam)]

[JVET-AL0246](https://jvet-experts.org/doc_end_user/current_document.php?id=15573) Crosscheck of JVET-AL0084 (EE1-1.2: LOP5 improvement with parallel 1x3/3x1 Backbone) [Y. Li (Bytedance)] [late]

[JVET-AL0085](https://jvet-experts.org/doc_end_user/current_document.php?id=15410) EE1-3.1: NNVC-LOP5 retraining with additional BVI-AOM dataset [A. Suneja, J. N. Shingala, A. Shyam, S. P. Badya (Ittiam), T. Shao, P. Yin, S. McCarthy (Dolby)]

[JVET-AL0104](https://jvet-experts.org/doc_end_user/current_document.php?id=15429) EE1-2.1: Lightweight Multiscale Reference Frame Generation for VVC Inter Coding [P. Li, C. Jung, Q. Qin (Xidian Univ.)]

[JVET-AL0297](https://jvet-experts.org/doc_end_user/current_document.php?id=15624) Crosscheck of JVET-AL0104 (EE1-2.1: Lightweight Multiscale Reference Frame Generation for VVC Inter Coding) [L. Murn (Nokia)] [late]

[JVET-AL0105](https://jvet-experts.org/doc_end_user/current_document.php?id=15430) EE1-2.2: RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding [Q. Qin, C. Jung (Xidian Univ.)]

[JVET-AL0298](https://jvet-experts.org/doc_end_user/current_document.php?id=15625) Crosscheck of JVET-AL0105 (EE1-2.2: RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding) [L. Murn (Nokia)] [late]

[JVET-AL0144](https://jvet-experts.org/doc_end_user/current_document.php?id=15469) EE1-3.1: Retraining LOP4 and LOP5 using extended dataset from BVI-AOM [D. Liu, J. Ström, M. Damghanian, P. Wennersten (Ericsson)]

[JVET-AL0145](https://jvet-experts.org/doc_end_user/current_document.php?id=15470) EE1-1.4: Conditional loop-filter [M. Santamaria, F. Cricri (Nokia)]

[JVET-AL0284](https://jvet-experts.org/doc_end_user/current_document.php?id=15611) Crosscheck of JVET-AL0145 (EE1-1.4: Conditional loop-filter) [J. Ström (Ericsson)] [late]

[JVET-AL0164](https://jvet-experts.org/doc_end_user/current_document.php?id=15489) EE1-1.1: Multiscale blocks in LOP5 and VLOP3 filters [R. Yang (Nokia)]

[JVET-AL0173](https://jvet-experts.org/doc_end_user/current_document.php?id=15498) Crosscheck of JVET-AL0164 (EE1-1.1: Multiscale blocks in LOP5 and VLOP3 filters) [Y. Li (Qualcomm)] [late]

[JVET-AL0169](https://jvet-experts.org/doc_end_user/current_document.php?id=15494) EE1-1.3 Dimension-wise decomposed representation of multiplier for content-adaptive loop filtering [Z. Xu, J. Konieczny, A. Filippov, C. Hollmann, V. Rufitskiy, T. Dong (TCL)]

[JVET-AL0185](https://jvet-experts.org/doc_end_user/current_document.php?id=15510) Crosscheck of JVET-AL0169 (EE1-1.3 Dimension-wise decomposed representation of multiplier for content-adaptive loop filtering) [M. Santamaria (Nokia)] [late] [miss]

[JVET-AL0187](https://jvet-experts.org/doc_end_user/current_document.php?id=15512) EE1-3.1: NNVC-LOP4 and LOP5 retraining with additional BVI-AOM dataset [T. Dumas, A. Monier, F. Galpin (InterDigital)] [late]

[JVET-AL0189](https://jvet-experts.org/doc_end_user/current_document.php?id=15514) EE1-3.2 – NNVC-HOP5 retraining adding BVI-AOM [F. Galpin (InterDigital)] [late]

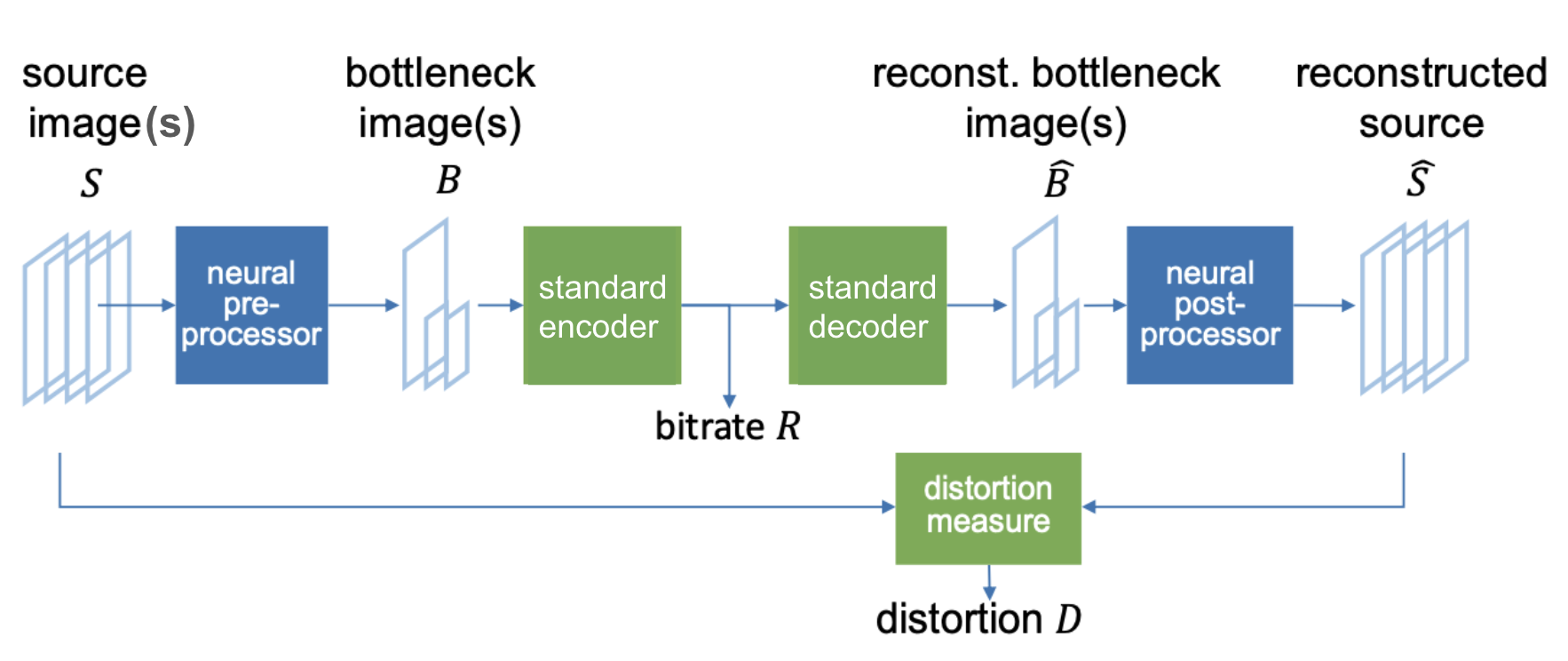
[JVET-AL0190](https://jvet-experts.org/doc_end_user/current_document.php?id=15515) EE1-3.3 – NNVC-VLOP3 retraining adding BVI-AOM [F. Galpin, Z. Ameur (InterDigital), R. Chang, L. Wang, X. Xu, S. Liu (Tencent)] [late]

### EE1 related and beyond-EE contributions: Neural network-based video coding (14)

Contributions in this area were discussed during 0820–0935 on Thursday 27 March 2025 and during 0720–0920 on Friday 28 March 2025 (chaired by JRO).

[JVET-AL0060](https://jvet-experts.org/doc_end_user/current_document.php?id=15366) Sandwiched Compression: Repurposing Standard Codecs with Neural Network Wrappers [O. Guleryuz (Google)]

This contribution discusses means of sandwiching standard image and video codecs between pre- and post-processing neural networks. The networks are jointly trained through a differentiable codec proxy to minimize a given rate-distortion loss. This sandwich architecture is not only geared toward improving the standard codec's performance on its intended content, but more importantly, toward adapting the codec to other types of image/video content and to other distortion measures. The sandwich learns to transmit ``neural code images'' that optimize overall rate-distortion performance, targeting significant improvements especially when the overall problem is well outside of the scope of the codec's design. Example applications of the sandwich architecture to standard codecs with mismatched sources transporting different numbers of channels, higher resolution, computer graphics, and with perceptual distortion measures are included. Respective rate-distortion-quality results are provided. Differentiable codec proxies approximating current standard codecs that enable sandwich designs are discussed. Example results on model complexity, visual quality under perceptual metrics, as well as sandwich configurations that offer interesting potentials in video compression and streaming are pointed to.



It was asked if the examples shown were part of the training data (e.g., cases where aliasing was avoided)? That was not the case.

Training was done outside of the codec. No specific implementation of a standard codec was used, only an approximation (“proxy”)

Examples bringing good gain were using superresolution and colour mapping. Was de-noising also used (e.g. reducing artifacts introduced by codec)? Somehow this would be part of the training.

It was asked if there would be only one version of pre-/postprocessing, independent of content. This would probably not be the case. It would need to be considered carefully how much rate would be necessary to communicate to the receiver end which kind of post processing would need to be used (e.g., NNPF could be used for that case).

One intention is also to repurpose conventional codecs for using perceptual metrics such as LPIPS.

Complexity of Pre-/postprocessor between 40 and 210 kMAC/pixel. The latter can run in real-time (70 fps) for a 1Kx1K picture size.

It was commented thar investigation on visual quality compared to standard codecs would be interesting (e.g., in CfE?).

[JVET-AL0080](https://jvet-experts.org/doc_end_user/current_document.php?id=15405) AHG11: Bit-exact reconstruction for NN video tools [L. Kerofsky, Y. Li, M. Karczewicz (Qualcomm)]

Bit-exact reconstruction is a requirement for modern codecs and standards. For a bit-exact standardization, undefined compiler specific operations must be avoided in the definition of calculations. The range of HW accelerator support considered for Neural Network tools should include both GPU and NPU. Expanded HW support comes with native floating point format support but limited integer support. It is asserted that despite using integer calculations, a NN design could fail to give bit-exact reconstruction in the event of undefined integer overflow. Methods are described to define such overflow or to provide means to prevent overflow allowing bit-exact reconstruction. It is recommended to study use of a floating-point format supported by common HW for use in accelerating NN calculation and defining a bit-exact calculation. If integer calculations are defined, overflow must be strictly avoided and a tool for proving avoidance of overflow is recommended to be developed.

It was emphasized that it would be important to use formats supported by various processing platforms (GPU, CPU, NPU, etc.). FP16 seems to be such a format, however also having different variants, as e.g. specified in IEEE 754. It was recommended to

* Identify classes of HW architectures (e.g., CPU, GPU, NPU, ASIC) needed to be considered and develop criteria for resources i.e., format and MAC requirements.
* Study the potential of FP16 to produce a bit-exact definition and support various HW acceleration. Note, IEEE 752 includes different rounding-direction attributes and confirmation must be made that a common set of rounding options are supported in addition to the IEEE 752 format.
* Evaluate performance of FP16 versus other NNVC models FP32 and INT16.
* For integer definition, produce analysis that overflow is avoided in the worst-case operation assuming 16-bit multiplies and 32-bit accumulator. This will impose limits on the model quantization. The impact of such limits on coding performance needs to be understood.

In the discussion, it was commented that SADL already implements different methods for checking overflows, such that if possible they could be avoided. However, even for INT16, there is no guarantee that different processors would handle overflows in the same way.

It is generally agreed that the topic of bit-exact reconstruction is highly important in the context of video standardization, and without doubt quantization of network parameters etc. has a lot of headroom of improvements.

[JVET-AL0121](https://jvet-experts.org/doc_end_user/current_document.php?id=15446) AHG11: Sample-based adaptive blending weight selection for LOP [H. Kwon, H. Ko (HYU)]

This contribution presents a method to select the weight adaptively for blending DBF- and LOP-filtered samples. The proposed method introduces an additional condition to control the blending weight selection based on the sample values. In this contribution, two approaches were evaluated: (1) a baseline method applied to both intra and inter slices and (2) a modified condition applied exclusively to inter slices. Experimental results for the proposed methods, based on NNVC-12.0, are reported as follows:

Test 1 (Baseline):

* RA: {Y: -0.06% U: -0.19% V: -0.23% | EncT: 99% DecT: 104%},
* LDB: {Y: -0.19% U: -0.83% V: -1.17% | EncT: 100% DecT: 103%},
* AI: {Y: 0.02% U: 0.01% V: 0.04% | EncT: 99% DecT: 100%}

Test 2 (Modified condition):

* RA: {Y: -0.06% U: -0.24% V: -0.26% | EncT: 100% DecT: 103%},
* LDB: {Y: -0.14% U: -1.10% V: -1.44% | EncT: 101% DecT: 102%}

Test 2 does not apply the method to intra pictures, where test 1 has loss. Why is decoding time increased? It is believed that the filter is used more frequently with the condition.

The adaptive weight needs computation at pixel basis both at encoder and decoder for classification.

Interesting gain in chroma, less in luma.

Investigate in EE. Also investigate the method of “appendix 1” of slide deck where signalling the additional processed blocks is used, but if possible also avoiding the sample-level classification at decoder. Also investigate using the method for other filters (HOP, VLOP, which may require different threshold values), and report about usage of filtering in additional blocks.

[JVET-AL0136](https://jvet-experts.org/doc_end_user/current_document.php?id=15461) AHG11: Over-Parameterized LOP In-Loop Filter [J. Han, C. Jung, Q. Qin (Xidian Univ.)]

This contribution proposes to enhance the backbone block (BBB) of LOP in-loop filter based on over-parameterized training. The proposed method does not increase multiply-accumulate (MAC) complexity and model parameters during inference, but enhances performance of the LOP in-loop filter by over-parameterized training. During the training phase, this contribution replaces the 1×3 and 3×1 separable convolution layers in LOP4 BBB with the over-parameterized convolution (OPC) module. The OPC module has a multi-branch structure to enhance the multi-scale feature extraction, thus improving the performance of the LOP4 network. During the inference phase, the OPC module is fused back into the original 1×3 and 3×1 separable convolution layers, which is identical to the original LOP in-loop filter. Compared to the NNVC-11.0 anchor (NNIntra enabled by default), the BD-rates of the proposed float32 model are {-0.02% (Y), -0.64% (U), -0.82% (V)} for the AI configuration and {-0.04% (Y), -1.90% (U), -1.55% (V)} for the RA configuration.

The contribution improves over a previous proposal on overparameterized model (JVET-AJ0080).

It was commented that the test was performed relative to NNVC11 (LOP4), and was not comparing against float model. Further, overparameterization likely causes longer training time, which might be more moderate in this proposal due to less usage of overparameterization.

Investigate in EE on top of newest LOP5, and possibly also to the other models of NNVC. Impact on training time relative to not using overparameterization should be reported, or ideally a version with comparable training time as for LOP5 should be investigated.

In the contribution, an training data set based on NNVC10 was used. In the EE, the set with distorted data based on NNVC6 should be used to allow better comparison with other proposals (see rules in EE description).

[JVET-AL0137](https://jvet-experts.org/doc_end_user/current_document.php?id=15462) AHG11: Backbone Block Enhancement of LOP In-Loop Filter with Over-Parameterized Training and Variable Channels [J. Han, C. Jung, Q. Qin (Xidian Univ.)]

This contribution proposes backbone block (BBB) enhancement of LOP in-loop filter with over-parameterized training and variable channels. The 1x3 and 3x1 separable convolutions in the LOP BBB are replaced with the 1x5 and 5x1 separable convolutions to increase the receptive field and enhance the prediction accuracy of the LOP network. Over-parameterized training to extend the 1x5 and 5x1 separable convolutions into a multi-branch structure is utilized to enhance the multi-scale feature extraction capability of the LOP BBB. Variable channels are adopted in the LOP BBB to enhance the richness of its input information while reducing network complexity. Therefore, this contribution reduces the complexity of LOP4 in-loop filter from 16.83 kMAC/pixel to 16.81 kMAC/pixel while enhancing the BD-rate performance. Compared to the NNVC-11.0 anchor, the BD-rate performance of the proposed float model with NNIntra enabled provides: {-0.19% (Y), -1.57% (U), -1.70% (V)} for the AI configuration, and {-0.07% (Y), -2.42% (U), -2.44% (V)} for the RA configuration.

It was commented that the proposal has interesting gains, to be studied in EE. Similar comments apply as for JVET-AL0136 regarding aligning model, training, comparison point, etc.

Additional complexity impact of the increased filter lengths should be studied, as well as the contribution in gain that comes by the usage of 5x1/1x5 filter kernels.

It was asked how the kMAC number decreases while the number of parameters increases. This is caused by reducing BBB blocks to 32x32 earlier, while the longer filter kernels require more parameters.

Continue from here at 0840.

[JVET-AL0165](https://jvet-experts.org/doc_end_user/current_document.php?id=15490) AHG11: Training NNSR using Reparameterization and Progressive Activation [H. Cho, S. Bahk, H. Kim (KHU), D. Kim, S. Lim (ETRI)]

This contribution proposes a training method that utilizes a reparameterization method to improve the performance of the NNSR in NNVC-11.0. In the proposed method, additional branches of network layers are employed during training to enhance feature learning, while the original network structure is maintained for inference. However, in the reparameterization method, each branch of network layers in training must remain linear to be merged into a single branch for inference. This limits the network’s ability to learn nonlinear features. To mitigate this limitation, the proposed method further introduces a progressive activation, which transitions from a nonlinear activation function to a linear activation function as the number of epochs increases.

These methods have been implemented based on the NNVC11.0 NNSR using SADL.

The BD-Rate results over NNVC11.0 NNSR for int16 are as follows:

1. Using reparameterization method

AI: -0.01%, -0.03%, -0.13%

RA: -0.02%, -0.06%, -0.25%

2. Using reparameterization method and progressive activation function

AI: %, %, %

RA: %, %, %

Gains reported above are only considering classes A1/A2.

Number of parameters and kMAC is increased relative to current NNSR.

The “progressive activation” replaces RELU by leaky RELU, therefore it should also increase the number of multiplications to be counted.

It was commented that the gain reported is more in the margin that usually could be observed in re-training.

No results on the benefit of overparameterization yet.

Training time increased approx. by 20 minutes/epoch.

Further study recommended, also reporting results without complexity increase relative to current NNSR, and with comparable training time.

[JVET-AL0166](https://jvet-experts.org/doc_end_user/current_document.php?id=15491) EE1 related: Improved VLOP with Attention [Y. Li, L. Kerofsky, M. Karczewicz (Qualcomm)]

A unified filter architecture for the Low-performance Operation Point (LOP) was proposed in JVET-AE0165 and refined in JVET-AF0043. Updated training strategy and configuration were presented in JVET-AH0042. VLOP1 was derived from LOP in JVET-AH0051. VLOP3 with earlier cropping and reduced inputs were integrated in JVET-AJ0054 and JVET-AJ0066. In JVET-AK0150, VLOP3 with residual groups and spatial attention was proposed with a significant coding gain.

This contribution proposes an improvement of the VLOP with attention mechanism of JVET-AK0150. The improvements are with respect to the simplification of the model and the model training stability as well as the performance. The simulation was conducted by using the NNVC-12 reference software, training was performed by using the VLOP3 training strategy, and SADL int16 model was used for the inference.

Complexity of the proposed model for VLOP is 5.09 (block-wise) kMAC/pixel.

The proposed filter (Int16 model) with NNIntra enabled provides: {-0.5%, -0.7%, -0.7%} BD-rate change for AI test configuration, and {-0.5%, -1.1%, -0.4%} for RA test configuration, versus the VLOP3 int16 (NNIntra enabled).

Compared to the VTM, the proposed filter with NNIntra enabled provides: {-7.8%, -9.4%, -9.0%} for the AI configuration, and {-6.2%, -7.6%, -6.1%} for the RA configuration.

3x3 convolution instead of separable was re-introduced in the proposal to reduce number of stages and improving the convergence and stability in training. It also improves chroma gain. It was however commented that it might be more critical in terms of generating overflows.

Two stages with attention blocks (compared to four in LOP).

It was commented that also the aspect of performing cropping in the beginning for luma is interesting.

Generally, interesting gain for VLOP.

Investigate in EE1.

[JVET-AL0167](https://jvet-experts.org/doc_end_user/current_document.php?id=15492) EE1 related: Further simplification of VLOP with Attention [Y. Li, L. Kerofsky, M. Karczewicz (Qualcomm)]

A unified filter architecture for the Low-performance Operation Point (LOP) was proposed in JVET-AE0165 and refined in JVET-AF0043. Updated training strategy and configuration were presented in JVET-AH0042. VLOP1 was derived from LOP in JVET-AH0051. VLOP3 with earlier cropping and reduced inputs were integrated in JVET-AJ0054 and JVET-AJ0066. In JVET-AL0166, improved VLOP3 with residual groups and spatial attention was proposed with a significant coding gain.

This contribution proposes a simplification of the VLOP with attention mechanism of JVET-AL0166. The simplification is to remove the residual group to reduce the intermediate memory usage for holding the activations. The simulation was conducted by using the NNVC-12 reference software, training was performed by using VLOP3 training strategy but with a lower starting LR of 0.0002, and SADL int16 model was used for the inference.

Complexity of the proposed model for VLOP is 5.09 (block-wise) kMAC/pixel.

The proposed filter (Int16 model) with NNIntra enabled provides: {-0.3%, 0.0%, -0.4%} BD-rate change for AI test configuration, and {-0.2%, -0.0%, -0.3%} for RA test configuration, versus the VLOP3 int16 (NNIntra enabled).

It was commented that a drop of performance is experienced in classes C and D.

No specific action is requested, contribution mainly for information.

[JVET-AL0184](https://jvet-experts.org/doc_end_user/current_document.php?id=15509) EE1-related: Deep Reference Frame Generation for Inter Prediction Enhancement [D. Ding, X. Chen, Z. Chen (Wuhan Univ.)]

[JVET-AL0312](https://jvet-experts.org/doc_end_user/current_document.php?id=15639) Crosscheck of JVET-AL0184 (EE1-related: Deep Reference Frame Generation for Inter Prediction Enhancement) [Z. Xie (OPPO)] [late] [miss]

[JVET-AL0196](https://jvet-experts.org/doc_end_user/current_document.php?id=15521) AHG 11: Neural Network Coded Reference Frame for Intra Coding with Residual Coding and Intra Blocks [F. Brand, T. Solovyev, E. Alshina (Huawei)]

[JVET-AL0203](https://jvet-experts.org/doc_end_user/current_document.php?id=15528) [AHG11] A Hybrid Framework Integrating End-to-End Learned Image Codec with Conventional Codec [N. Zou, A. Hallapuro, F. Cricri, H. Zhang, M. M. Hannuksela (Nokia)]

[JVET-AL0230](https://jvet-experts.org/doc_end_user/current_document.php?id=15557) AhG11/AhG12: Performance of the NNVC ILF in ECM [D. Rusanovskyy, K. Panusopone, S. Hong, L. Wang (Nokia)]

See also sec. 5.2.4.4

[JVET-AL0243](https://jvet-experts.org/doc_end_user/current_document.php?id=15570) [AHG11] Multilayer framework for supporting a hybrid codec using End-to-End Learned Image Codec and Conventional Video Codec [F. Urban, Y. Chen, F. Galpin, E. François (InterDigital)] [late]

[JVET-AL0250](https://jvet-experts.org/doc_end_user/current_document.php?id=15577) AHG11: Cross-component enhanced NNSR [T. Yang, W.-X. He, Y.-Q. Zhu, J.-D. Ye, X.-T. Xie, J.-S. Gong, Q. Liu (HUST), Z.-Y. Lv (vivo)] [late]

[JVET-AL0291](https://jvet-experts.org/doc_end_user/current_document.php?id=15618) EE1-related: Recommendations for resolving mismatches between LOP5 description and implementation [N. Le, F. Cricri (Nokia)] [late]

### SADL and NNVC implementation, CTC (2)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0100](https://jvet-experts.org/doc_end_user/current_document.php?id=15425) AHG14: The extension of SADL library [W. Ma, N. Fu, W. Bao, Z. Chen (Wuhan Univ.)]

[JVET-AL0265](https://jvet-experts.org/doc_end_user/current_document.php?id=15592) AhG14: SADL update [F. Galpin (InterDigital)] [late]

## AHG6/AHG12: Enhanced compression beyond VVC capability (76)

### Summary and BoG reports (1)

Contributions in this area were discussed during 1300–1515 and 1535–1740 on Thursday 27 March 2025, and during 0500–0625 on Friday 28 March 2025 (all chaired by JRO).

[JVET-AL0024](https://jvet-experts.org/doc_end_user/current_document.php?id=15402) EE2: Summary report of exploration experiment on enhanced compression beyond VVC capability [V. Seregin, J. Chen, R. Chernyak, K. Naser, J. Ström, F. Wang, M. Winken, X. Xiu, K. Zhang (EE coordinators)]

**List of tests**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Partitioning** | | | |
| 1.1a | Set MaxTTChromaISlice to 64 | P.-H. Lin  (Qualcomm) | R.-L. Liao  (Alibaba) |
| 1.1b | Chroma partition prediction | P.-H. Lin  (Qualcomm) | R.-L. Liao  (Alibaba) |
| 1.1c | Test 1.1a + Test 1.1b | P.-H. Lin  (Qualcomm) | C.-W. Kuo (Kwai) |
| 1.1d | Test 1.1a + Test 1.1b with non-normative variant | P.-H. Lin  (Qualcomm) | C.-W. Kuo (Kwai) |
| **2 Intra prediction** | | | |
| 2.1 | EIP filters with diagonal shapes | K. Panusopone (Nokia) | Z. Xie  (OPPO) |
| 2.2a | Constraints to CCPmerge modes | Y.-J. Chang  (Qualcomm) | J. Lainema  (Nokia) |
| 2.2b | Constraints to CCP modes | Y.-J. Chang  (Qualcomm) | J. Lainema  (Nokia) |
| 2.2c | Encoder only changes (Test 2.2a + Test 2.2b + SATD optimization) | Y.-J. Chang  (Qualcomm) | H. Huang  (OPPO) |
| 2.2d | Test 2.2a + Test 2.2b + Test 2.2c (SATD optimization) | Y.-J. Chang  (Qualcomm) | H. Huang  (OPPO) |
| 2.3 | CCP merge mode with adjustment | Y. Wang  (Bytedance) | C. Ma  (Kwai) |
| 2.4 | Block vector guided EIP | Z. Xie  (OPPO) | K. Panusopone (Nokia) |
| 2.5 | Flip-aware BV prediction in SGPM | J. Huo  (Xidian Univ.) | X. Li  (Alibaba) |
| 2.6a | On handling of Planar mode in MPM list | G.Wang  (vivo) | J. Fu  (PKU) |
| 2.6b | Additional DIMD blending modes in MPM list | G.Wang  (vivo) | Y. Liu  (Transsion) |
| 2.6c | Test2.6a+Test2.6b | G.Wang  (vivo) | J. Fu  (PKU)  Y. Liu  (Transsion) |
| 2.7 | Block vector guided DIMD | L. Zhang  (OPPO) | Y. Wang  (Bytedance) |
| 2.8a | Subblock-based CCCM | F. Pu  (Dolby) | withdrawn |
| 2.8b | Subblock-based CCCM without TU splitting | F. Pu  (Dolby) | withdrawn |
| 2.9 | Test 2.1 + Test 2.4 | K. Panusopone (Nokia)  Z. Xie  (OPPO) | P. Andrivon  (Ofinno) |
| 2.10 | Multiple filter taps for EIP | Z. Lyu  (vivo) | Z. Deng  (Bytedance) |
| 2.11 | Test 2.4 + Test 2.10 | Z. Xie  (OPPO)  Z. Lyu  (vivo) | Z. Deng  (Bytedance) |
| 2.12 | Non-adjacent DIMD for TMRL | V. Rufitskiy  (TCL) | withdrawn |
| **3** **Inter prediction** | | | |
| 3.1 | Subblock based spatial MVP | Z. Deng  (Bytedance) | Z. Lyu  (vivo)  S. Iwamura (NHK) |
| 3.2 | Extension on spatial and temporal merge candidates | J.-L. Lin  (Qualcomm) | L. Zhang (OPPO) |
| 3.3a | Additional spatial merge candidates | N. Zhang  (Bytedance) | X. Li  (Alibaba) |
| 3.3b | Additional pairwise-average merge candidates | N. Zhang  (Bytedance) | X. Li  (Alibaba) |
| 3.3c | Additional multiple-average merge candidates | N. Zhang  (Bytedance) | X. Li  (Alibaba) |
| 3.3d | Test 3.3a + Test 3.3b + Test 3.3c | N. Zhang  (Bytedance) | X. Li  (Alibaba) |
| 3.3e | Test 3.3d + Test 3.2 | N. Zhang  (Bytedance)  J.-L. Lin  (Qualcomm) | L. Zhang  (OPPO) |
| 3.4a | Joint GPM split modes and partition indices reordering | C. Ma  (Kwai) | J. Chen  (Alibaba) |
| 3.4b | Test 3.4a + replacing the existing GPM reordering scheme | C. Ma  (Kwai) | J. Chen  (Alibaba) |
| 3.5 | On affine motion compensation | H. Huang  (Qualcomm) | C. Ma  (Kwai) |
| 3.6 | MV refinement for TMVP | Z. Zhang  (Qualcomm) | Z. Deng  (Bytedance) |
| 3.7a | 4-tap interpolation filter set 0 for template matching | Z. Dai  (Alibaba) | L. Xu  (OPPO) |
| 3.7b | 4-tap interpolation filter set 1 for template matching | Z. Dai  (Alibaba) | L. Xu  (OPPO) |
| 3.7c | 4-tap interpolation filter set 0 for bilateral matching and DMVR | Z. Dai  (Alibaba) | L. Xu  (OPPO) |
| 3.7d | 4-tap interpolation filter set 1 for bilateral matching and DMVR | Z. Dai  (Alibaba) | L.Xu  (OPPO) |
| 3.8a | CMVP extension for constructed affine merge candidates with additional candidates | C. Li  (Alibaba) | L. Zhao (Bytedance) |
| 3.8b | CMVP extension for constructed affine merge candidates with no additional candidates | C. Li  (Alibaba) | L. Zhao (Bytedance) |
| 3.9 | Extended BDOF usage for MV refinement | R. Yu  (Qualcomm) | Y. Wang  (Bytedance) |
| 3.10a | OBMC modifications for GPM | R. Yu  (Qualcomm) | withdrawn |
| 3.10b | OBMC operation order of blocks and subblocks | R. Yu  (Qualcomm) | withdrawn |
| 3.10c | Test 3.10a + Test 3.10b | R. Yu  (Qualcomm) | withdrawn |
| **4** **Transform and coefficients coding** | | | |
| 4.1 | Advanced SBT | G. Laroche  (Canon) | Y. Zhang  (Qualcomm) |
| 4.2a | Advanced SBT with simplified search method | Y. Zhang  (Qualcomm) | G. Laroche  (Canon) |
| 4.2b | Combination test of Test 4.1 and Test 4.2a | Y. Zhang  (Qualcomm)  G. Laroche  (Canon) | L. Zhao (Bytedance) |
| 4.3a | On TS binarization and context bin budget management | M. Abdoli  (Xiaomi) | P. Astola  (Nokia) |
| 4.3b | Test 4.3a on very high bitrate (QP 2-7-12-17) | M. Abdoli  (Xiaomi) | P. Astola  (Nokia) |
| 4.3c | Test 4.3b with no context coded bin constraint on TS | M. Abdoli  (Xiaomi) | P. Astola  (Nokia) |
| 4.4a | Using the second NSPT set for IntraNN | G. Verba (Qualcomm) | T. Dong, V. Rufitskiy (TCL) |
| 4.4b | Retraining NSPT kernels | G. Verba (Qualcomm) | T. Dong, V. Rufitskiy (TCL) |
| 4.4c | Test 4.4a + Test 4.4b | G. Verba (Qualcomm) | M. Abdoli  (Xiaomi) |
| 4.4d | Test 4.4c + increase the number of output coefficients for NSPT | G. Verba (Qualcomm) | M. Abdoli  (Xiaomi) |
| **5 In-loop filtering** | | | |
| 5.1 | ALF-CCCM | P.Astola (Nokia) | R. G. Youvalari (Xiaomi) |
| 5.2 | CCSAO with reused CTU control | C.-W. Kuo (Kwai) | W. Yin  (Bytedance) |
| 5.3a | Cross-chroma input for chroma-ALF | W. Yin  (Bytedance)  C. Ma  (Kwai) | N. Hu  (Qualcomm) |
| 5.3b | Cross-chroma input for CC-ALF | W. Yin  (Bytedance)  C. Ma  (Kwai) | N. Hu  (Qualcomm) |
| 5.3c | Test 5.3a + Test 5.3b | W. Yin  (Bytedance)  C. Ma  (Kwai) | N. Hu  (Qualcomm) |
| 5.4 | NN-based luma ILF with ALF | Y. Li (Qualcomm) |  |
| **6 Other** | | | |
| 6.1 | Adaptive picture-level vertical mirroring | D. Mieloch (PUT) | M. Abdoli  (Xiaomi) |

**Description of tests**

***Partitioning***

**Test 1.1: Chroma partition prediction in separate tree condition (**[**JVET-AL0143**](https://jvet-experts.org/doc_end_user/current_document.php?id=15468)**)**

In this test, a chroma partition prediction method is evaluated for separate tree condition. It includes two aspects:

* Set the partition parameter MaxTTChromaISlice to 64 (currently it is set to 32)
* Disable some splits of a chroma block by the decoded luma region. For each chroma CTU, average luma BT depth, average luma MTT depth and non-squared blocks ratio are calculated from all the blocks in the collocated luma CTU. Splits of a chroma block are disallowed by the following conditions:
  + If BTdepthcurr > BTdepthlumaavg + BTdiff – 1, the TT splits of this block are disabled
  + If MTTdepthcurr + BTdiff < MTTdepthlumaavg and MTTdepthcurr is equal to 0, the TT splits of this block are disabled
  + If MTTdepthcurr + BTdiff < MTTdepthlumaavg, MTTdepthcurr is equal to 0 and ratiow>h/ratioh>w of luma blocks in collocated luma CTU is larger than half, the vertical/horizontal BT split is disabled

where BTdiff is the difference of luma and chroma maximum BT size in logarithmic scale.

Test 1.1a: Set MaxTTChromaISlice to 64.

Test 1.1b: Chroma partition prediction.

Test 1.1c: Test 1.1a + Test 1.1b.

Test 1.1d: Test 1.1a + Test 1.1b (encoder only).



Among the variants, test 1.1c comes with a small gain (which is combination of a and b) . It was asked why the decoding time is reduced. According to proponents, this is likely due to disallowing less certain splits in partitioning, which also causes less encoder checks. Test a has large encoding run time increase, and also larger gain relative to c, which in the combination with test b which makes the run time decrease.

Decision: Adopt JVET-AL0143 test 1.1.c.

***Intra prediction***

**Test 2.1: EIP filters with diagonal shapes (**[**JVET-AL0205**](https://jvet-experts.org/doc_end_user/current_document.php?id=15530)**)**

In ECM, three EIP filter shapes are supported shown in the figure below. In all three EIP filter shapes, their support areas only cover samples above and to the left of the predicting sample.

A screenshot of a game

AI-generated content may be incorrect.

In the test, EIP filters with diagonal shapes including samples above-right and below-left of the predicting sample in their support areas shown in the next figure are evaluated.

X

X

X

X

X

O

X

X

X

X

X

X

X

X

X

X

X

X

X

X

O

X

X

X

X

X

X

X

X

X

X

X

X

X

X

X

O

input of EIP

output of EIP

X

X

X

X

X

X

X

O

X

X

Test 2.1: EIP filters with diagonal shapes.

**Test 2.4: Block vector guided EIP (**[**JVET-AL0106**](https://jvet-experts.org/doc_end_user/current_document.php?id=15431)**)**

In the test, a block vector shown in the figure below, which is derived from the sparse searching process of IntraTMP in ECM, is used to determine the reference area for calculating the EIP filter parameters instead of directly using the adjacent spatial reconstructed area and BV EIP mode is coded as a sub-mode of EIP with a flag. Only square filter shape is allowed for the sub-mode.

A diagram of a diagram

AI-generated content may be incorrect.

Test 2.4: Block vector guided EIP

**Test 2.9: Combination of Test 2.1 and Test 2.4 (**[**JVET-AL0206**](https://jvet-experts.org/doc_end_user/current_document.php?id=15531)**)**

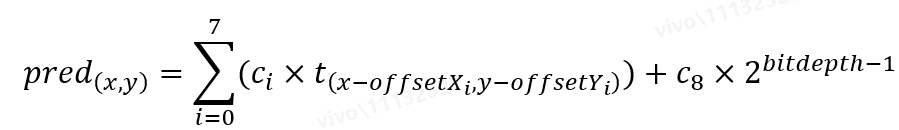
In the test, EIP filters with diagonal shapes replace the ones in ECM-16.1 and block-vector guided EIP is working as a sub-mode of regular EIP.

Test 2.9: Test 2.1 + Test 2.4

**Test 2.10: Multiple filter taps for EIP (**[**JVET-AL0124**](https://jvet-experts.org/doc_end_user/current_document.php?id=15449)**)**

In the test, two filter taps are supported and the index indicating which filter tap is used is signalled. The EIP mode in ECM uses a 15-tap filter and another 9-tap filter was applied to multi-model EIP only and is only applied to block whose area is larger than or equal to 64, and smaller than or equal 256.

For EIP mode using 9-tap filter, the prediction is calculated as follows:



Test 2.10: Multiple filter taps for EIP.

**Test 2.11: Combination of Test 2.4 and Test 2.10 (**[**JVET-AL0107**](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0107-v1.zip)**)**

In the test, BV guided EIP method only allows single-model EIP filter with square-shape, and the method of using multiple filter taps is only applied to multi-model EIP candidates.

Test 2.11: Test 2.4 + Test 2.11.

**Test 2.2: On cross-component intra prediction (**[**JVET-AL0191**](https://jvet-experts.org/doc_end_user/current_document.php?id=15516)**)**

This test evaluates different constraints to CCP and CCPmerge modes to improve the performance trade-off.

Since the CCPmerge list is constructed and reordered by template costs, the first candidate with the lowest template cost can contribute more gains.

In Test 2.2a, the CCPmerge fusion is restricted to use only the first CCPmerge candidate, where the fusion flag is only signalled if the first candidate is used.

In ECM, there are two types of CCP modes, i.e., single model and multi-model, and three types of templates, i.e., top-only template, left-only template, and top-and-left template. The constraints for CCP modes are tested by disabling either multi-model or single-model, and/or disabling the templates among top-only template, left-only template, and top-and-left template.

In Test 2.2b, the included constraints for CCP modes are listed as follows, where signalling is modified to exclude those modes if the disabling condition is satisfied:

* Multi-model CCCMwMDF mode is disabled if template is top-only and left-only
* Multi-model GLCCCM mode is disabled if template is top-only and left-only
* GLM mode is disabled if template is top-only template

In Test 2.2c, a mode candidate list is constructed at encoder by evaluating SATD/SAD cost (similar encoder process is used for intra modes evaluation for luma component) for intra chroma modes, and up to 27 candidates (based on the cost difference between a candidate and the first candidate) with the smallest cost are selected to perform full rate-distortion optimization. Additionally, it also uses mode selection from tests 2.2a and 2.2b but without any signalling restriction.

Test 2.2a: Constraints to CCPmerge modes

Test 2.2b: Constraints to CCP modes

Test 2.2c: Encoder only changes (Test 2.2a + Test 2.2b + SATD)

Test 2.2d: Test 2.2a + Test 2.2b + Test 2.2c (SATD optimization)

**Test 2.3: CCP merge mode with adjustment (**[**JVET-AL0126**](https://jvet-experts.org/doc_end_user/current_document.php?id=15451)**)**

CCP merge mode with adjustment is tested, in which a CCP model is updated using a template comprising of neighbouring samples of the current block. If the CCP model is a CCCM model as formulated in (1), the first parameter *c*0 and other parameters will be updated using an adjustment parameter *u* as in (2), where *decimBits* denotes the decimal precision in CCCM.

predChromaVal = *c*0C + *c*1N + *c*2S + *c*3E + *c*4W + *c*5P + *c*6B (1)

*c*’0 = *c*0 + (*u* << (*decimBits* – *shift*)) (2)

The optimal *u* is determined from a pre-defined set according to the SAD costs by applying the updated CCP model to the template.

In the test, the pre-defined set of *u* is {–7, –5, –3, –1, 1, 3, 5, 7} and *shift* is set equal to five. When CCP merge mode is used, a flag is signaled to indicate whether the method is applied or not. If used, the CCP merge candidate list is constructed only including CCCM models and its variants (e.g., Gradient and location based CCCM, CCCM using non-downsampled luma samples, CCCM with multiple downsampling filters), and an additional flag is signaled to indicate whether to adjust other parameters.

**Test 2.5: Flip-aware BV prediction in SGPM (**[**JVET-AL0188**](https://jvet-experts.org/doc_end_user/current_document.php?id=15513)**)**

In ECM, the IBC-RRIBC flip type is inherited in IBC, DBV, and BVG-CCCM modes, and a flip-aware BV adjustment (motion shift is added to a block vector candidate obtained from a neighbouring block according to a symmetric rule) approach is applied to refine the block vector candidate. BV based prediction is also used in combination with SGPM, when the merge candidates (adjacent and non-adjacent blocks) with block vectors are constructed. However, as shown in the next table, the IBC-RRIBC flip type is not inherited from merge BV candidates and a flip-aware BV adjustment approach is not applied to refine the block vector candidate in SGPM.

Inheritance of IBC-RRIBC flip type in different modes

|  |  |
| --- | --- |
| Mode | Whether to inherit IBC-RRIBC flip type and apply flip-aware BV adjustment |
| IBC | Yes |
| DBV | Yes |
| BVG-CCCM | Yes |
| SGPM | No |

In the test, IBC-RRIBC flip type is inherited from a merge candidate for SGPM and flip-aware BV adjustment approach is applied to refine the block vector candidate. Correspondingly, when RRIBC is applied (flip type > 0), the samples in a prediction block based on BV are flipped according to the flip type of the current block, which is similar to the case of IBC, DBV, BVG-CCCM modes.

Test 2.5: Flip-aware BV prediction in SGPM.

**Test 2.6: Improvement on MPM (**[**JVET-AL0125**](https://jvet-experts.org/doc_end_user/current_document.php?id=15450)**)**

In ECM, in MPM list construction, the first entry is always the Planar mode, the remaining entries are composed of the intra modes of the left (L), above (A), below-left (BL), above-right (AR), and above-left (AL) neighbouring blocks, DIMD modes, and the intra modes of non-neighbouring blocks.

In the test, the following MPM modification aspects are included:

1. Planar mode is conditionally added to the MPM list, if a current CU satisfies the IntraNN enabling condition, the Planar mode will not be placed in the first position in the MPM list.
2. In the MPM list filling process, more DIMD modes are added and placed at the top of the MPM list, and besides DIMD mode, two dimdBlendModes are added instead of one.

Test 2.6a: On handling of Planar mode in MPM list.

Test 2.6b: Additional DIMD blending modes in MPM list.

Test 2.6c: Test 2.6a + Test 2.6b.

**Test 2.7: Block vector guided DIMD (**[**JVET-AL0108**](https://jvet-experts.org/doc_end_user/current_document.php?id=15433)**)**

In the test, BV is used to located neighbouring samples for DIMD intra modes derivation. This mode is indicated by a flag as a sub-mode of DIMD.

Up to 5 block vectors are obtained by a searching process similar to IntraTMP. To reduce complexity, the process of obtaining BVs and deriving intra modes is modified as follows:

1. After sparse search and obtaining merge candidates, only the best BV candidate is used for further refinement search instead of using 30 candidates as in IntraTMP;
2. A template cost threshold is set proportional to the minimum template cost, and BVs with template costs above the threshold will not be used to build HoG and prediction;
3. The reference area is sub-sampled to derive intra modes when the current block size is equal to or greater than 128.

With each block vector, a reference area in the current picture is determined as shown in the next figure and its samples are used to derive the intra modes and corresponding amplitudes.

Two intra modes with the highest amplitudes are selected from the HoG and the prediction of the current block is the blending of those 2 predictors and a non-directional predictor. These two intra modes are also used to select the transform set when using the multiple transform set selection method. The non-directional predictor is the blending of up to 5 BV-based predictors obtained using the block vectors.

A diagram of a graph and direction

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Encoder optimization is also performed for the method considering SATD cost to whether include the mode into full RD check.

Test 2.7: Block vector guided DIMD



Test 2.9 was supported by various experts, including crosschecker. The change is asserted to be straightforward, and the benefits of 2.1 and 2.4 are additive in 2.9. the additional test 2.10 (multiple filter taps) does not have a good tradeoff, and in combination with the other two tests (2.11) has less gain than 2.9.

Decision: Adopt JVET-AL0206 test 2.9

Tests 2.2x target encoder run time decrease by constraining and/or performing less RD checks in the context of CCP merge. Tests 2.2c and 2.2d have attractive tradeoff (small loss, but >4% encoder time reduction, test d a bit more). Even though it could be asserted that most run time reduction comes from the SATD optimization, and using that as a non-normative change rather than never using signalling of the modes which are constrained in a and b (as done in c), or introducing a syntax change (as done in d), such a test had not been requested, and in general from the results available, test d is supported by several experts as being the most attractive variant.

Decision: Adopt JVET-AL0191 test 2.2d.

Test 2.3 has some gain both in luma and chroma without on impact on encoding and decoding time. The refinement is computed on the template, but no additional RD check necessary. It is asserted that there would be no interference with the encoder optimization in 2.2, as the SATD optimization would not beused in that additional step.

Decision: Adopt JVET-AL0126 test 2.3.

Test 2.5 extends the flip-aware BV adjustment to SGPM. Though it gives only small gain for screen content with a small increase of encoder run time, this is supported for consistency by one independent expert, and also by cross-checker. The template needs also to be flipped, but according to the original proponents of SGPM, this seems to be implemented efficiently (by reading samples in reverse order), as the run time increase is relatively low.

Decision: Adopt JVET-AL0188 test 2.5

Test 2.6x is supported by several experts (including crosscheckers) as it has small gain without much impact on runtime, and is asserted as a straightforward modification of MPM list modification. The combination test 2.6c indicates that the gains of the two elements are additive.

Decision: Adopt JVET-AL0125 Test 2.6c

Test 2.7 is supported by several experts as being straightforward and having similar tradeoff as other adopted proposals.

Decision: Adopt JVET-AL0108 Test 2.7

***Inter prediction***

**Test 3.1: Subblock-based spatial MVP (**[**JVET-AL0160**](https://jvet-experts.org/doc_end_user/current_document.php?id=15485)**)**

In ECM, up to 51 SbTMVP and affine candidates can be inserted into the subblock-based merge mode candidate list. After template-based reordering, 20 of these candidates are sorted out for the final merge index signalling.

In the test, subblock-based spatial MVP is included to derive the subblock motion field from spatial neighbour blocks. Possible 5 directions of the new candidates, where MVs of subblocks are inherited in a directional way, are shown in the figure below.

Up to 5 subblock-based spatial MVP candidates are added after SbTMVP candidates and before affine merge candidates. All the subblock motion candidates are reordered in the same way as in ECM and the amount of the final candidates is not changed.

If a subblock-based spatial MVP candidate is selected, the motion data, such as motion vectors, reference indices, and prediction direction, of the corresponding neighbouring subblocks is copied to the current subblocks along a predefined direction, as depicted in the next figure.

A grid of white squares with black text

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AI-generated content may be incorrect. A grid of white squares with black text

AI-generated content may be incorrect.

A screenshot of a grid

AI-generated content may be incorrect. A grid of squares with black text

AI-generated content may be incorrect.

Examples of subblock-based spatial MVP candidate types (MVs are inherited along the direction of horizontal, vertical, diagonal-top-left, diagonal-bottom-left and diagonal-top-right).

Test 3.1: Subblock based spatial MVP.

**Test 3.2: Extension on spatial and temporal merge candidates (**[**JVET-AL0151**](https://jvet-experts.org/doc_end_user/current_document.php?id=15476)**)**

In the test, additional spatial and temporal merge candidates along the CU boundary are included into merge candidate list. The positions relative to current block which are used to derive the spatial and temporal merge candidates are shown in the next figure. The additional spatial merge candidates are added into the list after adjacent spatial merge candidates and before non-adjacent spatial merge candidates. The additional temporal merge candidates are added into the list after existing temporal candidates.

|  |  |
| --- | --- |
| A black grid with blue lines  AI-generated content may be incorrect. | A black background with blue lines  AI-generated content may be incorrect. |
| spatial merge candidates | temporal merge candidates |

Test 3.2: Extension on spatial and temporal merge candidates.

**Test 3.3: Additional inter merge candidates (**[**JVET-AL0157**](https://jvet-experts.org/doc_end_user/current_document.php?id=15482)**)**

In the test, additional spatial, pairwise-average, and multiple-average candidates are introduced.

As shown in the figure below, an above-middle spatial candidate is fetched from the neighbouring block B3 or B4, and a left-middle spatial candidate is fetched from the neighbouring block A2 or A3.

Besides, pairwise candidates in the pairwise merge list can be derived with any two candidates in the initial merge candidate list after the first round of ARMC.

A black grid with blue lines

AI-generated content may be incorrect.

Additionally, multiple-average motion candidates are added after the pairwise-average motion candidates. When four candidates with the same reference picture in the reference picture list LX are available, the MV in the reference picture list LX of the multiple-average motion candidate denoted as mvLX is calculated as:

mvLX = (mvLX\_A + mvLX\_B + mvLX\_C + mvLX\_D) >>2,

wherein mvLX\_A, mvLX\_B, mvLX\_C, and mvLX\_D are MVs of the four candidates.

The multiple-average motion candidates are only introduced for non-low delay pictures.

Test 3.3a: Additional spatial merge candidates

Test 3.3b: Additional pairwise-average merge candidates

Test 3.3c: Additional multiple-average merge candidates

Test 3.3d: Test 3.3a + Test 3.3b + Test 3.3c

Test 3.3e: Test 3.2 + Test 3.3d

**Test 3.4: Joint reordering of GPM split modes and partition indices (**[**JVET-AL0134**](https://jvet-experts.org/doc_end_user/current_document.php?id=15459)**)**

In the test, split modes and partition indexes for the GPM modes, including the regular GPM and GPM-TM, are jointly reordered using template matching. When the method is applied, for each CU that is coded with GPM or GPM-TM modes, a candidate list is built with each entry containing one split mode and the MVs of the two GPM partitions. The candidate list is reordered using the template-based scheme and the selected split/motion pair is signalled to decoder.

In Test 3.4a, one additional flag is introduced to indicate whether the scheme is applied to each GPM CU. If the flag is true, one index is further signalled to indicate the selected candidate in the reordered candidate list.

In Test 3.4b, the existing GPM reordering is replaced with the scheme such that no extra signalling is needed.

Test 3.4a: Joint GPM split modes and partition indices reordering.

Test 3.4b: Test 3.4a replacing the existing GPM reordering scheme.

**Test 3.5: On affine motion compensation (**[**JVET-AL0079**](https://jvet-experts.org/doc_end_user/current_document.php?id=15404)**)**

In ECM, when an affine coded block meets the BDOF condition, BDOF is applied to the subblocks. Otherwise, regular MC is performed with adaptive subblock size. If OBMC flag is true, subblock size starts from 4x4, otherwise (OBMC flag is false) the subblock size starts from 1x1, i.e. per-pixel based. PROF is performed if the subblock size is larger than 4x4.

In the test, per-pixel based motion compensation is performed for affine coded block regardless of the OBMC flag. The inner subblock OBMC is skipped if per-pixel based motion compensation is performed. When an affine coded block meets the BDOF condition, affine BDOF is applied to the block and per-pixel based affine motion compensation is not performed.

Test 3.5: Per-pixel affine motion compensation.

**Test 3.6: MV refinement for TMVP (**[**JVET-AL0214**](https://jvet-experts.org/doc_end_user/current_document.php?id=15541)**)**

In the test, MV refinement is performed to TMVP. The refinement process is to find an MV in a reference picture (CurRefPic) which has the minimum SATD cost between a reference template in the CurRefPic and the collocated template (ColTmpl) in the collocated picture (ColPic). The size of ColTmpl is up to 16x16, which is derived from grouping similar 4x4 blocks surrounding the collocated block (ColBlk) in ColPic.

The refinement starting point (ColScaledMv) is derived from the collocated MV (ColMv) in the collocated reference picture (ColRefPic) with scaling. The scaling factor is (CurRefPoc – ColPoc) / (ColRefPoc – ColPoc).

When CurRefPic is between ColPic and ColRefPic, the search area consists of { ColBlk position, ColBlk position + ColMv }, otherwise, the search area is around ColBlk position + ColScaledMv with the search range { -SR, SR }, where SR is set to (ColMv – ColScaledMv) if ColRefPic is between CurRefPic and ColPic, otherwise, SR is set to ColScaledMv.

Next figures show two examples of deriving the refined MV (RefinedColScaledMv) in CurRefPic.





When ColBlk has two MVs, it derives each RefinedColScaledMv independently. TMVP MV is derived from RefinedColScaledMv with scaling, wherein, the scaling factor is (CurRefPoc – CurPoc) / (CurRefPoc – ColPoc).

Test 3.6: MV refinement for TMVP.

**Test 3.7: On interpolation filter for template matching (**[**JVET-AL0161**](https://jvet-experts.org/doc_end_user/current_document.php?id=15486)**)**

In ECM, a 2-tap bilinear interpolation filter with 8-bit coefficient precision is applied in the template matching based tools (e.g., TM-AMVP, TM-MRG, ARMC-TM, TM-OBMC, TM-MMVD, …) to generate the fractional samples. Additionally, the 2-tap bilinear interpolation filter is applied in the bilateral matching and DMVR with 4-bit coefficient precision.

In the test, the 2-tap bilinear interpolation filter in the template matching based tools, bilateral matching and DMVR is replaced with a 4-tap interpolation filter and two sets of DCT-based interpolation filters were tested. The first filter (set 0) is sampled from the 4-tap interpolation filter on chroma components in motion compensation in VVC. The second filter (set 1) is sampled from the 4-tap filter for intra template prediction.

Test 3.7a: 4-tap interpolation filter set 0 for template matching.

Test 3.7b: 4-tap interpolation filter set 1 for template matching.

Test 3.7c: 4-tap interpolation filter set 0 for bilateral matching and DMVR.

Test 3.7d: 4-tap interpolation filter set 1 for bilateral matching and DMVR.

**Test 3.8: CMVP extension for constructed affine merge candidates (**[**JVET-AL0162**](https://jvet-experts.org/doc_end_user/current_document.php?id=15487)**)**

In ECM, affine candidates are generated from adjacent and non-adjacent neighbours. The motion information of three adjacent vertices as well as TMVP or three non-adjacent vertices are utilized to derive CPMVs of the current CU.

In the test, chained motion vector prediction (CMVP) is introduced to construct affine merge candidates.

As shown in next figure, taking CMVP for constructed adjacent affine candidates as example, the traced motion of the top-right (MV4) and bottom-left (MV5) positions can be derived as the accumulation of source MVs (MV0, MV1) and MVs (MV2) or BVs (MV3). A similar process is repeated to derive the traced motion of the left-top position and temporal MV. The four traced MVs can thus construct additional affine candidates using the existing method in ECM.

A screenshot of a computer screen

AI-generated content may be incorrect.

Regarding the constructed non-adjacent affine candidates, the same method is applied to the motion information of the three non-adjacent positions. The extension of CMVP for constructed non-adjacent affine candidates is only applied to LDB configuration.

CMVPs are derived for unidirectional MVs, so CMVPs are traced to construct affine candidates for MVs of adjacent or non-adjacent positions from List 0 following the MVs from List 1.

In Test 3.8a, the affine merge candidate list is augmented with two additional candidates and the tested CMVP for affine is applied for the blocks whose width and height are both larger than or equal to 8.

In Test 3.8b, no additional candidates are added, where final size of the affine merge candidates list after ARMC remains unchanged.

Test 3.8a: CMVP based constructed affine merge candidates with additional candidates.

Test 3.8b: CMVP based constructed affine merge candidates without additional candidates.

**Test 3.9: Extended BDOF usage for MV refinement (**[**JVET-AL0081**](https://jvet-experts.org/doc_end_user/current_document.php?id=15406)**)**

In ECM, BDOF usage has been extended to be applicable for bi-predictive inter blocks with reference pictures from the same direction. The extended BDOF is used for adjusting luma prediction sample values for inter blocks as well as for refining MVs for affine blocks.

In the test, BDOF usage is further extended to refine MVs for regular inter merge blocks with reference pictures from the same direction.

Test 3.9: Extended BDOF usage for MV refinement

Test 3.1 is supported by several experts (including crosscheckers), results are confirmed and gain/tradeoff is attractive in particular for LB.

Decision: Adopt JVET-AL0160 test 3.1

3.2 and 3.3x are targeting improvements by adding more spatial merge candidates. The combination 3.3e is supported by several experts as being the most attractive variant (slightly higher gain in RA compared to the combination 3.3d, the latter is without test 3.2). In general, the different elements are mostly additive in gain, where some of the seem to be better contributing to RA, others to LB, such that in the end the tradeoff in both settings is attractive.

Decision: Adopt JVET-AL0157 test 3.3e

Several experts supported the adoption of test 3.4a, as it uses a similar method as SGPM and gives attractive gain in RA. Replacing the existing reordering (3.4b) does not provide benefit.

Decision: Adopt JVET-AL0134 test 3.4a

Test 3.5 applies pixel-based affine MC (except in some constrained cases). The tradeoff is attractive (small reduction of encoding time, and gain in both RA and LB). Confirmed by cross-checkers, and supported also by other experts.

Decision: Adopt JVET-AL0079 test 3.5

Test 3.6 improves the TMVP refinement, and gives attractive gain particular for LB (which may be explained by the fact that it is competing with a smaller number of refinement strategies in that case). Tradeoff with encoding time is good. According to crosscheckers, the method is straightforward to implement, and results match.

Decision: Adopt JVET-AL0214 test 3.6

Tests 3.7x are using 4-tap filters for template matching (variants c and d are using it only for DMVR and bilateral matching, therefore not applicable in case of LB, and also have almost no gain in RA). In terms of performance, filter sets 0 and 1 are almost identical (set 1 slightly better in RA), also complexity-wise there should be no difference. Encoding and decoding run times are increased, but the tradeoff with coding gain is still asserted as attractive. The additional usage of the 4-tap filter for DMVR and bilateral matching does not seem to give sufficient benefit, and would likely further increase the run time, as per tests c/d.

Decision: Adopt JVET-AL0161 test 3.7b

Test 3.8x constructs more affine candidates by using CMVP (chained MVs). 3.8a uses those as additional candidates, whereas 3.8b replaces some existing candidates. Gain is observed in both RA and LB. Method asserted as straightforward, and several proponents (including crosscheckers) supported 3.8a for its slightly better tradeoff.

Decision: Adopt JVET-AL0162 test 3.8a

Test 3.9 extends BDOF usage for MV refinement, which brings reasonable tradeoff for LB in particular, only very small gain in RA.

Decision: Adopt JVET-AL0081 test 3.9

***Transform and coefficient coding***

**Test 4.1: Advanced SBT with direction and position inference (**[**JVET-AL0181**](https://jvet-experts.org/doc_end_user/current_document.php?id=15506)**)**

In the test, the position and the direction of a subblock partition is derived for SBT in implicit manner without signalling, this mode is indicated by a flag and applied only to rectangular shape partitions. This mode can also be applied to SBT sub-partition. Implicit SBT TU is considered in the deblocking filter process.

For each subblock size and direction, the encoder evaluates the best position of the transform part (grey area) shown in the next figure. Then, based on the best position, the direction for each subdivision is determined. Eventually the encoder determines the best subdivision.

The position selected is the position of the subblock which maximizes the sum of gradients from the inter prediction. And regarding the direction (vertical or horizontal), the selected direction is the one that maximizes the sum of gradients of each best position.

A screenshot of a computer

AI-generated content may be incorrect.

To reduce complexity at encoder, early termination was added.

Test 4.1: Advanced SBT.

**Test 4.2a: Advanced SBT with simplified search method (**[**JVET-AL0227**](https://jvet-experts.org/doc_end_user/current_document.php?id=15554)**)**

In the test, the gradient search of Test 4.1 is modified , where the position with the maximum gradient values is identified first and local search around that position is performed instead of searching the whole TU as shown in the next figure.

A screen shot of a computer screen

AI-generated content may be incorrect.

The gradient value computation process is SIMD optimized, and a gradient padding is applied at block boundaries for the first and last rows/columns by repeating the gradient values from the nearest available row and column.

To reduce complexity at encoder, early termination was added.

Test 4.2: Advanced SBT with simplified search method.

**Test 4.2b: Combination test of Test 4.1 and Test 4.2a (**[**JVET-AL0229**](https://jvet-experts.org/doc_end_user/current_document.php?id=15556)**)**

In the combination test, the gradient padding and SIMD optimization from Test 4.2a is applied on top of Test 4.1.

Test 4.2b: Test 4.1 + Test 4.2a (gradient padding and SIMD optimization).

**Test 4.3: On coefficient level binarization in Transform Skip (**[**JVET-AL0158**](https://jvet-experts.org/doc_end_user/current_document.php?id=15483)**)**

The current residual coding scheme of Transform Skip (TS)-coded TUs consists of A) dividing the TU into Coefficient Groups (CGs) of size 4x4, B) scanning CGs following the diagonal scan order, C) scanning the quantized residual coefficients within each CG and coding them.

At the coefficient-level, the coding process is carried out based on one of two methods, namely *context-coding* and *Rice-coding*. The choice between the two methods is based on whether any context bin budget is left in a variable called m\_remainingContextBins. If there is still budget left, the typical binarization decomposes a coefficient level into a set of syntax element flags (i.e. coefficient significance flag, coefficient sign, gt1, parityFlag, gt2, gt4, gt6 and gt8) and codes them using CABAC contexts. Otherwise, (running out of context budget), the entire coefficient is coded in the Rice mode, without the above binarization scheme.

It is asserted that a shortcoming of the above process is that the context bin budget is determined at the TU-level and is progressively consumed while the CGs are coded in the scan order. This means that the first scanned CGs have higher priority for using CABAC contexts, while later scanned CGs are more likely to end up with no context bin budget left. The most severe case happens when the context bin budget is exhausted in a middle of CG, while the remaining CGs include several zero coefficients. In the absence of the significance flag, those zero coefficients go through bitrate-intensive Rice coding.

In the test, the binarization of residual coefficients in the TS is modified, such that the significance flags of TS-coded coefficients are always context-coded at the CG-level, the binarization of coefficient levels of TS is conditionally determined based on the context bin budget. Specifically, for each CG, if the context budget is not yet exhausted, the default binarization (i.e. sigFlag, gt1, parity flag, gtX) is used, as in the anchor. Otherwise, if the context budget is exhausted for the CG, the new binarization decomposes each coefficient level into significance flag and remaining level. Then the significance flag is context coded while the remaining level is Rice coded.

Test 4.3a: Significant flags are always context coded for TS.

Test 4.3b: Test 4.3a applied for QPs 2, 7, 12, 17

Test 4.3c: ECM-16.1 without context budget

**Test 4.4: IntraNN NSPT set (**[**JVET-AL0215**](https://jvet-experts.org/doc_end_user/current_document.php?id=15542)**)**

In ECM, NSPT kernel set is chosen based on the transform block size, prediction mode, intra mode and MTSS. NSPT primary kernel sets for each mode are summarized in the next table.

|  |  |  |  |
| --- | --- | --- | --- |
| NSPT sets | Set 1 | Set 2 | Set 3 |
| Prediction modes | Regular intra, PDP, SGPM, IntraNN | TIMD, DIMD, MIP, EIP | IntraTMP, inter |

In Test 4.4a, IntraNN-coded blocks are set to reuse the second kernel set, shared with TIMD-, DIMD-, MIP-, and EIP-coded blocks as shown in the table below.

|  |  |  |  |
| --- | --- | --- | --- |
| NSPT sets | Set 1 | Set 2 | Set 3 |
| Prediction modes | Regular intra, PDP, SGPM | TIMD, DIMD, MIP, EIP, IntraNN | IntraTMP, inter |

Test 4.4a: Using the second NSPT set for IntraNN.

Test 4.4b: ECM-16.1 with all NSPT kernels retrained.

Test 4.4c: Test 4.4a with all NSPT kernels are retrained.

Test 4.4d: Test 4.4a with the amount of output non-zero coefficients for NSPT is increased (less zero-out) for 4x8 (24), 4x16 (32), 8x32 (32) block shapes and all NSPT kernels are retrained.

In Tests 4.4b-d, the kernels are retrained specially for the configuration of each specific test, to ensure a better adaptation of the kernels.



Test 4.1 is more or less the continuation of last meeting’s EE, but with reduced encoder run time by early termination. Test 4.2a is adding another local search for the best partition position by a gradient method, which however has less attractive tradeoff. Test 4.2b simplifies the gradient computation by padding, omits the local search, combines and also reduces runtime by SIMD optimization. It was also tried to improve the consistency with the deblocking position, though this is still not yet perfectly aligned with the actual TU boundary (following the discussion in last meeting).

Test 4.1 is asserted to be best understood, as it is a slight modification of the method from last EE, now also giving acceptable tradeoff in encoding time. It is further asserted that a slightly better tradeoff of 4.2b (which includes 4.1 as well) comes by the SIMD implementation, such that the additional elements in 4.2b do not seem to provide much benefit (SIMD could also be applied to 4.1 and might improve run time, but this does not seem to be overly necessary to keep implementation simple)

Decision: Adopt JVET-AL0181 test 4.1

Test 4.3 targets to improve the performance of TS residual coding by modifying the method for limitation of context coded bins. This is effective only for screen content. Upon request made by the last meeting, also results at low QP was investigated, which was expected to demonstrate larger gain.

It was commented that, in contrast to the request in last meeting, the tests for low QP were not using a subsampling at every 8th frame, rather coding the first 100 frames of the sequences. The results still indicate the better gain in low QP, and also that the proposed limitation is relatively close to the case of giving up the budget (test 4.3c). It was remarked that the gain by giving up the budget is less than it was during VVC development, which may be due to the fact that better screen content tools are in ECM.

Some concern was raised by several experts that the actual budget limitation in the proposal is less restrictive as significance flag is always context coded independent of the limitation approach. It was asked which worst case number of context coded bins would occur when all coefficients would get a significance flag encoded? Another interesting information could be to know how the performance of the current ECM method would increase when the budget limitation was loosened. It would also be interesting to report the actual number of context coded bins for both the existing ECM method as well as the proposal (both for tests 4.3a and 4.3b). It should also be analysed/reported if cases of TUs would be found where the budget is exceeded (both overall as well as on sequence level). Revisit provided that additional information could be made available during the meeting.

Considering the fact that ECM is not a standard under development and a budget limitation is not of highest importance, more careful study is deemed to be useful. Without doubt, in a real standard such a budget limitation would need to be implemented, and from the results it is likely that better methods than the one currently used (carried over from VVC) can be designed.

Test 4.4 investigates usage of NSPT second set for NNIntra (test 4.4a), whereas currently set 1 is used. When using the existing kernels, the effect is marginal. However, when the sets are re-trained, it becomes more evident that set 2 is better suitable for NNIntra (test 4.4c), which has more visible gain compared to 4.4b where set 1 is used for NSPT.

Test 4.4d investigates the increase of non-zero coefficients on top of 4.4c, which however comes without a penalty of memory increase (as the number of kernels is decreased for some block sizes), but increases the number of multiplications (which causes the runtime increase).

The same training set and strategy was used as in previous NSPT training.

Overall, though having less coding gain compared to 4.4d, 4.4c is asserted to have the best tradeoff encoding runtime vs. performance. It also has less modifications relative to the current design. It was also commented that the additional modifications done in 4.4d are not well documented in the contribution.

Decision: Adopt JVET-AL0215 test 4.4c

It was suggested to further study 4.4d in the upcoming EE to achieve a better tradeoff. Proponents are requested to update the contribution such that the different elements can be better understood and more specific aspects to be studied in EE can be fomulated. Revisit.

* 1. ***In-loop filtering***

**Test 5.1: ALF-CCCM ([JVET-AL0153](https://jvet-experts.org/doc_end_user/current_document.php?id=15478))**

In the test, an additional cross-component filtering scheme is examined where cross-component filters are derived at the decoder-side as shown in the next figure. The method is not applied to I-slices.

A diagram of a block diagram

AI-generated content may be incorrect.

Each CTU is divided into non-overlapping blocks and for each block the cross-component filter coefficients are derived using SAO/CCSAO luma and chroma outputs. The convolution is applied on the SAO/CC-SAO luma output. To obtain a correction signal, the SAO/CC-SAO chroma samples are subtracted from the convolution output samples.

The correction is weighted by 0.5 and added to the ALF chroma output, the reconstruction becomes *chromaRec =* *alfChroma + ccAlf + 0.5\*cccmCorrection*.

The encoder decides the best block size for each CTU using a rate-distortion optimization (RDO) loop. There are eight possible blocks sizes 4x4, 8x2, 2x8, 8x8, 16x16, 32x32, 64x64, 128x128.

For each CTU, the encoder’s RDO decides the best cross-component model from eight possible models, they differ in the number of samples, non-linear term, and biases. The nonlinear and bias terms are the same as in the 7-tap CCCM model.

CCCM solver is used for deriving the filter coefficients. The 6-tap down sampling filter (used in CCCM and CCLM) is used for mapping the co-located luma into the chroma grid.

For inter configurations, a picture may inherit the block sizes and model types for all CTUs from a reference picture. The reference picture is derived from the L0 and L1 lists. Only reference pictures with ALF-CCCM present in at least one CTU are considered. The reference picture with the smallest POC distance to the current POC is selected. If activated, the picture level inheritance will skip the CTU-level signalling completely for the current picture.

Test 5.1: ALF-CCCM.

**Test 5.2: CCSAO with reused CTU control ([JVET-AL0142](https://jvet-experts.org/doc_end_user/current_document.php?id=15467))**

In ECM, band- and edge-based classifiers are supported for CCSAO. The encoder decides the best on/off control and classifier for each CTU, and signals the classifier parameters, offsets, and control information for each frame. Classifier parameters and offsets are stored for use in future frames. However, control information is not stored and cannot be reused for future frames.

In the test, CCSAO CTU control information of the current frame is stored and can be reused for future pictures, the control reuse for a picture is indicated by a flag.

At encoder, the decision on whether to reuse the CCSAO parameters and the CTU control information from a previous picture is made independently for each picture. Therefore, it does not introduce any additional latency.

Test 5.2: CCSAO with reused CTU control.

**Test 5.3: Cross-Chroma Input for Chroma-ALF and CC-ALF ([JVET-AL0135](https://jvet-experts.org/doc_end_user/current_document.php?id=15460))**

In the current design of chroma ALF, the filter shape includes a diamond 9×9 filter and a cross 5×5 filter, as shown in the next figure. The diamond 9×9 shape takes chroma reconstruction samples before ALF as input while the cross 5×5 shape takes the fixed-filter-output samples as inputs.

图示

低可信度描述已自动生成

In the current design of CC-ALF, the filter shape includes a cross 9×9 filter and two diamond 3×3 filters, as shown in the figure below. The cross 9×9 shape takes luma reconstruction samples before ALF as input, and the two-diamond 3×3 shapes take luma residual samples and chroma reconstruction samples before ALF as input, respectively.

图示

描述已自动生成

In the test, cross-chroma design is introduced into chroma ALF and CC-ALF, where Cb reconstructed samples can be used to filter Cr samples, while Cr reconstructed samples can also be used to filter Cb samples.

In Test 5.3a, the cross-chroma method is applied to chroma ALF and the modified filter shape is shown in the next figure. Additional taps take reconstruction samples before DBF of one chroma component as input to filter the other chroma component. Other filter taps are not changed.

图示

描述已自动生成

In Test 5.3b, the same strategy is applied to CC-ALF and the modified filter shape is shown in the figure below.

图示

描述已自动生成

No additional storage is required since chroma reconstruction samples before DBF have been already stored for the fixed filter of chroma ALF in ECM. The tested methods are always applied and there is no filter shape switching design.

Test 5.3a: Cross-chroma input for chroma ALF.

Test 5.3b: Cross-chroma input for CC-ALF.

Test 5.3c: Test 5.3a + Test 5.3b.

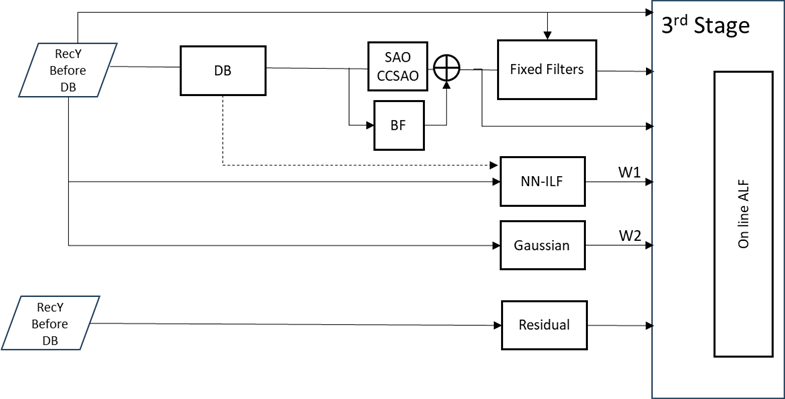
**Test 5.4: On the performance improvement of NN-based ILF in ALF ([JVET-AL0168](https://jvet-experts.org/doc_end_user/current_document.php?id=15493))**

NNVC VLOP architecture is shown in the next figure. In that design, Y, Cb and Cr samples are being filtered jointly. Luma branch employs a cascade of 8 backbones blocks, with chroma branch comprising a single backbone block. Each backbone block implements 3D convolution with separable 1x3, 3x1 and 1x1 kernels. In the test, chroma data is not used for NN input and no chroma branch processing is performed.

A computer screen shot of a computer

AI-generated content may be incorrect.

Inference interface of NNVC ILF was implemented in ECM, with NN-ILF being introduced as an extension of the ECM ALF filter. NN-filter operates on input reconstructed pixels in parallel to existing Fixed, Residual and Gaussian filters. Simplified block diagram of the ECM-ALF extension with NN-ILF is shown below.



A flag is signalled to indicate whether the weight W1 for the NN-ILF is equal to 1 or 0, and the weight W2 for the Gaussian filter is derived as W2=1-W1.

Complexity-aware RDO was introduced, where NN filtering is disabled for blocks, if provided distortion reduction is found to be below a threshold.

EE software is configurable and includes two interface options differing in the position of the NN loop filter. In the first interface option, corresponding to the NNVC filter position, the NN loop filter is applied in parallel to Deblocking Filter and before SAO, BIF, and ALF.

The second interface option (tested in this EE) has chroma channel removed in addition to placing the NN filter in parallel to the existing Fixed, Residual, and Gaussian filters.

Proponents of the test suggest that both interfaces should be made optional in ECM for testing various NN based filters.



For test 5.1, the issue regarding latency which had been raised by the last meeting has been resolved by using SAO output. The gain in chroma is attractive, and the runtime tradeoff is acceptable. Confirmed by crosscheckers and supported by other experts.

Decision: Adopt JVET-AL0153 test 5.1

Test 5.2 needs additional memory to store the CCSAO control parameters (CTU level, not large memory). The approach is straightforward, similarly used already in ALF-CCCM. No impact on runtime, some gain by bitrate reduction. Confirmed by crosscheckers and supported by other experts.

Decision: Adopt JVET-AL0142 test 5.2

Tests 5.3x uses the unfiltered other chroma component as input for filtering the current one. Chroma components can still be filtered in parallel. This is done for chroma ALF (5.3a) and CC-ALF (5.3b), chroma gains are not fully additive in 5.3c, but there is a small luma loss in AI for 5.3a and 5.3c, and for RA in 5.3c, likely caused by additional signalling.

Decision: Adopt JVET-AL0135 test 5.3b.

Test 5.4 implements a simplified version of NN-ILF (luma only), including an interface which is more general, also supporting chroma filtering or using other filters. It is asserted than having such an interface in ECM is beneficial for further experimentation. Decoder runtime (CPU) does not represent a reasonable tradceoff, and the reduction of encoder runtime shown in the results seems to be an error in measurement. It is supported by various experts to adopt the proposal (but not in CTC), and to include the interface in the software. A cross-checker reports that partial results match (add number of cross-check) after a recent fix of the interface software.

Upon question, it was explained by proponents that in the design used in test 5.4, it is controlled at frame level whether the output of NN-ILF or of the Gaussian filter is used as input to the online ALF stage.

Revisit after further cross-check of the interface and review of other contributions regarding usage of NN-ILF in ECM.

***Other***

**Test 6.1: Adaptive picture-level vertical mirroring ([JVET-AL0199](https://jvet-experts.org/doc_end_user/current_document.php?id=15524))**

In the test, a vertical mirroring can be applied to input pictures. Encoder performs the selection of whether mirroring is performed before encoding the whole picture. No additional in-loop optimizations or coding modes are introduced.

Input image Iorg (each component independently) is filtered using a 3x3 Sobel filter for 45-degree edges detection (resulting in image I45) and a 3x3 Sobel filter for 135-degree edges detection (resulting in image I135).

For each pixel (x,y), it is checked whether one of the edge directions is dominant, i.e., the difference between I45(x,y) and I135(x,y) greater than a threshold (set, e.g., to 160 for a 10-bit video). If so, only the dominant pixel value persists, and the other is set to zero.

Then, all the non-zero values of I45 and I135 are counted:

If S135 > (S45 + TH), the frame is not mirrored. Otherwise, it is mirrored vertically. TH was set to -6000.

Test 6.1: Adaptive picture-level vertical mirroring.



The decision about mirroring does not require two-pass encoding. According to cross-checker, run times in the table are unreliable and should be slightly above 100% for the encoder. However, there is still a mismatch in the cross-checked results. Revisit after that is resolved and RA results are completed. It was also requested that information is provided about usage of the method on a per-sequence basis.

It was further commented that the approach of mirroring could have significant impact on correctly using information from reference frame such as control information of filters in inter frames. The proponents believe this is not a problem, as the approach is only using the mirroring in intra pictures and these are written in the correct orientation into the reference buffer.

### EE2 contributions: Enhanced compression beyond VVC capability (31)

There was no presentation or discussion about specific proposals in this category.

For actions decided to be taken, see section 5.2.1, unless otherwise noted.

[JVET-AL0079](https://jvet-experts.org/doc_end_user/current_document.php?id=15404) EE2-3.5: On affine motion compensation [H. Huang, R. Yu, Z. Zhang, Y. Zhang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0273](https://jvet-experts.org/doc_end_user/current_document.php?id=15600) Crosscheck of JVET-AL0079 (EE2-3.5: On affine motion compensation) [C. Ma (Kwai)] [late]

[JVET-AL0081](https://jvet-experts.org/doc_end_user/current_document.php?id=15406) EE2-3.9: Extended BDOF usage for MV refinement [R. Yu, H. Huang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0252](https://jvet-experts.org/doc_end_user/current_document.php?id=15579) Crosscheck of JVET-AL0081 (EE2-3.9: Extended BDOF usage for MV refinement) [Y. Wang (Bytedance)] [late]

[JVET-AL0106](https://jvet-experts.org/doc_end_user/current_document.php?id=15431) EE2-2.4: block vector guided EIP [Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AL0307](https://jvet-experts.org/doc_end_user/current_document.php?id=15634) Crosscheck of JVET-AL0106 (EE2-2.4: block vector guided EIP) [K. Panusopone (Nokia)] [late]

[JVET-AL0311](https://jvet-experts.org/doc_end_user/current_document.php?id=15638) Crosscheck of JVET-AL0106 (EE2-2.4: block vector guided EIP) [Z. Zhang (Alibaba)] [late]

[JVET-AL0107](https://jvet-experts.org/doc_end_user/current_document.php?id=15432) EE2-2.11: a combination of EE2-2.4 and EE2-2.10 [Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO), Z. Lv, C. Zhou, G. Wang (vivo)]

[JVET-AL0296](https://jvet-experts.org/doc_end_user/current_document.php?id=15623) Crosscheck of JVET-AL0107 (EE2-2.11: a combination of EE2-2.4 and EE2-2.10) [Z. Deng (Bytedance)] [late]

[JVET-AL0108](https://jvet-experts.org/doc_end_user/current_document.php?id=15433) EE2-2.7: Block vector guided DIMD [L. Zhang, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AL0280](https://jvet-experts.org/doc_end_user/current_document.php?id=15607) Crosscheck of JVET-AL0108 (EE2-2.7: Block vector guided DIMD) [Y. Wang (Bytedance)] [late]

[JVET-AL0315](https://jvet-experts.org/doc_end_user/current_document.php?id=15642) Crosscheck of JVET-AL0108 (EE2-2.7: Block vector guided DIMD) [Z. Zhang (Alibaba)] [late]

[JVET-AL0124](https://jvet-experts.org/doc_end_user/current_document.php?id=15449) EE2-2.10: Multiple filter taps for EIP [Z. Lyu, C. Zhou, G. Wang (vivo)]

[JVET-AL0258](https://jvet-experts.org/doc_end_user/current_document.php?id=15585) Crosscheck of JVET-AL0124 (EE2-2.10 Multiple filter taps for EIP) [Z. Deng (Bytedance)] [late]

[JVET-AL0125](https://jvet-experts.org/doc_end_user/current_document.php?id=15450) EE2-2.6: Improvement on MPM [G. Wang, C. Zhou, Z. Lv (vivo)]

[JVET-AL0262](https://jvet-experts.org/doc_end_user/current_document.php?id=15589) Crosscheck of JVET-AL0125 (EE2-2.6a/c: Improvement on MPM) [J. Fu, Z. Li (PKU)] [late]

[JVET-AL0295](https://jvet-experts.org/doc_end_user/current_document.php?id=15622) Crosscheck of JVET-AL0125 (EE2-2.6b/c: Improvement on MPM) [Y. Liu, Y. Huo (Transsion)] [late]

[JVET-AL0126](https://jvet-experts.org/doc_end_user/current_document.php?id=15451) EE2-2.3: CCP merge mode with adjustment [Y. Wang, K. Zhang, W. Yin, Z. Deng, N. Zhang, L. Zhao, M. Salehifar, L. Zhang (Bytedance)]

[JVET-AL0274](https://jvet-experts.org/doc_end_user/current_document.php?id=15601) Crosscheck of JVET-AL0126 (EE2-2.3: CCP merge mode with adjustment) [C. Ma (Kwai)] [late] [miss]

[JVET-AL0134](https://jvet-experts.org/doc_end_user/current_document.php?id=15459) EE2-3.4: Joint reordering of GPM split modes and partition indices [C. Ma, X. Xiu, X. Wang (Kwai)]

[JVET-AL0316](https://jvet-experts.org/doc_end_user/current_document.php?id=15643) Crosscheck of JVET-AL0134 (EE2-3.4: Joint reordering of GPM split modes and partition indices) [K. Jia (Alibaba)] [late]

[JVET-AL0135](https://jvet-experts.org/doc_end_user/current_document.php?id=15460) EE2-5.3: Cross-Chroma Input for Chroma-ALF and CC-ALF [W. Yin, K. Zhang, H. Liu, Y. Wang, Z. Deng, N. Zhang, L. Zhao, M. Salehifar, L. Zhang (Bytedance), C. Ma, X. Xiu, C.-W. Kuo, X. Wang (Kwai)]

[JVET-AL0277](https://jvet-experts.org/doc_end_user/current_document.php?id=15604) Crosscheck of JVET-AL0135 (EE2-5.3: Cross-Chroma Input for Chroma-ALF and CC-ALF)) [N. Hu (Qualcomm)] [late]

[JVET-AL0142](https://jvet-experts.org/doc_end_user/current_document.php?id=15467) EE2-5.2: CCSAO with reused CTU control [C.-W. Kuo, X. Xiu, X. Wang (Kwai)]

[JVET-AL0253](https://jvet-experts.org/doc_end_user/current_document.php?id=15580) Crosscheck of JVET-AL0142 (EE2-5.2: CCSAO with Reused CTU Control) [W. Yin (Bytedance)] [late]

[JVET-AL0143](https://jvet-experts.org/doc_end_user/current_document.php?id=15468) EE2-1.1: Chroma partition prediction in separate tree condition [P.-H. Lin, J.-L. Lin, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0279](https://jvet-experts.org/doc_end_user/current_document.php?id=15606) Crosscheck of JVET-AL0143 (EE2-1.1: Chroma partition prediction in separate tree condition) [R.-L. Liao (Alibaba)] [late]

[JVET-AL0285](https://jvet-experts.org/doc_end_user/current_document.php?id=15612) Crosscheck of JVET-AL0143 (EE2-1.1: Chroma partition prediction in separate tree condition) [C.-W. Kuo (Kwai)] [late]

[JVET-AL0149](https://jvet-experts.org/doc_end_user/current_document.php?id=15474) EE2-2.12: Non-adjacent DIMD for TMRL [V. Rufitskiy, A. Filippov, T. Dong, H. Qin, J. Konieczny, K. Ding (TCL)]

[JVET-AL0151](https://jvet-experts.org/doc_end_user/current_document.php?id=15476) EE2-3.2: Extension on spatial and temporal merge candidates [J.-L. Lin, P.-H. Lin, Z. Zhang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0293](https://jvet-experts.org/doc_end_user/current_document.php?id=15620) Crosscheck of JVET-AL0151 (EE2-3.2: Extension on spatial and temporal merge candidates) [L. Zhang (OPPO)] [late]

[JVET-AL0153](https://jvet-experts.org/doc_end_user/current_document.php?id=15478) EE2-5.1: ALF-CCCM [P. Astola, I. Jumakulyyev, D. Bugdayci Sansli, J. Lainema (Nokia)]

[JVET-AL0238](https://jvet-experts.org/doc_end_user/current_document.php?id=15565) Crosscheck of JVET-AL0153 (EE2-5.1: ALF-CCCM) [R. G. Youvalari (Xiaomi)] [late]

[JVET-AL0157](https://jvet-experts.org/doc_end_user/current_document.php?id=15482) EE2-3.3: Additional inter merge candidates [N. Zhang, K. Zhang, Z. Deng, L. Zhao, Y. Wang, W. Yin, M. Salehifar, L. Zhang (Bytedance), J.-L. Lin, P.-H. Lin, Z. Zhang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0269](https://jvet-experts.org/doc_end_user/current_document.php?id=15596) Crosscheck of JVET-AL0157 (EE2-3.3: Additional inter merge candidates) [[X. Li (Alibaba)](mailto:sid.lxw@alibaba-inc.com)] [late]

[JVET-AL0294](https://jvet-experts.org/doc_end_user/current_document.php?id=15621) Crosscheck of JVET-AL0157 (EE2-3.3e: Additional inter merge candidates) [[L. Zhang (OPPO)](mailto:zhanglai@oppo.com)] [late]

[JVET-AL0158](https://jvet-experts.org/doc_end_user/current_document.php?id=15483) EE2-4.3: On coefficient level binarization in Transform Skip [M. Abdoli, R. G. Youvalari, F. Plowman, A. Tissier (Xiaomi)]

[JVET-AL0240](https://jvet-experts.org/doc_end_user/current_document.php?id=15567) Crosscheck of JVET-AL0158 (EE2-4.3: On coefficient level binarization in Transform Skip) [P. Astola (Nokia)] [late]

[JVET-AL0160](https://jvet-experts.org/doc_end_user/current_document.php?id=15485) EE2-3.1: Subblock-based spatial MVP [Z. Deng, K. Zhang, N. Zhang, L. Zhao, Y. Wang, W. Yin, M. Salehifar, L. Zhang (Bytedance)]

[JVET-AL0251](https://jvet-experts.org/doc_end_user/current_document.php?id=15578) Crosscheck of JVET-AL0160 (EE2-3.1: Subblock-based spatial MVP) [Z. Lyu (vivo)] [late]

[JVET-AL0161](https://jvet-experts.org/doc_end_user/current_document.php?id=15486) EE2-3.7: On interpolation filter for template matching [Z. Dai, R.-L. Liao, J. Chen, X. Li, Y. Ye (Alibaba)]

[JVET-AL0255](https://jvet-experts.org/doc_end_user/current_document.php?id=15582) Crosscheck of JVET-AL0161 (EE2-3.7: On interpolation filter for template matching)) [L. Xu (OPPO)] [late]

[JVET-AL0162](https://jvet-experts.org/doc_end_user/current_document.php?id=15487) EE2-3.8: CMVP extension for constructed affine merge candidates [C. Li, R.-L. Liao, J. Chen, Y. Ye (Alibaba)]

[JVET-AL0261](https://jvet-experts.org/doc_end_user/current_document.php?id=15588) Crosscheck of JVET-AL0162 (EE2-3.8: CMVP extension for constructed affine merge candidates) [L. Zhao (Bytedance)] [late] [miss]

[JVET-AL0168](https://jvet-experts.org/doc_end_user/current_document.php?id=15493) EE2-5.4: On the performance improvement of NN-based ILF in ALF [Y. Li, M. Karczewicz, J. Wang, L.Kerofsky, H. Wang, N. Hu, R. Yu, M. Coban, V. Seregin (Qualcomm)]

[JVET-AL0319](https://jvet-experts.org/doc_end_user/current_document.php?id=15646) Crosscheck of JVET-AL0168 (EE2-5.4: On the performance improvement of NN-based ILF in ALF - interface 2) [T. Poirier (InterDigital] [late] [miss]

[JVET-AL0181](https://jvet-experts.org/doc_end_user/current_document.php?id=15506) EE2: Tests 4.1 on Advanced SBT with direction and position inference [G. Laroche, P. Onno (Canon)]

[JVET-AL0188](https://jvet-experts.org/doc_end_user/current_document.php?id=15513) EE2-2.5: Flip-aware BV prediction in SGPM [J. Huo, Y. Fei, L. Wang, Y. Ma, F. Yang (Xidian Univ.)]

[JVET-AL0237](https://jvet-experts.org/doc_end_user/current_document.php?id=15564) Crosscheck of JVET-AL0188 (EE2-2.5: Flip-aware BV prediction in SGPM) [X. Li (Alibaba)] [late]

[JVET-AL0191](https://jvet-experts.org/doc_end_user/current_document.php?id=15516) EE2-2.2: On cross-component intra prediction [Y.-J. Chang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0268](https://jvet-experts.org/doc_end_user/current_document.php?id=15595) Crosscheck of Test 2.2c and d in JVET-AL0191 (EE2-2.2: On cross-component intra prediction) [H. Huang (OPPO)] [late]

[JVET-AL0283](https://jvet-experts.org/doc_end_user/current_document.php?id=15610) Crosscheck of JVET-AL0191 (EE2-2.2: On cross-component intra prediction) for tests EE2-2.2a and EE2-2.2b [J. Lainema (Nokia)] [late]

[JVET-AL0199](https://jvet-experts.org/doc_end_user/current_document.php?id=15524) EE2-6.1: Adaptive picture-level vertical mirroring [D. Mieloch, J. Stankowski, M. Lorkiewicz, A. Dziembowski, D. Karwowski (PUT)]

[JVET-AL0236](https://jvet-experts.org/doc_end_user/current_document.php?id=15563) Crosscheck of JVET-AL0199 (EE2-6.1: Adaptive picture-level vertical mirroring) [M. Abdoli (Xiaomi)] [late]

[JVET-AL0205](https://jvet-experts.org/doc_end_user/current_document.php?id=15530) EE2-2.1: EIP filters with diagonal shapes [K. Panusopone, M. He, S. Hong, L. Wang, J. Lainema, D. Rusanovskyy (Nokia)]

[JVET-AL0313](https://jvet-experts.org/doc_end_user/current_document.php?id=15640) Crosscheck of JVET-AL0205 (EE2-2.1: EIP filters with diagonal shapes) [Z. Xie (OPPO)] [late]

[JVET-AL0206](https://jvet-experts.org/doc_end_user/current_document.php?id=15531) EE2-2.9: Test 2.1 + Test 2.4 [K. Panusopone, M. He, S. Hong, L. Wang, J. Lainema, D. Rusanovskyy (Nokia), Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AL0264](https://jvet-experts.org/doc_end_user/current_document.php?id=15591) Crosscheck of JVET-AL0206 (EE2-2.9: Test 2.1 + Test 2.4) [P. Andrivon (Ofinno)] [late]

[JVET-AL0309](https://jvet-experts.org/doc_end_user/current_document.php?id=15636) Crosscheck of JVET-AL0206 (EE2-2.9: Test 2.1 + Test 2.4) [Z. Lyu (vivo)] [late]

[JVET-AL0214](https://jvet-experts.org/doc_end_user/current_document.php?id=15541) EE2-3.6: MV refinement for TMVP [Z. Zhang, J.-L. Lin, Y. Zhang, H. Huang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0257](https://jvet-experts.org/doc_end_user/current_document.php?id=15584) Crosscheck of JVET-AL0214 (EE2-3.6 MV refinement for TMVP) [Z. Deng (Bytedance)] [late]

[JVET-AL0215](https://jvet-experts.org/doc_end_user/current_document.php?id=15542) EE2-4.4: IntraNN NSPT set [G. Verba, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0244](https://jvet-experts.org/doc_end_user/current_document.php?id=15571) Crosscheck of JVET-AL0215 (EE2-4.4cd: IntraNN NSPT set) [M. Abdoli (Xiaomi)] [late]

[JVET-AL0281](https://jvet-experts.org/doc_end_user/current_document.php?id=15608) Crosscheck of JVET-AL0215 (EE2-4.4ab: IntraNN NSPT set) [T. Dong, V. Rufitskiy (TCL)] [late]

[JVET-AL0227](https://jvet-experts.org/doc_end_user/current_document.php?id=15554) EE2-4.2a: Advanced SBT with simplified search method [Y. Zhang, E. Ye, H. Wang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0259](https://jvet-experts.org/doc_end_user/current_document.php?id=15586) Crosscheck of JVET-AL0227 (EE2-4.2a: Advanced SBT with simplified search method) [G. Laroche (Canon)] [late]

[JVET-AL0229](https://jvet-experts.org/doc_end_user/current_document.php?id=15556) EE2-4.2b: Combination test of EE2-4.1 and EE2-4.2a [G. Laroche, P. Onno (Canon), Y. Zhang, E. Ye, H. Wang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0260](https://jvet-experts.org/doc_end_user/current_document.php?id=15587) Crosscheck of JVET-AL0229 (EE2-4.2b: Combination test of EE2-4.1 and EE2-4.2a) [L. Zhao (Bytedance)] [late] [miss]

### EE2 related contributions (7)

Contributions in this area were discussed during 0630–0700 and XXXX–XXXX on Friday 28 March 2025 (chaired by JRO).

[JVET-AL0109](https://jvet-experts.org/doc_end_user/current_document.php?id=15434) EE2-related: On binarization of a coefficient level in TSRC [Y. Yu, L. Xu, J. Gan, H. Yu, D. Wang (OPPO)]

A coefficient level is binarized and bypass-coded with truncated Rice-Golomb with Rice parameter 1 when the CABAC bin budget is exhausted in the TSRC. Two bins are needed for coding a coefficient level 0. This contribution proposes to use a flag to indicate if the coefficient level is zero or not and then binarize the coefficient level minus 1 with Rice parameter 0 for non-zero coefficient levels. Simulation results of the proposed method on top of ECM-16.1 are reported below:

All-Intra:

Natural content: { 0.00%, 0.02%, 0.01%, 99.8%%, 99.9%}

Class F: {-0.10%, -0.05%, -0.17%, 99.6%, 100.4 %}

Class TGM: {-0.16%, -0.22%, -0.19%, 99.9 %, 100.4 %}

Random-Access:

Class F: {-0.06%, 0.26%, -0.06%, 99.8 %, 98.7 %}

Class TGM: {-0.09%, -0.07%, -0.06%, 99.8 %, 99.5 %}

Similar to 4.3, the binarization is changed when the budget would be reached, but does not exceed the budget. Though having less gain (likely due to the fact that less priority is given to the significance flag), this is an interesting concept.

Study in EE. Also results for higher rates should be provided (as in test 4.3, but observing the test conditions that were requested in last meeting – see notes in EE review).

[JVET-AL0299](https://jvet-experts.org/doc_end_user/current_document.php?id=15626) Crosscheck of JVET-AL0109 (EE2-related: On binarization of a coefficient level in TSRC) [K. Panusopone (Nokia)] [late]

[JVET-AL0110](https://jvet-experts.org/doc_end_user/current_document.php?id=15435) EE2-related: On ALF-CCCM [N. Song, L. Xu, Y. Yu, H. Yu, D. Wang (OPPO)]

This contribution proposes a method of applying an adaptive factor for ALF-CCCM (Adaptive Loop Filter Based CCCM) in EE2-5.1 to replace a fixed factor. In addition, the usage of multi-models is also updated. On top of ECM-16.1, the test results are summarized as follows:

AI: {not applicable}

RA: -0.xx%(Y), -0.xx%(U), -0.xx%(V), xx.x%(EncT), xx.x% (DecT))

LDB: -0.xx%(Y), -0.xx%(U), -0.xx%(V), xx.x%(EncT), xx.x% (DecT))

LDP: -0.xx%(Y), -0.xx%(U), -0.xx%(V), xx.x%(EncT), xx.x% (DecT))

Compare with the EE result:

AI: {not applicable}

RA\*: 0.01%(Y), -0.52%(U), -0.48%(V), xx.x%(EncT), xx.x% (DecT))

LDB: -0.05%(Y), -1.01%(U), -0.84%(V), xx.x%(EncT), xx.x% (DecT))

LDP: -0.04%(Y), -1.26%(U), -1.10%(V), xx.x%(EncT), xx.x% (DecT))

Straightforward extension of the method from EE2-5.1, giving additional gain. According to cross-checkers. Impact on runtime should be marginal. Study in EE.

[JVET-AL0276](https://jvet-experts.org/doc_end_user/current_document.php?id=15603) Crosscheck of JVET-AL0110 (EE2-related: On ALF-CCCM) N. Hu (Qualcomm)

[JVET-AL0192](https://jvet-experts.org/doc_end_user/current_document.php?id=15517) EE2-related: Harmonization of SGPM-BV and LIC [J. Huo, Y. Fei, L. Wang, Y. Ma, F. Yang (Xidian Univ.)]

[JVET-AL0270](https://jvet-experts.org/doc_end_user/current_document.php?id=15597) Crosscheck of JVET-AL0192 (EE2-related: Harmonization of SGPM-BV and LIC) [X. Li (Alibaba)] [late]

[JVET-AL0202](https://jvet-experts.org/doc_end_user/current_document.php?id=15527) EE2-related: Adaptive picture-level vertical mirroring based on decimated video [D. Mieloch, M. Lorkiewicz, A. Dziembowski (PUT)]

[JVET-AL0225](https://jvet-experts.org/doc_end_user/current_document.php?id=15552) EE2-related: On In-Loop Filtering in ECM [D. Rusanovskyy, M. Santamaria, N. Le, F. Cricri, K. Panusopone, S. Hong, L. Wang, J. Lainema (Nokia)]

[JVET-AL0228](https://jvet-experts.org/doc_end_user/current_document.php?id=15555) EE2-related: NNLF interface in ECM [T. Poirier, F. Galpin, G. Boisson (InterDigital), Y. Li, M. Karczewicz, J. Wang, L. Kerofsky, H. Wang, N. Hu, R. Yu, M. Coban, V. Seregin (Qualcomm)]

[JVET-AL0234](https://jvet-experts.org/doc_end_user/current_document.php?id=15561) EE2-related: affine bilateral matching merge mode [H. Huang, V. Seregin, M. Karczewicz (Qualcomm)]

### ECM modifications and software improvements beyond EE2 (38)

#### Intra and CIIP (8)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0111](https://jvet-experts.org/doc_end_user/current_document.php?id=15436) Non-EE2: Matrix-based position dependent intra prediction for GPM/CIIP [Z. Sun, Y. Yu, L. Xu, H. Yu, D. Wang (OPPO)]

[JVET-AL0272](https://jvet-experts.org/doc_end_user/current_document.php?id=15599) Crosscheck of JVET-AL0111 (Non-EE2: Matrix-based position dependent intra prediction for GPM/CIIP) [X. Li (Alibaba)] [late]

[JVET-AL0174](https://jvet-experts.org/doc_end_user/current_document.php?id=15499) Non-EE2: TIMD fusion with neural network based intra prediction [Y.-H Lin, K.-W Liang, C.-Y Teng, Y.-C Yang (Sharp), K. Naser, T. Dumas, E. François, F. Le Léannec (InterDigital)]

[JVET-AL0179](https://jvet-experts.org/doc_end_user/current_document.php?id=15504) Non-EE2: Intra Merge Mode Enhancements [M. Blestel, P. Andrivon (Ofinno)]

[JVET-AL0183](https://jvet-experts.org/doc_end_user/current_document.php?id=15508) Non-EE2: Block Vector-based Intra Mode Derivation [J.-K Lee, D. Ruiz Coll, M. Blestel (Ofinno)] [late]

Initial version rejected as “placeholder”

[JVET-AL0195](https://jvet-experts.org/doc_end_user/current_document.php?id=15520) Non-EE2: TIMD-BV extension with enhanced IntraTMP merge list [J. Fu, J. Zhang, Y. Zhao, S. Ma (PKU), C. Huang (ZTE), K. Naser, M. Radosavljević, S. Puri, T. Dumas (InterDigital), D. Ruiz Coll, J.-K Lee (Ofinno)] [late]

Initial version rejected as “placeholder”

[JVET-AL0271](https://jvet-experts.org/doc_end_user/current_document.php?id=15598) Crosscheck of JVET-AL0195 (Non-EE2: TIMD-BV extension with enhanced IntraTMP merge list) [X. Li (Alibaba)] [late]

[JVET-AL0231](https://jvet-experts.org/doc_end_user/current_document.php?id=15558) Non-EE2: On interpolation filter for TIMD [Y. Wang, W. Yin, K. Zhang, Z. Deng, N. Zhang, L. Zhao, M. Salehifar, L. Zhang (Bytedance)]

[JVET-AL0241](https://jvet-experts.org/doc_end_user/current_document.php?id=15568) Non-EE2: Intra TMP sub-modes depending on the template type information [T. Dumas, K. Naser, M. Radosavljević, F. Le Léannec (Interdigital)] [late]

[JVET-AL0290](https://jvet-experts.org/doc_end_user/current_document.php?id=15617) [AHG12] Combination of JVET-AL0174, JVET-AL0195 and JVET-AL0241 on Enhanced TIMD with NNIP and Optimized Block Vector Derivation [K. Naser, S. Puri, T. Dumas, M. Radosavljević, F. Le Léannec, E. François (InterDigital), J. Fu, Y. Zhao, J. Zhang, S. Ma (PKU), C. Huang (ZTE), D. Ruiz Coll, J.-K. Lee (Ofinno), Y.-H. Lin, C.-Y. Teng, K.-W. Liang, Y.-C. Yang (Sharp)] [late]

#### Inter (2)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0248](https://jvet-experts.org/doc_end_user/current_document.php?id=15575) AHG12: On Motion Vector Prediction [D. Bugdayci Sansli, P. Astola, J. Lainema (Nokia)] [late]

[JVET-AL0287](https://jvet-experts.org/doc_end_user/current_document.php?id=15614) AHG12: Generated Merge Candidates [D. Bugdayci Sansli, P. Astola, J. Lainema (Nokia)] [late]

#### GPM (2)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0193](https://jvet-experts.org/doc_end_user/current_document.php?id=15518) Non-EE2: Extension of Template Types in Regression-Based GPM [Y. Yao, J. Huo, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang (Hisense)]

[JVET-AL0082](https://jvet-experts.org/doc_end_user/current_document.php?id=15407) AHG12: Modifications to regression-based GPM with intra and inter prediction [R. Yu, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0256](https://jvet-experts.org/doc_end_user/current_document.php?id=15583) Crosscheck of JVET-AL0082 (AHG12: Modifications to regression-based GPM with intra and inter prediction) [K. Jia (Alibaba)] [late]

#### In-Loop Filters (6)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0110](https://jvet-experts.org/doc_end_user/current_document.php?id=15435) EE2-related: On ALF-CCCM [N. Song, L. Xu, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AL0300](https://jvet-experts.org/doc_end_user/current_document.php?id=15627) Crosscheck of JVET-AL0110 (EE2-related: On ALF-CCCM) [P. Astola (Nokia)] [late]

[JVET-AL0182](https://jvet-experts.org/doc_end_user/current_document.php?id=15507) AhG-12: On TALF reference picture extensions [P. Onno, B. Galmiche, G. Laroche (Canon)]

[JVET-AL0254](https://jvet-experts.org/doc_end_user/current_document.php?id=15581) Crosscheck of JVET-AL0182 (AhG-12: On TALF reference picture extensions) [L. Xu (OPPO)] [late]

[JVET-AL0220](https://jvet-experts.org/doc_end_user/current_document.php?id=15547) AHG12: Reuse of ALF control information [N. Hu, H. Wang, M. Karczewicz, V. Seregin (Qualcomm)]

[JVET-AL0230](https://jvet-experts.org/doc_end_user/current_document.php?id=15557) AhG11/AhG12: Performance of the NNVC ILF in ECM [D. Rusanovskyy, K. Panusopone, S. Hong, L. Wang (Nokia)]

[JVET-AL0232](https://jvet-experts.org/doc_end_user/current_document.php?id=15559) Non-EE2: on TALF input extension [C. Ma, X. Xiu, X. Wang (Kwai)]

[JVET-AL0275](https://jvet-experts.org/doc_end_user/current_document.php?id=15602) Non-EE2: Non-linear clipping for CCALF [N. Song, L. Xu, Y. Yu, H. Yu, D. Wang (OPPO)] [late]

#### Entropy coding, transforms, quantization, and transform coefficient coding (5)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0112](https://jvet-experts.org/doc_end_user/current_document.php?id=15437) Non-EE2: Third transform set selection for intraNN [Z. Xie, F. Wang, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AL0314](https://jvet-experts.org/doc_end_user/current_document.php?id=15641) Cross-check of JVET-AL0112 (Non-EE2: third transform set selection for intraNN) [T. Dumas (InterDigital)] [late]

[JVET-AL0150](https://jvet-experts.org/doc_end_user/current_document.php?id=15475) Non-EE2: CABAC context switch of sig\_coeff\_flag and abs\_level\_gtx\_flag for LFNST/NSPT [T. Kusakabe, K. Abe, T. Sugio, T. Nishi (Panasonic)]

[JVET-AL0198](https://jvet-experts.org/doc_end_user/current_document.php?id=15523) Non-EE2: Optimization of probability estimation in CABAC [D. Karwowski, D. Mieloch, M. Lorkiewicz, J. Stankowski (PUT)]

[JVET-AL0087](https://jvet-experts.org/doc_end_user/current_document.php?id=15412) AHG12: Predictive transform coefficient coding [T. N. Canh, F. Pu, P. Yin, S. McCarthy (Dolby)]

[JVET-AL0306](https://jvet-experts.org/doc_end_user/current_document.php?id=15633) Cross-check of JVET-AL0087 AhG12: Predictive transform coefficient coding [F. Le Léannec (InterDigital)] [late]

[JVET-AL0113](https://jvet-experts.org/doc_end_user/current_document.php?id=15438) AHG12: Directional sign prediction [L. Xu, Y. Yu, Z. Sun, L. Zhang, H. Yu, D. Wang (OPPO)]

[JVET-AL0305](https://jvet-experts.org/doc_end_user/current_document.php?id=15632) Crosscheck of JVET-AL0113 (on directional sign prediction) [P. Onno (Canon)] [late] [miss]

#### Other (0)

This section is kept as template for future use.

### CTC for EE2/ECM and general ECM improvements (0)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

See also discussion under section 4.4 and 4.14.

# High-level syntax (HLS) and related proposals (78)

## AHG9: Additions for HEVC and AVC (7)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0057](https://jvet-experts.org/doc_end_user/current_document.php?id=15363) AHG9: Inclusion of the encoder optimization information SEI message in HEVC [M. M. Hannuksela, J. Boyce (Nokia)]

[JVET-AL0059](https://jvet-experts.org/doc_end_user/current_document.php?id=15365) AHG9: Inclusion of the packed regions information SEI message in HEVC [J. Boyce, M. M. Hannuksela (Nokia)]

[JVET-AL0061](https://jvet-experts.org/doc_end_user/current_document.php?id=15367) AHG 9: Encoder optimization information for AVC and HEVC [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AL0062](https://jvet-experts.org/doc_end_user/current_document.php?id=15368) AHG 9: AI usage restrictions SEI message for AVC and HEVC [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AL0148](https://jvet-experts.org/doc_end_user/current_document.php?id=15473) AHG9: Generative face video and generative face video enhancement SEI messages for HEVC and AVC [J. Chen, B. Chen, Y. Ye (Alibaba), S. Gehlot, G.-M. Su, P. Yin, S. McCarthy (Dolby), A. Trioux, F. Yang (Xidian Univ.), Y.-K. Wang (Bytedance), H.-B. Teo, J.-Y. Thong, K. Abe (Panasonic), Y. Xu, K. Yang, Y. Li (SJTU)]

[JVET-AL0210](https://jvet-experts.org/doc_end_user/current_document.php?id=15535) AHG9: On SEI processing order SEI message for HEVC and AVC [Y. Sanchez, T. M. Borges, R. Skupin, C. Hellge, T. Schierl (Fraunhofer HHI)]

[JVET-AL0317](https://jvet-experts.org/doc_end_user/current_document.php?id=15644) On CLVS and SEI messages in HEVC [D. Podborski, A. Tourapis (Apple)] [late] [miss]

## AHG9: Aspects on SEI messages in VSEIv4 and related (47)

### Film grain characteristics SEI message (3+1)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0086](https://jvet-experts.org/doc_end_user/current_document.php?id=15411) AHG9/AHG13: On Spatial Resolution for the Film Grain Characteristics (FGC) SEI message [J. Samuelsson-Allendes, S. Deshpande (Sharp)]

[JVET-AL0204](https://jvet-experts.org/doc_end_user/current_document.php?id=15529) AHG9: On picture width and height for the film grain characteristics SEI message [M. M. Hannuksela, J. Boyce (Nokia)]

[JVET-AL0211](https://jvet-experts.org/doc_end_user/current_document.php?id=15536) AHG9: Resolution nesting for FGC SEI message [R. Skupin, Y. Sanchez, A. Wieckowski, T. M. Borges, C. Hellge, T. Schierl (Fraunhofer HHI)]

*Aspect on FGC SEI – JVET- AL0211 also relates to 6.4 on potential needs for additional SEI message*

[JVET-AL0288](https://jvet-experts.org/doc_end_user/current_document.php?id=15615) AHG2, AHG9, AHG13: on FGC SEI reference picture size [P. de Lagrange (InterDigital)] [late]

See section 4.2

### SEI processing order and processing order nesting SEI messages (5)

Contributions in this area were discussed during 0500–0730 on Thursday 27 March 2025 (chaired by J. Boyce).

[JVET-AL0063](https://jvet-experts.org/doc_end_user/current_document.php?id=15369) AHG9: On SPO SEI message [Y. He, M. Karczewicz (Qualcomm)]

This contribution proposes the following changes to the SPO SEI message.

1. Exclude user data registered by ITU-T T.35 SEI message and user unregistered SEI message from SPO prefix indication boundary constraint to be consistent with SEI prefix indication SEI message.
2. Constrain the value of po\_for\_human\_viewing\_idc and po\_for\_machine\_analysis\_idc shall be equal to the value of nnpfc\_for\_human\_viewing\_idc and nnpfc\_for\_machine\_analysis\_idc of the associated NNPFC SEI message when NNPFC is the last stage of processing chain. Constrain the value of po\_for\_human\_viewing\_idc shall not be equal 3 when AR SEI message with the value of ar\_not\_optimzed\_for\_viewing\_flag equal to 1 is the last stage of the processing chain.
3. Add a constrain that the same type of SEI message indicated by the SPO SEI message shall have the same value of po\_sei\_processing\_order, or an alternative constraint that requires the uniqueness of the SEI message type in SPO SEI message.

v2 removes two proposed constraints and adds one alternative constraint option from v1.

Item 1 agreed.

Item 2 is a sensibility constraint. A concern was expressed about the phrasing when some of the relevant SEI messages are not present.

A suggestion was made that a note could be used instead of a constraint.

Revisit item 2 after reworded.

For Item 3, option 1 was not preferred. A suggestion was made that option 2 was unnecessarily strict.

Revisit item 3 after reworded.

[JVET-AL0064](https://jvet-experts.org/doc_end_user/current_document.php?id=15370) AHG9: On the SPO SEI message complexity signaling [Y. He, M. Karczewicz (Qualcomm)]

This contribution proposes to add additional complexity information of mandatory processing stages and sub-chains besides the complexity information of processing chain in the SPO SEI message. It is asserted that a decoder may not be able to support entire processing chain due to the complexity concern, the decoder may process mandatory processing stages with zero or more sub-chains if the complexity information is present for the mandatory processing stages and sub-chains.

A large number of syntax elements are proposed, which seems to go beyond the “minor necessary changes” guidance.

Are there any implications for extensibility? An extension must be backwards compatible, and would need to provide improvement for new decoders without breaking older decoders.

A suggestion was raised to signal complexity for minimum rather than mandatory.

A concern was raised with using the word “mandatory” within SEI message syntax or semantics.

Decision (ed): delegate to the editors to replace existing “mandatory” wording in the semantics.

Revisit for consideration for TuC after restructuring to be an extension and to reword to avoid using “mandatory” wording.

[JVET-AL0065](https://jvet-experts.org/doc_end_user/current_document.php?id=15371) AHG9: On PON SEI message [Y. He, M. Karczewicz (Qualcomm)]

This contribution proposes to remove pon\_processing\_order[ i ] in the PON SEI message. It is asserted that a PON-nested SEI message may be duplicated multiple times in a PON SEI message when it is associated with different SPO SEI messages with different pon\_processing\_order value. Removing pon\_processing\_order[ i ] also simplifies the parsing process.

A question was raised if removing pon\_processing\_order[ i ] affects functionality of the PON SEI message.

The contribution suggests that removing the pon\_processing\_order[ i ] syntax element simplifies parsing. It was suggested that removing the syntax element would require more operations to determine the order by matching payload types.

It was suggested that nesting in a PON with the current design allows distinguishing between SEI messages by the order.

It was suggested to keep the current design for design stability.

No action.

[JVET-AL0178](https://jvet-experts.org/doc_end_user/current_document.php?id=15503) AHG9: Use cases for energy savings information in SPO SEI messages [C-H. Demarty, E. François, F. Aumont, O. Le Meur (InterDigital)]

This contribution proposes to enhance the SEI processing order (SPO) SEI message with information indicating whether the SPO chain was optimized for energy savings purposes.

When energy consideration comes to play, such information can for example be used by a receiver to decide whether or not to apply the processing chain specified by the SPO SEI message. It can also be used to choose one SPO chain against another, depending on the energy status of the receiver.

Different use case scenarios can be envisioned which leverage the energy savings information. This contribution proposes to describe three of them.

The contribution is being proposed for VSEI v4.

Essentially the same syntax and semantics is proposed as in JVET-AK0156 are proposed, but additional use case information is provided.

The contribution is providing new functionality, which may not be suitable for VSEI v4 at this stage. It could be considered for TuC if done as an extension.

It was suggested that the location of syntax elements should be move to be backwards compatible for an extension if it were included in the TuC.

It was suggested that it is difficult for the encoder to know if all decoder implementations would have energy savings.

[JVET-AL0208](https://jvet-experts.org/doc_end_user/current_document.php?id=15533) AHG9: On SPO root-process signaling constraint [T. M. Borges, Y. Sanchez, R. Skupin, C. Hellge, T. Schierl (Fraunhofer HHI)]

This contribution proposes to constrain the usage of a "root" process (i.e., poSubChainIdx[ j ] equal to 0 and po\_sei\_importance\_flag[ PoSeiTypeIdx[ j ] ] equal to 1 and po\_sei\_processing\_degree\_flag[ PoSeiTypeIdx[ j ] ] equal to 1) when preceded by any open-ended sub-chain. The latter can cause early termination of PoSeiList without the inclusion of such root process, which generates ambiguity in the intended behavior of such critical process.

Proposes adding a constraint.

Decision: Adopt. The exact wording of the language can be fine-tuned during editing.

### NNPF SEI extensions (5)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0075](https://jvet-experts.org/doc_end_user/current_document.php?id=15381) AHG9: On nnpfa\_num\_input\_pic\_shift [M. M. Hannuksela (Nokia)]

Chaired by S. Deshpande on 27 March 2025 at 07:30

It is asserted that an NNPF that is not the initial process of the processing chain is invoked, in turn, to the corresponding picture of the current cropped decoded picture (currCdoPic) to which the NNPF is activated and each associated inserted picture of currCdoPic. However, it is asserted that when an NNPFA SEI message including the nnpfa\_num\_input\_pic\_shift syntax element persists to currCdoPic, the intent is to invoke the NNPF only once among the corresponding picture of currCdoPic and the associated inserted pictures of currCdoPic using the indicated shift when selecting input pictures to the NNPF. It is also asserted that a decision in relation to JVET-AJ0114 was to require inclusion an NNPFA SEI message with nnpfa\_num\_input\_pic\_shift into a PON SEI message, but this decision has not been implemented.

The proposals of this contribution can be summarized as follows:

1. It is proposed to add a gating flag nnpfa\_selected\_input\_flag for nnpfa\_num\_input\_pic\_shift.
2. It is proposed to add a constraint: when an NNPFA SEI message is not included in a PON SEI message, nnpfa\_selected\_input\_flag shall be absent or equal to 0.
3. When an NNPFA SEI message is included in a PON SEI message and nnpfa\_selected\_input\_flag is absent or indicates the absence of nnpfa\_num\_input\_pic\_shift, the NNPF is invoked, in turn, to the corresponding picture of currCdoPic and each associated inserted picture of currCdoPic.
4. When an NNPFA SEI message is included in a PON SEI message and nnpfa\_selected\_input\_flag is present and indicates the presence of nnpfa\_num\_input\_pic\_shift, the NNPF is invoked to the picture selected according to the value of nnpfa\_num\_input\_pic\_shift.

The problem statement 1 is agreed and as per decision at the previous meeting, this should be implemented and that can be done by adding a constraint.

Decision (BF): Agreed to add the constraint (which was already agreed in previous meeting but not implemented)

It was asked if the purpose of the proposed flag is to specify which pictures the shift should be applied to (e.g. to all or just non-interpolated pictures). It was asked if when the proposed flag is 0, the shift is still also applied to the current picture and where will the shift information be obtained from in that case. It was answered that conceptually the NNPF is invoked multiple times with different shifts. Two participants commented that it was not clear that there is a need to add a flag. Offline discussion amongst interested parties was planned.

Revisit after offline discussion.

[JVET-AL0076](https://jvet-experts.org/doc_end_user/current_document.php?id=15382) AHG9: On multi-purpose NNPFs [M. M. Hannuksela, F. Cricri (Nokia)]

Chaired by S. Deshpande on 27 March 2025 at 08:00

This contribution proposes changes to avoid the need to define multiple NNPFs and NNPF cascades by enabling the adaptive use of NNPF models that include bypass connections so that filtering for a particular purpose among multiple purposes of the NNPF can be skipped. For example, in an NNPF that supports both resolution upsampling and quality enhancement, where only the last few layers perform upsampling (common architectural choice for memory and computational saving), the proposal enables skipping such last few layers in the NNPF inference when only quality enhancement is desired.

This contribution includes the following proposed items:

1. nnpfa\_target\_purposes\_present\_flag, indicating if nnpfa\_target\_purposes\_idc is present.
2. nnpfa\_target\_purposes\_idc indicating a bit-field where the enabled bits are a subset of the enabled bits in nnpfc\_purpose; thus, a subset of the NNPFC-indicated purposes can be indicated in an NNPFA SEI message.
3. nnpfPurpose is set equal to nnpfa\_target\_purposes\_idc (if present) or nnpfc\_purpose (otherwise). The purpose-dependent variables (ChromaUpsamplingFlag, ResolutionResamplingFlag, etc.) are derived from nnpfc\_purpose for NNPFC SEI message syntax parsing and from nnpfPurpose for constraints and NNPF operation.
4. A bit of nnpfc\_auxiliary\_inp\_idc, namely nnpfc\_auxiliary\_inp\_idc & 8, is defined to indicate that a purpose is input to the NNPF as a part of the input tensor.
   1. When nnpfc\_auxiliary\_inp\_idc & 8 is equal to 0, nnpfa\_target\_purposes\_present\_flag shall be equal to 0. Since legacy VSEI decoders would not process NNPFs with nnpfc\_auxiliary\_inp\_idc & 8 greater than 0, they would not parse NNPFA SEI messages with the new syntax elements present and hence legacy compatibility is not compromised.
   2. The purpose is included in the input tensor as an additional matrix, similarly to the strength control value (QP), the text prompt, and the seed value.

It was commented by the proponents that this is not a bug-fix proposal.

It was commented if the memory requirement for a single NNPF with two purposes will be necessarily significantly lower than having two separate single purpose NNPFs. The proponent commented that rather than the memory aspect, the complexity of having two separate NNPFs in this case may be a more important issue to consider. Another participant commented that the memory requirement for a single filter was likely to be lower.

It was asked if the proposals here also allows a case where nnpfc purpose is a subset and nnpfa purpose adds more purposes. The proponents had only considered the case where nnpfc purpose is a superset. The proposal already includes such a constraint (to make nnpfc a superset). It was commented by a participant that if additional purposes are added in nnpfa, some additional syntax elements would need to be signalled in nnpfa.

One participant commented that this does not necessarily add new functionality as the use case can be realized by existing syntax. Also it was commented that this proposal may be thought of as adding alternative option for a functionality that is already supported, albeit possibly for better efficiency. Some examples with memory savings and bit rate savings were requested to consider if this should be considered for TuC.

It was asked if this proposal would also require some changes or may have some impact to handling of processing chains (e.g. if input pictures are different for different purposes). It was commented that the proposal text handles this aspect.

The proponent may request a revisit if additional data can be provided at this meeting.

Further study is recommended (on providing example savings as mentioned above, and also to consider if this may affect handling of processing chains).

[JVET-AL0096](https://jvet-experts.org/doc_end_user/current_document.php?id=15421) AHG9: On signalling of extension syntax elements in NNPFA SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

Chaired by S. Deshpande on 27 March 2025 at 08:30

The current design of the NNPFA SEI message in VSEI V4 determines the presence of extended syntax elements using more\_data\_in\_payload( ). It is asserted that using only that function may cause backward compatibility such that a VSEI V4 decoder may misinterpret byte alignment bits in a VSEI V3 bitstream as extended syntax elements.

This contribution proposes to add additional check using payload\_extension\_present() to distinguish between byte alignment bits and extended syntax elements, ensuring backward compatibility.

The proponent commented that this is an asserted bug-fix.

It was commented that what is proposed is needed but not sufficient. JVET-T0048 provides an example to use the extension correctly and that meeting’s minutes capture the decision to do it correctly. Thus it is proposed to add SeiExtensionBitsPresentFlag = 1 inside the two if statements.

Decision: Agreed to fix the bug as proposed with additional change which makes the bug-fix as follows:

 if( more\_data\_in\_payload( ) )

          if( payload\_extension\_present( ) ) {

              SeiExtensionBitsPresentFlag = 1

… }

[JVET-AL0159](https://jvet-experts.org/doc_end_user/current_document.php?id=15484) AHG9: On backbone and tail of NNPFs [F. Cricri, M. M. Hannuksela (Nokia)]

Chaired by S. Deshpande on 27 March 2025 at 08:45

This contribution proposes additions to the metadata extension of the NNPFC SEI message that allow to identify a backbone and a tail which make up a complete NNPF, via two distinct URIs. When the backbone is shared among two (or more) NNPFs, the backbone needs to be downloaded only once, by using its URI. For any subsequent NNPF using that same backbone, the decoding system can skip downloading it again, and can use the backbone’s URI to retrieve it from memory or local storage.

This contribution includes the following proposed items:

1. nnpfc\_backbone\_info\_flag, indicating whether nnpfc\_backbone\_uri and nnpfc\_tail\_uri are present.
2. nnpfc\_backbone\_uri and nnpfc\_tail\_uri, specifying URIs identifying the backbone and the tail of the NNPF, respectively.

A non-proponent thought the functionality was interesting and should be considered for TuC (not VSEI v4). A participant requested additional information regarding how often NNPF is implemented as a backbone and a tail. Another participant asked typically how much typically is the % of data for backbone versus tail. The proponent gave a ballpark that backbone will be around 80% with tail being 20%. Some concrete data for this % was requested – maybe for the example included in the document.

The proponent may request a revisit if additional data can be provided at this meeting.

Further study is recommended.

[JVET-AL0292](https://jvet-experts.org/doc_end_user/current_document.php?id=15619) AHG9: On Signalling NNPF Characteristics in NNPFA upon Updates of Purposes [C.-H. Demarty, E. François, F. Aumont, O. Le Meur (InterDigital)] [late]

Chaired by S. Deshpande on 27 March 2025 at 09:00

Contribution JVET-AL0076 proposes to update the NNPF purposes in the NNPFA SEI message in the case of multipurpose NNPFs.

Updating the purposes of an NNPF implies that some characteristics of the NNPF need also to be updated, in particular characteristics related to the output of the NNPF.

This contribution proposes to add signalling of updated values of such characteristics in the NNPFA SEI message.

The discussion was focused on if for resolution resampling update of parameters would be needed in the nnpf update. It was asked why new parameters need to be signalled in NNPFA in this case. Proponents specified that the variables used would be from nnpfa purpose and so the resolution will be that of the input picture. It was commented by proponents that this type of text may be missing in JVET-AL0076. This needs to be double-checked.

Further study recommended.

### Encoder optimization information SEI message *(*3)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0056](https://jvet-experts.org/doc_end_user/current_document.php?id=15362) AHG9: On the encoder optimization information SEI message [M. M. Hannuksela (Nokia)]

Chaired by S. Deshpande on 27 March 2025 from 09:10 to 09:20 and 13:00 onwards.

The contribution proposes the following changes relating to the encoder optimization information (EOI) SEI message:

1. It is proposed to change the semantics of eoi\_type to allow extensions in future VSEI versions as follows:
2. The value of eoi\_type shall be in the range of 0 to 63, inclusive, in bitstreams conforming to this version of this Specification.

Decision: Agreed to this sensibility range value.

1. When the value of eoi\_type is greater than or equal to 64, VSEI v4 decoders are required to parse the EOI SEI message syntax until the last syntax element specified in VSEI v4 and ignore all remaining syntax elements.

This relates to requiring that any possibly added new elements in V5 should go after current syntax elements.

This item is related to item 1 in JVET-AL0123 and was discussed together.

Decision: Agreed

1. It is proposed to specify the value range of eoi\_quant\_threshold\_delta as follows:
2. To limit the count of bytes needed to store the value of eoi\_quant\_threshold\_delta, it is proposed to constrain its value to be in the range of 0 to 65 535, inclusive, in the VSEI text.
3. It is proposed to constrain the value of eoi\_quant\_threshold\_delta in the VVC interface text of the EOI SEI message so that the resulting QP threshold is within the valid QP range of VVC, namely in the range of −QpBdOffset to +63, inclusive.

This item is related to item 12 in JVET-AL0123 and was discussed together.

It was asserted that max range for AVC, HEVC is 0-99 and for VVC 0-111 and so JVET-AL0123 proposes range 0-255. The proponent had considered reserving a larger value range for a potential future codec. Another comment was to use an upper range value between 255 to 65535.

It was commented that giving a more neutral name to such an syntax element is what we had done for another similar syntax (e.g. nnpfc strength value) i.e. not name it with the word “quant” in the name. This was delegated to the editors.

Regarding the item 2b here and item 12, the exact proposed language is slightly different but is similar in spirit, with one difference being if the upper bound value is included or excluded. A revisit to confirm if the upper bound value is included or excluded.

Decision: Agree to use range of 0 to 1023 in VSEI specification. Also agreed to specifying the range in VVC, with exact language delegated to the editors. The aspect of syntax element renaming is delegated to the editors.

1. It is proposed to replace "access unit" with "picture unit" in the semantics of eoi\_src\_pic\_flag.

It is asserted that the term “the capture unit in the same access unit” is ambiguous.

This is same as item 8 of JVET-AL0123.

Decision: Agreed

[JVET-AL0123](https://jvet-experts.org/doc_end_user/current_document.php?id=15448) AHG9: On the encoder optimization information (EOI) SEI message [J. Xu, Y.-K. Wang (Bytedance)]

Chaired by S. Deshpande on 27 March 2025 at 13:25

This contribution proposes the following changes for the encoder optimization information (EOI) SEI message:

1. Specify a valid range for eoi\_type.

See notes under item 1 of JVET-AL0056.

1. Signal original source picture width minus 1 and original source picture height minus 1.
2. Specify a constraint on the original source picture width and height to avoid conflicts in semantics.

It was commented that this is to avoid a case where encoder does something redundant and it does not seem harmful. The exact wording regarding meaning of variable EoiSpatialResamplingFlag was discussed and was asserted to indicate that resampling had taken place. It was commented that may be this can be described in a note with a slightly softer language, also the use of “cropped decoded picture width/ height” seems to refer to codec characteristics. There was some confusion if the proposed language covers both cases. It was asked if we should have interface variables defined to make the constraint very specific. Editors to handle the exact language.

1. Clarify the semantics of eoi\_object\_based\_idc.

It was commented by two participants that any optimization done by EOI can be prior to encoding or during encoding. Also encoder implementation may not be clear about what is before and during encoding. It was thus agreed to remove the words “prior to encoding” from bitmask 0x01 semantics.

1. Specify a constraint on eoi\_object\_based\_idc to disallow some conflicts.

It was commented that adding it for ( eoi\_object\_based\_idc & 0x01) combination is not necessary. Constraint for the values ( eoi\_object\_based\_idc & 0x04 ) and ( eoi\_object\_based\_idc & 0x08 ) makes sense but it was asked if this should be a note.

Decision (ed.): Delegated to the editors to add a note as describe above.

1. Clarify the semantics of eoi\_privacy\_protection\_method\_idc.

It was commented that “privacy information” is not be better than “personal information”. The change about “prior to encoding” should not be done as discussed related to item 4 above.

No action on this aspect except change the word “undiscernible” to “unidentifiable”.

1. Change the values of different privacy protection methods.

There were use cases described to allow combinations, so no action was taken.

1. Fix the semantics of eoi\_src\_pic\_flag.

See notes under item 3 of JVET-AL0056.

1. Enable signalling of eoi\_src\_pic\_flag when eoi\_num\_int\_pic is equal to 0.

It was commented that for the value 0 for eoi\_num\_int\_pics the eoi\_src\_pic\_flag may not be meaningful. It was asked if encoder always knows which is the original source picture if temporal interpolation was done before encoder. It was answered that in that case eoi\_num\_int\_pics can be set to 0 and current if condition does not need to signal eoi\_src\_pic\_flag. A participant thought that the encoder should still know in this case which is the original source picture. It was commented that in general the encoder might or might not know instead of does or does not know.

It was delegated to the editors to clarify the meaning of the semantics of eoi\_num\_int\_pics equal to 0 to clarify that encoder might not know which pictures are the source pictures.

1. Signal two flags to indicate horizontal and vertical spatial resampling type.

JVET-AL0310 is related and provides another option and was discussed together with this.

In JVET-AL0310 instead of using 2 flags, 2 idcs are used providing more information.

First question is if we want to allow indicating different resampling factors in horizontal and vertical dimensions and what are the use cases for that. It was questioned if there are practical use cases that picture is stretched in one spatial dimension and contracted or kept the same in the other dimension.

It was commented that this is a bit of a feature change and it was agreed by a proponent that this is not a bug-fix. It was asked if this can be done after v4 and it was commented that the syntax for that would be a bit different. It was commented by proponents that this can be considered a necessary change.

Decision: agreed to JVET-AL0310.

1. Extend eoi\_privacy\_info\_type by 1 bit.

It was commented that the “object” as proposed here is very general. It was also asked if we should only define specific types of objects (e.g. computer screen). It was commented if this would make people not specify type of privacy values defined by just setting this bit to 1 instead.

It was asked if background blurring would set this bit to 1. It was commented that the current bit 0x04 could be used for that.

No action taken at this meeting.

1. Specify range constraint for eoi\_quant\_threshold\_delta.

See notes under item 2 of JVET-AL0056.

Decision: Agreed on items 2, 3 and other items as noted above.

[JVET-AL0221](https://jvet-experts.org/doc_end_user/current_document.php?id=15548) AHG9: EOI SEI message with luma range adaptation for machine analysis [T. Partanen, M. M. Hannuksela, H. Zhang, A. Aminlou (Nokia)]

Chaired by S. Deshpande on 27 March 2025 at 15:25

The contribution proposes to include the TuC design of luma range adaptation for the encoder optimization information (EOI) SEI message into VSEI v4 with the following changes:

1. Addition of eoi\_luma\_adaptation\_idc, which specifies the type or method for luma range adaptation and for which the following values are specified:
   1. Value 0 specifies that the luma value range has been adapted for display power saving.
   2. Value 1 specifies that luma sample values have been pre-processed by multiplying with lumaRatioMult, which is derived from eoi\_ratio\_luma\_value and eoi\_ratio\_luma\_sign\_flag.
2. Gating of the presence of eoi\_display\_model by eoi\_luma\_adaptation\_idc equal to 0.
3. When eoi\_luma\_adaptation\_idc is equal to 1, addition of eoi\_backscale\_ratio\_value, which indicates whether and by which factor the decoded luma sample values were scaled back in the encoding system when deriving performance metrics (e.g., mAP) used for optimizing the luma range. Decoding systems can use the same back-scaling ratio in their operation.

The contribution provides experiment results as a showcase for demonstrating the usefulness of the proposed signalling for machine analysis tasks. Experiments on the OpenImages dataset on object detection and segmentation task show that the proposed adaptive luma down-scaling and back-scaling predictions achieve -28.6% and -25.0% BD-rate reduction. Version 2 of the contribution adds showcase results on the SFU dataset on object detection task, with -13.2% (LD), -11.7% (RA), and -9.7% (AI) BD-rate reductions.

V2 was discussed.

It was commented that for SFU the back-scaling was computed on the first picture and used for entire sequence.

It was commented that for machine analysis, whether chroma should also be used. The proponent commented that use of chroma has not been tried in this contribution and in JVET-AH0115.

It was asked if this adaptation should be done as bit-depth truncation or more fine grained as proposed here. It was commented by proponents that bit-depth truncation is special case and NN chose more fine grained values and not just 1 bit truncation.

It was asked with the additional changes the purpose description should clarify the additional aspect supported.

It was asked if nonlinear luma adaptation or other ways of doing luma adaptation should be studied and if this is added to VSEI v4, how that would work. It was commented by proponent that the eoi\_luma\_adaptation\_idc can provide further extensibility in future.

Multiple participants commented that this is interesting, but more suitable for TuC at this stage.

Decision: agreed to add to TuC

It was asked by proponent of JVET-AH0115 to consider including that document also in TuC. It was commented that the addition of JVET-AL0221 is a superset of JVET-AH0115 and the additional aspect which is for chroma did not have any results. It was suggested to do further study of JVET-AH0115 which has similar motivation.

[JVET-AL0310](https://jvet-experts.org/doc_end_user/current_document.php?id=15637) AHG 9: On signalling of resampling type for EOI SEI message [C. Kim, H. Tan (LGE), J. Xu, Y.-K. Wang (Bytedance)] [late]

This contribution provides a solution option for the problem assertd by contribution JVET-AL0123 item 10. It is asserted that the problem of different resampling types for different dimensions is a valid problem.

This contribution proposes to use two indications for signalling the resampling types (i.e., for horizontal and vertical dimensions) in encoder optimization information (EOI) SEI message. The detail of the suggested modification is as follows:

1. Replace the current syntax element eoi\_spatial\_resampling\_type\_flag with two 2-bits indication syntax elements called eoi\_spatial\_hor\_resampling\_type\_idc and eoi\_spatial\_ver\_resampling\_type\_idc.
2. For each idc, the semantics of the values is as follows:
   * 0 means no resampling is applied in that dimension.
   * 1 means subsampling is applied in that dimension.
   * 2 means upsampling is applied in that dimension.
   * 3 is reserved.
3. Add a constraint such that when these two indications are present, their values shall not both be equal to 0.

Compared with the modification suggested in JVET-AL0123, where two flags are used to indicate resampling type in two dimensions, the solution described in this contribution provides more resampling information.

See the notes under JVET-AL0123 item 10.

### Object mask information SEI message *(*3)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0066](https://jvet-experts.org/doc_end_user/current_document.php?id=15372) AHG9: Lossy compression with Object mask info SEI [J. Boyce, M. M. Hannuksela (Nokia)]

Chaired by S. Deshpande on 27 March 2025 at 16:00

The process described in the OMI SEI message to map sample positions to mask ID values compares the decoded auxiliary picture samples to signaled sample values. The process requires an exact match between the decoded sample value and the omi\_aux\_sample\_value[ i ][ j ], which is not robust to lossy compression. It is proposed to modify the OMI SEI message to add robustness to lossy compression by adding syntax elements for an exact match flag and a tolerance value.

It was asked by a participant if encoder needs to give an indication to the decoder about exact match and separately to signal the tolerance range.

Proponent commented that it is also possible to consider an option where encoder signals exact match flag only and a note is added regarding how decoder could handle it in that case. It was commented that exact match flag by itself is not that helpful as it is just an indication. The proponent commented that the tolerance value can also be signaled unconditionally.

It was asked if decoder can figure out if it is lossy or lossless compression. One participant commented that the tolerance still can’t guarantee exact match. It was commented by proponent that exact match flag is just a recommendation and does not guarantee exact match. It was commented that tolerance value of 0 can indicate same information as exact match flag.

Decision: agreed (editors to consider renaming exact match flag to another name)

[JVET-AL0067](https://jvet-experts.org/doc_end_user/current_document.php?id=15373) AHG9: On the OMI SEI [J. Boyce, M. M. Hannuksela (Nokia)]

Chaired by S. Deshpande on 27 March 2025 at 16:25

Based on a study of the text of the OMI SEI message, a number of small changes are proposed to improve clarity of the design, summarized as follows.

* Item 1: Require non-zero width and height of bounding boxes:

It was commented that for AR SEI regions width and height could be 0 (e.g. for cursors or something similar). It was commented by proponent that this SEI may not be supporting such use cases. It was commented that cursor example may be a bounding box of size 1 instead of zero-sized bounding box.

Decision: Agreed

It was suggested to add an editorial note to AR SEI for zero-size bounding boxes.

* Item 2: Clarify that bounding box parameters are in units of chroma samples:

It is asserted that the mapping process does not use chroma sample units, but ranges of some syntax are considering chroma samples.

It was asked how the software implements this. It was commented that the original design intent was to do this in luma domain.

Instead of making the proposed change, the range values highlighted in cyan could be modified to do things in luma sample value units.

A non-proponent thought doing this in chroma sample units may be better.

Another participant commented that in multiple places in specification we have text defining things in units of luma sample and putting constraints in other places and so it was preferred to do it that way. This was supported by multiple participants. It was commented that AR SEI seems to use a multiplication by SubWidthC and SubHeightC.

An example text from AR SEI was:

The identified object rectangle contains the luma samples with horizontal picture coordinates from SubWidthC \* ( ConfWinLeftOffset  + ar\_bounding\_box\_left[ ar\_object\_idx[ i ] ] ) to SubWidthC \* ( ConfWinLeftOffset  + ar\_bounding\_box\_left[ ar\_object\_idx[ i ] ] + ar\_bounding\_box\_width[ ar\_object\_idx[ i ] ] ) − 1, inclusive, and vertical picture coordinates from SubHeightC \* ( ConfWinTopOffset + ar\_bounding\_box\_top[ ar\_object\_idx[ i ] ] ) to SubHeightC \* ( ConfWinTopOffset + ar\_bounding\_box\_top[ ar\_object\_idx[ i ] ] + ar\_bounding\_box\_height[ ar\_object\_idx[ i ] ] ) − 1, inclusive.

Also VVC cropping window may be doing it similarly.

Virtual boundaries were specified differently for a reason (of being divisible by 8).

Initially there was support to modify the change the cyan highlighted constraints instead to be consistent with using units of luma samples. Additionally add a constraint that relevant bounding box parameters mod width or height is equal to 0.

Subsequent discussion resulted in more support to make this consistent with AR SEI and cropping in VVC.

Decision: Agreed to make the change as proposed, but not to use the words “chroma samples”.

* Item 3: Clarify that the mask mapping process uses luma samples

Decision: Agreed, add word “luma” as proposed.

* Item 4: Require that cropped width and height of the auxiliary pictures be equal to those of the primary picture

About the first proposed constraint: It was asked if the first proposed constraint is too strict. The OMI SEI is associated with primary layer. Multiple auxiliary picture layers correspond to the use case of object overlap. It was agreed instead to add a language to say that the entire OMI SEI should be ignored if any of the auxiliary picture layers that are referred are not present.

About the second proposed constraint: It was asked if the second proposed constraint is too strict. It was asked if it is not sufficient that the mask is smaller the primary picture size. It was agreed to do this by requiring that the mask is within the auxiliary picture size and it can be smaller than primary picture size and exact wording is delegated to the editors.

* Item 5: Allow different luma bit-depths for the primary layer and the object mask auxiliary layers. Change it proposed to VSEI and VVC interface text. It was asked if it is allowed currently to have different bit depths for auxiliary and primary pictures. It was commented that this is only allowed if it is scalably coded. It was commented that currently the VSEI spec text does not explicitly prohibit having different bit depth values. It was suggested to define a higher value range for omi\_mask\_sample\_value\_length\_minus8 instead in VSEI and to specify it to be less than BitDepthY in VVC interface text.

Revisit to review the text.

[JVET-AL0071](https://jvet-experts.org/doc_end_user/current_document.php?id=15377) AHG9: On OMI SEI message [Y. He, M. Karczewicz (Qualcomm)]

Chaired by S. Deshpande on 28 March 2025 at 05:00

This contribution proposes the following constraints for the OMI SEI message in VSEIv4.

1. Constrain the i-th auxiliary layer object mask identifiers, omi\_mask\_id[ i ][ j ] and omi\_mask\_id[ i ][ k ], shall be different when j is not equal to k.

There was a discussion regarding usefulness of allowing the repetition of mask id as currently supported in our specification, within the same SEI message. A participant commented that usually ids should be unique. Another participant commented that in the current design id values are unique. A participant commented that repeating an SEI message is ok but repeating same information in one SEI message is not common and not desirable.

Decision: agreed.

1. Add constraint that the value of omi\_num\_mask\_in\_pic[ i ] shall be greater than 0, for at least one value of i, when OMI SEI message is the first OMI SEI message. Such constraint prevents the first OMI SEI message from containing no object mask.

Some possible corner cases which may desire the behavior as per the current specification were discussed. It was commented that the current related constraint which is in the specification was added in the last meeting to do correct initialization of OMI masks. The current design intent is to allow a first OMI SEI with empty masks and this constraint will prevent that. So no action was taken on this item.

1. Add constraint to avoid empty object mask. It requires at least one sample pI[ i ] [ x ][ y ] at location (x, y) in the cropped object mask picture in the i-th auxiliary layer associated with the current primary layer is associated with the object mask with the identifier of MaskId [ i ][ j ]

Multiple participants commented that doing this may be unnecessary and lossy compression or the case where objects may appear and disappear may cause issues if this constraint is imposed. Also checking this constraint may be cumbersome for an encoder. So no action was taken on this item.

### Generative face video SEI messages (3)

Contributions in this area were discussed during 0515–0645and XXXX–XXXX on Friday 28 March 2025 (chaired by J. Boyce).

[JVET-AL0102](https://jvet-experts.org/doc_end_user/current_document.php?id=15427) AHG9/AHG16: SEI message and further experiments on QP-adaptive GFVC [W. Kang, L. Liu, C. Jung (Xidian Univ.)]

This contribution provides further experiments incorporating SEI messaging into the QP-adaptive GFVC framework (JVET-AK0069) on 256x246 and 512x512 test sequences from Classes A, B, C and D, in accordance with JVET AHG16's feedback. The results on the 256x256 test set in SEI mode reveal that the QP-adaptive GFVC achieves BD-rate reductions of 11.32% in DISTS and 10.3% in LPIPS. Moreover, when evaluated on both the 256×256 and 512×512 test sets, the QP-adaptive GFVC demonstrates BD-rate reductions of 16.57% in DISTS and -1.89% in LPIPS. The results verify the robustness and effectiveness of the QP-adaptive GFVC in enhancing perceptual quality and compression efficiency across different resolutions and compression conditions.

The proposal aims to improve quality. The provided syntax and semantics seem incomplete. A change to the software is proposed.

A question was raised about the experimental results for the 512x512 and how bitrate was reduced given that additional syntax was signalled.

The proposal seems to not fit within our guidelines of changes to be made to VSEI v4 at this meeting.

It was suggested to have side discussion with the original proponents of GFVC.

[JVET-AL0155](https://jvet-experts.org/doc_end_user/current_document.php?id=15480) AHG9: Further fixes and cleanup on GFV and GFVE SEI messages [J. Chen, B. Chen, Y. Ye (Alibaba)]

Aspect 1: remove the inference for the syntax elements gfv\_num\_matrices\_equal\_to\_num\_kps\_flag[ i ], gfv\_num\_matrices\_info[ i ], gfv\_matrix\_width\_minus1[ i ], gfv\_matrix\_height\_minus1[ i ] gfv\_num\_matrices\_minus1[ i ] and gfv\_matrix\_for\_3D\_space\_flag[ i ] in case of prediction being enabled.

Aspect 2: modify the inference for the syntax element gfv\_matrix\_for\_3D\_space\_flag[ i ] to align the semantics and simplify the inference for the syntax elements gfv\_matrix\_width\_minus1[ i ] and gfv\_matrix\_height\_minus1[ i ].

Aspect 3: modify the inference condition for the syntax elements gfv\_matrix\_element\_precision\_factor\_minus1 and gfv\_num\_matrix\_types\_minus1 for text cleanup.

Aspect 4: remove redundant process in the derivation of variable numMatrices[ i ].

Aspect 5: remove unnecessary constraint on gfv\_num\_matrix\_types\_minus1

Aspect 6: remove unnecessary constraint on numMatrices[ i ], matrixWidth[ i ] and matrixHeight[ i ].

Aspect 7: add the inference for the syntax elements gfve\_matrix\_element\_precision\_factor\_minus1, gfve\_num\_matrices\_minus1, gfve\_matrix\_height\_minus1[ i ] and gfve\_matrix\_width\_minus1[ i ] which is currently missing from the text.

Aspect 8: change a constraint in VVC spec. to allow signalling multiple GFV and GFVE SEI messages with different content within one picture unit.

Aspect 1, Aspect 2, Aspect 4 agreed. (Editorial)

For aspect 3, the change to semantics of gfv\_matrix\_element\_precision\_factor\_minus1 is agreed, with addition of removing “when gfv\_matrix\_present\_flag is equal to 1”. For the semantics of gfv\_num\_matrix\_types\_minus1, can just say when “gfv\_matrix\_pred\_flag is equal to 1". Aspect 3 agreed with noted changes and editorial cleanup delegated to the editors.

Revisit aspect 5, aspect 6.

Aspect 7, Aspect 8 agreed.

[JVET-AL0156](https://jvet-experts.org/doc_end_user/current_document.php?id=15481) AHG9/AHG16: Colour calibration for generative face video coding [J. Chen, B. Chen, Y. Ye (Alibaba), S. Yin, S. Wang (CityUHK)]

This contribution proposes to add a colour calibration process on the generated face pictures as an optional post-processing to solve the occasional colour shift issue observed in some generated pictures by the proponent. Three options are provided in the contribution as follows.

Option 1: add a calibration flag in the GFV SEI message and perform colour calibration on the generated picture based on the distribution parameters derived from the current decoded picture when the calibration flag is on.

Option 2: add a calibration flag in the GFV SEI message and signal the color distribution parameters when the flag is on, and perform the color calibration on the generated pictures based on the distribution parameters signaled.

Option 3: add an indication flag in GFV SEI message to indicate whether the current generated picture can be used for the colour calibration of the current generated picture.

This contribution proposes a new feature for quality improvement.

It was questioned if this change could be done in an extension rather than in VSEI v4.

It was suggested to just add a note in the v4 semantics that a decoder may choose to apply color calibration.

Some sample images for option 1 were provided. Video examples can be provided.

No comparison of the three options was provided.

A suggestion was made to clarify in which colour space the colour calibration should be performed.

Some support was expressed for option 3 with some modifications to the language, because it was the simplest option with least change to the specification. Suggested language to consider: ".. the current decoded picture is suitable for colour correction …"

It was suggested to study calibration using the previous reconstructed or source picture.

Revisit after discussion in 4.15 and after video examples are provided.

### Digitally signed content SEI messages (11)

Contributions in this area were discussed during 0645–1030 and 1300–1630 on Friday 28 March 2025 (chaired by J. Boyce).

[JVET-AL0078](https://jvet-experts.org/doc_end_user/current_document.php?id=15403) AHG9: On Digital Signing [S. Deshpande (Sharp)]

Following is proposed related to digital signing:

* Proposal 1: Signaling is proposed to allow digitally signing a SEI message.
* Proposal 2: A syntax rearrangement is proposed for syntax elements in the digitally signed content initialization SEI message.
* Proposal 3: It is proposed to signal a tag URI as an identifier in digitally signed content initialization, digitally signed content selection and digitally signed content verification SEI messages. Alternatively, a modification is proposed to the inference of dscs\_id.

Additional syntax elements would be added to any SEI message that was desired to be signed. It would be possible to add these syntax elements to newly defined SEI messages. For existing SEI messages, it may be possible to include the additional syntax elements in an extension of the SEI message.

It is proposed to apply proposal 1 to the AI usage restrictions SEI message in VSEI v4.

It is proposed to individually sign each SEI message separately from the rest of the bitstream. It was suggested that it would be possible to remove the SEI message and its signature which would not be able to be detected. A signed SEI message could be added to a completely different bitstream but would still appear valid. It would be unclear what VCL that a signed SEI message applied to.

It was suggested that it would be preferable to associate the SEI message signature with the rest of the bitstream.

Further study is encouraged on proposal 1.

Proposal 2 rearranges some syntax elements to group key related syntax elements. Proposal 2 is agreed for VSEI v4, with the change of moving the substream information to the end of message.

Proposal 3 proposes signalling a tag URI to replace or add to the dscs\_id.

The use case proposed for the dscs\_id in JVET-AK0206 differs from than the use case described in this contribution. In this contribution, a use case is described for having multiple parties sign.

It was noted that signaling a tag URI would add significant overhead.

It was suggested that an attacker could rewrite the tag URI.

It was suggested that having the ID just indicates and enables that different, independent signing systems could be in use at the same time, while there is sufficient other information in the DSCI SEI messages to identify the different signers. I.e., the ID was not intended to provide sufficient differentiation information for different signers.

The existing semantics of the DSC IDs could be improved to make the intended purpose more clear. This is delegated to the editors. Perhaps can remove “has been produced by a content provider”.

A change is proposed for inference of DSCS verification substream ID, to be equal to the value of dsci\_id in the preceding DSCI SEI message, rather than to be equal to 0. JVET-AL0118 also has a related proposal.

It was suggested that if multiple different DSCI SEI messages with different values of DSCI ID are present, the the inference value of DSCS ID will be equal to the DSCI ID of the the DSCI SEI message that is being processed.

Revisit inference of DSCS ID after side activity led by Y.-K. Wang.

[JVET-AL0103](https://jvet-experts.org/doc_end_user/current_document.php?id=15428) AHG9: Editorial changes for the three DSC SEI messages [Y.-K. Wang, J. Xu (Bytedance)]

The changes are briefly summarized as follows:

1. Include the three DSC SEI messages in one umbrella subclause, just like the two NNPF SEI messages, or the SPO and PON SEI messages.
2. the definitions of verification period, verification NAL unit, and verification substream, and use them throughout the semantics of the three SEI messages.
3. Various other asserted editorial changes.

The detailed proposed text changes, marked relative to JVET-AK2005-v1, are included in an attachment to this contribution.

In -v2 of this contribution, the spec text changes have been updated, revoking the removal of the two constraints on relative order, between DSCI and DSCV SEI messages in an AU, and between DSCS and a DSCV SEI messages in a PU, and editorially modifying the reinstated constraints. It was later realized that although the constraints are not needed for VVC and HEVC, wherein the DSCV SEI message is specified to be contained in suffix SEI NAL units, but they are still needed for standards such as AVC wherein there is no specification of suffix SEI NAL units.

Proposal 1 editorial change to put all three DSC SEI messages in one umbrella subclause is agreed for VSEI v4.

Proposal 2 provides definitions of key terms.

Support expressed for having definitions, but the name of the verification NAL unit is suggested to be changed to verification inclusion NAL unit.

It was noted that the DSCI SEI message does not need to be changed if sub-bitstream extraction is performed because it can describe more than what is contained in the bitstream – DSCI describes a maximum number of substreams.

A -v3 to be uploaded, which is expected to include only editorial changes.

The -v3 version is agreed. (Editorial)

[JVET-AL0115](https://jvet-experts.org/doc_end_user/current_document.php?id=15440) AHG9: Substream dependency signalling in the DSCI SEI message [Y.-K. Wang (Bytedance), Y. Li, K. Yang (SJTU), J. Xu (Bytedance), Y. Xu (SJTU)]

It is asserted that the substream dependency signalling in the DSCI SEI message though the two loops of the reference substream flag syntax element has redundancy. For example, if substream ss2 depends on substream ss1, and substream ss3 depends on ss2, then it is known that ss3 depends on ss1 and thus that dependency does not need to be signalled but can be inferred.

This contribution proposes a change to the DSCI SEI message syntax to avoid such redundancy, through a derived variable flag to condition the presence of the reference substream flag syntax element.

The detailed proposed text changes are provided in an attachment to this contribution. The changes are marked relative to the spec text provided in JVET-AL0103, which includes asserted purely editorial changes to the DSC SEI messages based on JVET-AK2006-v1.

The goal of the proposal is to save bits. No data is provided on the amount of bitrate savings.

It was suggested that the proposed change would require more analysis of dependencies to parse the SEI message.

In was suggested that in HLS designs we often try to avoid signaling redundancies.

No action.

[JVET-AL0116](https://jvet-experts.org/doc_end_user/current_document.php?id=15441) AHG9: On DSCI content UUID [Y. Li (SJTU), J. Xu, Y.-K. Wang (Bytedance), K. Yang, Y. Xu (SJTU)]

Currently, the content UUID is required to be present when there is at least one independent non-base layer (INBL). The motivation can be seen from the JVET-AK meeting minutes for JVET-AK0287: "*For independent non-base layer, uuid is required to be included for verification to avoid tampering.*" However, if an INBL is depended by a higher layer, then tempering of the INBL can be detected. Therefore, it is asserted that dependency by higher layers should also be taken into consideration on requiring the presence of content UUID.

This contribution proposes such changes to the DSCI SEI message semantics.

The changes are summarized as follows:

1. Replace the variable IndependentNonBaseSubstreams with NumFullyIndependentSubstreams, which is derived to be equal to the number of substreams that do not depend on other substreams and are not depended by other substreams.
2. When dsci\_key\_retrieval\_mode\_idc is equal to 0 or NumFullyIndependentSubstreams is greater than 0, dsci\_content\_uuid\_present\_flag shall be equal to 1.

The detailed proposed text changes are provided in an attachment to this contribution. The changes are marked relative to the spec text provided in JVET-AL0103, which includes asserted purely editorial changes to the DSC SEI messages based on JVET-AK2006-v1.

A fully independent substream does not have any other substreams that depend on it, in addition to not depending on another substream.

It was suggested that the original design intent for requiring the UUID for independent non-base layers was to avoid tampering.

The proposal relaxes the requirements for presence of UUID so that it doesn’t apply in as many cases as the existing design.

No action.

[JVET-AL0117](https://jvet-experts.org/doc_end_user/current_document.php?id=15442) AHG9: On association of NAL units to DSC verification substreams [Y.-K. Wang, J. Xu (Bytedance), Y. Li, K. Yang, Y. Xu (SJTU)]

Currently, relevant NAL units are associated to a verification substream either explicitly by signalling the verification substream ID in a DSCS SEI message present in a PU, or implicitly by inferring the verification substream ID equal to 0. Therefore, for bitstream with multiple layers and/or multiple temporal sublayers where each operation point corresponds to one verification substream, for each PU in a non-base layer or non-base sublayer, a DSCS SEI message needs to be included in the PU. However, when each operation point corresponds to one verification substream, which is asserted to be a typical case, the verification substream ID values can be inferred thus avoid sending lots of DSCS SEI messages.

This contribution proposes changes that supports such an implicit association of relevant NAL units to verification substreams.

changes are summarized as follows:

1. Add three interface variables (LayerId, SubLrId, and MaxNumSubLrs), in both the SEI message semantics and the VVC interface text, for layer ID, sublayer ID, and the maximum number of sublayers.
2. Add a flag dsci\_vss\_implicit\_association\_mode\_flag to the DSCI SEI message to indicate whether the inference of verification substream ID is according to the values of MaxNumSubLrs, LayerId, and SubLrId, or is simply inferred to be equal to 0.
3. In the DSCS SEI message semantics, specify that, if dsci\_vss\_implicit\_association\_mode\_flag is equal to 1, the verification substream ID value is inferred to be equal to MaxNumSubLrs \* LayerId + SubLrId, and otherwise inferred to be equal to 0.

The detailed proposed text changes to VSEI and to VVC are separately provided in two attachments to this contribution. The VSEI changes are marked relative to the spec text provided in JVET-AL0103, which includes asserted purely editorial changes to the DSC SEI messages based on JVET-AK2006-v1. The VVC changes are marked relative to JVET-AK2005-v2.

Interface text for AVC is not provided, and will likely require some changes vs. the VVC interface.

It is noted that the temporal ID of non-VCL NAL units may not be known until VCL NAL units are available, so may require a change in decoder operation.

A single flag is added to the syntax, and additional changes to the inference semantics of the DSCS SEI.

This approach could not easily be added later as an extension.

The proposal has bitrate savings for every PU when multiple substreams are present, which may be substantial.

Decision: Conditionally adopt to VSEI v4, subject to review of AVC and HEVC interface text.

[JVET-AL0118](https://jvet-experts.org/doc_end_user/current_document.php?id=15444) AHG9: Miscellaneous changes for the three DSC SEI messages [Y.-K. Wang, J. Xu (Bytedance), Y. Li, K. Yang, Y. Xu (SJTU)]

This contribution proposes the following changes for three digitally signed content (DSC) SEI messages, namely the digitally signed content initialization (DSCI) SEI message, the digitally signed content selection (DSCS) SEI message, and the digitally signed content verification (DSCV) SEI message:

1. Add definitions of GDR picture and GDR AU, update the definition of IRAP AU accordingly, and change the constraint on presence of DSCI SEI messages to be: When a DSCI SEI message with a particular dsci\_id value dscIdVal is present in any AU of a CVS, a DSCI SEI message with dsci\_id equal to dscIdVal shall be present in each IRAP or GDR AU in the CVS.
2. Replace the asserted unclear constraint on content of DSCI or DSCV SEI messages with the following: All DSCV SEI messages having a particular value of dscv\_id and a particular value of dscv\_vss\_id in a verification period for dsci\_id equal to the particular value of dscv\_id shall have the same content.
3. Add the DSC ID aspect to the constraint on presence of DSCS SEI messages so that it becomes the following: When a CVS does not contain a DSCI SEI message with a particular dsci\_id value dscIdVal, the CVS shall not contain a DSCS SEI message with dscs\_id equal to dscIdVal.
4. Infer the value of dscs\_id to be equal to the dsci\_id of the associated DSCI SEI message (instead of to be equal to 0) when a DSCS SEI message is not present in a PU.
5. Add the following constraint on relative order between DSCS and DSCV SEI messages in an AU: When an AU contains a DSCS SEI message with dscs\_id equal to dscIdA and dscs\_vss\_id equal to vssIdA and a DSCV SEI message with dscv\_id equal to dscIdA and dscv\_vss\_id equal to vssIdA, the DSCS SEI message shall precede the DSCV SEI message in decoding order.
6. Change the constraint on absence of relevant verification NAL units after the current DSCV SEI message to be after the current PU, such that the constraint becomes the following: Within the current verification period, there shall be no verification NAL unit of the verification substream with verification substream ID equal to dscv\_vss\_id succeeding the current PU in decoding order.
7. Change the derivation of reference digests for fixing two asserted bugs.
8. Clarify that all concatenation operations of verification NAL units and, when needed, reference digests, for obtaining a message used for calculating the message digest, or for constructing the identification string for a verification substream, are performed in decoding order for verification NAL units and in increasing order of refIdx for reference digests.

The discussions and the detailed proposed changes are based on the spec text provided in JVET-AL0103, which includes asserted purely editorial changes to the DSC SEI messages based on JVET-AK2006-v1.

In -v2 of this contribution, for item 7 a different proposed change was included for fixing the two asserted bugs.

Proposal 1 agreed, with the wording of the definition of IRAP is suggested to be changed to replace “and” with “such that when”. The exact language is delegated to the editors.

Proposal 2 identifies an unclear constraint on content of DSCI or DSCV SEI messages. Related proposals in JVET-AL0222 and JVET-AL0131 identify the same problem but propose a different spec change to address.

Agreed to remove the constraint.

Proposal 3 agreed.

Proposal 4 is related to side activity.

Proposal 5 agreed.

Proposal 6 is already covered in JVET-AL0103-v3.

For proposal 7, it is suggested that some constraint may be needed, and to possibly add language “in the current verification period” in the determination of the reference digest.

Revisit proposal 7.

Proposal 8 agreed.

Decision: adopt to VSEI v4 as noted above.

[JVET-AL0119](https://jvet-experts.org/doc_end_user/current_document.php?id=15443) AHG9: Support of low-delay DSC verification process [Y.-K. Wang, J. Xu (Bytedance), Y. Li, K. Yang, Y. Xu (SJTU)]

Currently, within a verification period (the period between two consecutive DSCI SEI messages), it is not allowed to have multiple DSCV SEI messages for a particular substream while between some of these DSCV SEI messages there are verification NAL units for the verification substream. It is asserted that this results in a delay issue, as the verification of any substream can only be performed at the end of a verification period.

This contribution proposes changes to allow verifying a subset of a substream while the verification NAL units are being received, before the reception of the entire substream.

The changes are summarized as follows:

1. Within a verification period, it is allowed to have multiple DSCV SEI messages for a particular substream while between two consecutive DSCV SEI messages there are verification NAL units for the verification substream.
2. It is specified that dscv\_signature contains the digital signature for the current verification substream subset, which consists of only those verification NAL units for the verification substream present in the current PU or in PUs earlier in decoding order in the current verification period, and the derivation of the current and reference digests is updated accordingly.

The detailed proposed text changes to VSEI are provided in an attachment to this contribution. The VSEI changes are marked relative to the spec text provided in JVET-AL0103 plus the asserted bug fix proposed in JVET-AL0118 item 7. The spec text provided in JVET-AL0103 includes asserted purely editorial changes to the DSC SEI messages based on JVET-AK2006-v1.

In -v2 of this contribution, the basis text for detailed proposed text changes to VSEI has been updated for using the updated asserted bug fix for JVET-AL0118 item 7 in JVET-AL0118-v2. The actual changes proposed in the contribution itself have not been changed.

The proposal allows to send multiple DCSV SEI messages for a substream for the same DSCI SEI, without requiring repeating of the DSCI SEI.

It was noted that the existing design has alignment of verification of all substreams when a new DSCI is present, and was suggested that this proposal does not require alignment of verification of all substreams.

It was suggested to do a comparison of tradeoffs between shortening the verification period using the existing design vs. the proposed design with multiple DSCV SEI messages in a verification period, including understanding the practical amount of delay needed and understanding the implementation burden. It was suggested that sub 1 second delay may not be required.

It is noted that the DSCV SEI message is large compared to the DSCI SEI message.

No action.

[JVET-AL0131](https://jvet-experts.org/doc_end_user/current_document.php?id=15456) AHG9: Proposed changes for miscellaneous aspects of SEIs in VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*Aspects on DSC – JVET- AL0131 also relates to the AI usage restrictions and packed regions SEI messages*

See notes on JVET-AL0118 for aspect 1.

[JVET-AL0132](https://jvet-experts.org/doc_end_user/current_document.php?id=15457) AHG9: Editorial updates for VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*Aspects on DSC – JVET- AL0132 also relates to the packed regions and image format metadata SEI messages*

This contribution proposes several editorial modifications for VSEI v4 draft. The proposed modifications are as follows:

(Related to DSC SEI messages)

1. Clarify the semantics related to IDs

See notes on JVET-AL0103 for aspect 1.

[JVET-AL0186](https://jvet-experts.org/doc_end_user/current_document.php?id=15511) AHG9: Subpicture support for digitally signed content SEI messages [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

This contribution proposes changes to the digitally signed content SEI messages to support content verification of extracted coded picture segments, where a picture segment is a subpicture for VVC.

It is asserted by the proponents that although the solution of the digitally signed content SEI messages supports verification of the digital signature when pictures in higher temporal sublayers or layers are pruned from the bitstream, the current solution does not support verification of the digital signature for extracted subpictures.

An additional mode is proposed to be added, and three different options are presented:

1. When the proposed mode is enabled, a picture segment ID is added to the digitally signed content selection SEI message that indicates which coded picture segments to associate with the verification substream.
2. When the proposed mode is enabled, a flag for each VCL NAL unit in the PU is signalled in the digitally signed content selection SEI message. The flag indicates whether or not the corresponding VCL NAL unit is included in the verification substream.
3. When the proposed mode is enabled, the content selection SEI message indicates that the first PH, APS, or VCL NAL unit that follows the SEI message in decoding order is included in the verification substream.

For all options above, the proposed mode may be enabled for VVC if sps\_subpic\_info\_present\_flag is equal to 1 but is always disabled for AVC and HEVC.

In all of the options, SPS and PPS are not associated with any verification substream when the proposed mode is enabled, since it is asserted that SPS and PPS need to be rewritten when extracting coded subpictures from a bitstream.

It was questioned if use of the scalable nesting or regional nesting SEI messages could address the use case.

It was suggested that if all coded subpictures are available at the decoder, signatures for the full coded pictures can be used to verify the subpictures. However, if sub-bitstream extraction is performed prior to transmission of the bitstream by the decoder, it may be desirable to separately verify the subpictures.

Option 1 proposes excluding the SPS and PPS from the ref digest calculation, to handle rewriting. It was questioned if that would impact tamper resistance.

The proposed Option 2 DSCS SEI message has a parsing dependency on the DSCI SEI message

Option 3 proposes adding a DSCS SEI for each NAL unit, which has more overhead.

Some concern was expressed about including in VSEI v4.

It was suggested that region based verification may be of interest beyond sub-bitstream extraction. It might be interesting to sign groups of subpictures.

The proposal is written for VSEI v4 and not as an extension.

Decision: Add to the TuC including all options, but based on a JVET-AL2006 document as the base text.

[JVET-AL0222](https://jvet-experts.org/doc_end_user/current_document.php?id=15549) AHG9: On Digitally Signed Content SEI messages [K. Sühring, T. Hinz, Y. Sanchez, J. Pfaff, H. Schwarz, D. Marpe, T. Wiegand (Fraunhofer HHI)]

This contribution proposes to add two new flags to the digitally signed content SEI messages indicating the first and last signed segment. This allows to intentionally interrupt the signature chaining between CVSs, e.g. to allow splicing. Signalling the last signed segment also allows detection of removed access units at the end of the signed content.

The contribution also proposes a modification of the AVC interface text for improved multi-layer support.

In v2 a third aspect is added proposing a fix for a bitstream constrain on digitally signed content verification SEI.

Proposal 1 agreed.

Slides are presented and not available yet. Will be uploaded in a new version.

Regarding proposal 2, the existing design is able to detect manipulation (added or removed pictures) at the beginning or middle of a CVS but cannot detect removal of pictures at the end of the CVS. The proposal also addresses splicing and ad insertion.

Proposal 2 adds a flag to the DSCI SEI and a flag to the DSCV SEI. It also proposed including the signing status in the IdString used to calculate the reference digest.

It was suggested that Note 1 may also need updating.

It was suggested to improve the semantics for dscv\_signed\_content\_end\_flag. This is delegated to the editors.

For proposal 3, see notes for JVET-AL0118.

Decision: Adopt Proposals 1 and 2 to VSEI v4.

### Packed regions information SEI message *(*7+2)

Contributions in this area were discussed during 1630–1730 on Friday 28 March 2025 (chaired by J. Boyce).

[JVET-AL0070](https://jvet-experts.org/doc_end_user/current_document.php?id=15376) AHG9: On packed regions information SEI message [T. Chujoh, Z. Fan, R. Ishimoto, T. Ikai (Sharp)]

1. The loop's variable i has been started from 1. An index equal to 0 is not used.
2. The syntax element pri\_resampling\_ratio\_idx[ i ] in the array is misspelled.
3. In the syntax table of pri\_multilayer\_flag, pri\_region\_layer\_id[ i ] and pri\_region\_is\_a\_layer\_flag[ i ] are related. But, in the semantics of pri\_multilayer\_flag, pri\_region\_is\_a\_layer\_flag is not described.
4. When pri\_num\_resampling\_ratios\_minus1 equals 0, the syntax element pri\_resampling\_ratio\_idx[ i ] does not exist; however, the inferred value is not defined.
5. When pri\_target\_pic\_params\_present\_flag equals 0, the syntax elements pri\_target\_pic\_width\_minus1 and pri\_target\_pic\_height\_minus1 do not exist; however, the inferred values are not defined.
6. When pri\_targe\_pic\_params\_present\_flag equals 0, the syntax elements pri\_target\_region\_top\_left\_x[i] and pri\_target\_region\_top\_left\_y[i] do not exist. However, the target picture cannot be reconstructed without those syntax elements.
7. The regions in the input picture are packed, not overlapped. It is believed that the target regions should be defined.
8. The values of pri\_target\_pic\_width\_minus1 and pri\_target\_pic\_height\_minus1 should be constrained depending on the chroma format.
9. Depending on the chroma format, the values of the top-left sample position, the width, and the height of the rectangle regions should be constrained. However, those specifications are incomplete.
10. When pri\_multilayer\_flag equals 1, multiple layers exist. However, the basic semantics of PRI SEI seem to consider a single layer.

Regarding Item 1, the loop index is intentionally started from 1 with values for index 0 inferred.

JVET-AL0129 is also related. Revisit after JVET-AL0129 is reviewed.

Item 2 agreed.

Item 3 agreed. JVET-AL0132 Item 2 also proposes.

Regarding Item 4, it was questioned if inference is needed, because the syntax element is not used. JVET-AL0122 Item 2 also proposes. Revisit after checking if an inference value is needed.

Regarding Items 5 and 6, it was suggested that it isn’t always necessary to reconstruct a target picture, in which case reconstruction of the target picture isn’t needed. No action on items 5 and 6.

Item 7 is related to JVET-AL0129 item 3 and JVET-AL0122 Item 11. A bug has been identified in that the position in the target picture rather than the coded picture should be used. Should look at all proposals to select how to fix. Revisit.

Item 8 is related to JVET-AL0122 item 10 and JVET-AL0098 item 4. If no action is taken there, this item should be agreed. Revisit.

Item 9 proposes 3 solution options to enforcing chroma alignment. JVET-AL0122 item 7 relates to the second part of solution 1. JVET-AL0129 item 11 is related to the first part of solution 1.

Y.-K. Wang to provide a summary of related PRI proposals to make it easier to compare the alternative related proposals.

[JVET-AL0072](https://jvet-experts.org/doc_end_user/current_document.php?id=15378) AHG9: On PRI SEI message [Y. He, M. Karczewicz (Qualcomm)]

[JVET-AL0098](https://jvet-experts.org/doc_end_user/current_document.php?id=15423) AHG9: On target picture in packed regions information SEI message [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

[JVET-AL0120](https://jvet-experts.org/doc_end_user/current_document.php?id=15445) AHG9: On the packed regions information SEI message - part 1 [Y.-K. Wang, J. Xu (Bytedance)]

[JVET-AL0122](https://jvet-experts.org/doc_end_user/current_document.php?id=15447) AHG9: On the packed regions information (PRI) SEI message - part 2 [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AL0129](https://jvet-experts.org/doc_end_user/current_document.php?id=15454) AHG9: On signaling of regions in PRI SEI message [J. Lee, H. Tan, J. Nam, C. Kim, J. Lim, S. Kim (LGE)]

[JVET-AL0131](https://jvet-experts.org/doc_end_user/current_document.php?id=15456) AHG9: Proposed changes for miscellaneous aspects of SEIs in VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*Aspects on PRI – JVET- AL0131 also relates to the digitally signed content and AI usage restrictions SEI messages*

[JVET-AL0132](https://jvet-experts.org/doc_end_user/current_document.php?id=15457) AHG9: Editorial updates for VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*Aspects on PRI – JVET- AL0132 also relates to the digitally signed content and image format metadata SEI messages*

[JVET-AL0303](https://jvet-experts.org/doc_end_user/current_document.php?id=15630) AHG9: Editorial fixes to the packed regions information SEI message [F. Urban, E. François, D. Doyen, C.-H. Demarty (InterDigital)] [late]

### Image format metadata SEI message (3+1)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0068](https://jvet-experts.org/doc_end_user/current_document.php?id=15374) AHG9: On image format metadata (IFM) SEI [J. Boyce, M. M. Hannuksela (Nokia), A. T. Hinds (Tencent)]

[JVET-AL0094](https://jvet-experts.org/doc_end_user/current_document.php?id=15419) AHG9: On payload length of image format metadata (IFM) SEI [A. T. Hinds, Gilles Teniou, S. Wenger (Tencent), Chris Bai, P. Green (on behalf of ICC)]

[JVET-AL0128](https://jvet-experts.org/doc_end_user/current_document.php?id=15453) AHG9: On image format metadata SEI message [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AL0132](https://jvet-experts.org/doc_end_user/current_document.php?id=15457) AHG9: Editorial updates for VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*Aspects on IFM – JVET- AL0132 also relates to the digitally signed content and packed regions SEI messages*

### Other (4+1)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0058](https://jvet-experts.org/doc_end_user/current_document.php?id=15364) AHG9: On the AI usage restrictions SEI message [M. M. Hannuksela, L. Kondrad, K. Kammachi-Sreedhar, E. B. Aksu, J. Boyce (Nokia)]

[JVET-AL0131](https://jvet-experts.org/doc_end_user/current_document.php?id=15456) AHG9: Proposed changes for miscellaneous aspects of SEIs in VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*Aspects on AI usage restrictions - JVET- AL0131 also relates to the digitally signed content and packed regions SEI messages*

[JVET-AL0077](https://jvet-experts.org/doc_end_user/current_document.php?id=15383) AHG9: On the text description information SEI message [M. M. Hannuksela, J. Boyce (Nokia)]

[JVET-AL0130](https://jvet-experts.org/doc_end_user/current_document.php?id=15455) AHG9: Source picture timing for interlaced video with SPTI SEI message [J. Lee, H. Tan, J. Nam, C. Kim, J. Lim, S. Kim (LGE)]

[JVET-AL0249](https://jvet-experts.org/doc_end_user/current_document.php?id=15576) AHG9: Proposed modifications to VSEI to address national body comments [J. Boyce (editor)] [late]

## AHG9: Aspects on SEI messages in TuC for VSEI (15)

### NNPF SEI messages *(*3)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0175](https://jvet-experts.org/doc_end_user/current_document.php?id=15500) AHG9: On Target Mastering Colour Volume Information in the NNPFC SEI message for Tone Mapping [C-H. Demarty, E. François, F. Aumont, O. Le Meur (InterDigital)]

[JVET-AL0177](https://jvet-experts.org/doc_end_user/current_document.php?id=15502) AHG9: On Signalling Tone Mapping Related Information in NNPFA [C-H. Demarty, E. François, F. Aumont, O. Le Meur (InterDigital)]

[JVET-AL0209](https://jvet-experts.org/doc_end_user/current_document.php?id=15534) AHG9: On providing robustness against layer dropping in multi-layer NNPF [T. M. Borges, Y. Sanchez, R. Skupin, C. Hellge, T. Schierl (Fraunhofer HHI)]

### Constituent rectangles SEI (3)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0095](https://jvet-experts.org/doc_end_user/current_document.php?id=15420) AHG 9: On constituent rectangles SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AL0139](https://jvet-experts.org/doc_end_user/current_document.php?id=15464) AHG9: On multilayer support for CR SEI [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

[JVET-AL0308](https://jvet-experts.org/doc_end_user/current_document.php?id=15635) AHG9: On layer ID syntax elements in VSEI TuC [J. Xu, Y.-K. Wang (Bytedance)] [late]

### Display rectangles SEI (4)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0097](https://jvet-experts.org/doc_end_user/current_document.php?id=15422) AHG 9: Gaussian blur filling method in display rectangles SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AL0099](https://jvet-experts.org/doc_end_user/current_document.php?id=15424) AHG9: On design of display rectangles SEI message [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

[JVET-AL0138](https://jvet-experts.org/doc_end_user/current_document.php?id=15463) AHG9: VVC interface for Display Rectangles SEI [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

[JVET-AL0141](https://jvet-experts.org/doc_end_user/current_document.php?id=15466) AHG9: Showcase on the implementation of display rectangles SEI [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)] [late] [miss]

### Other (6)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0091](https://jvet-experts.org/doc_end_user/current_document.php?id=15416) AHG9: On the multiplane image information (MPII) SEI message [S. McCarthy, S. Oh, W. Husak (Dolby)]

[JVET-AL0093](https://jvet-experts.org/doc_end_user/current_document.php?id=15418) AHG 9: On value range for syntax elements coded as u(v) [H. Tan, C. Kim, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AL0140](https://jvet-experts.org/doc_end_user/current_document.php?id=15465) AHG9: Region-specific quality metrics for QM SEI [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

[JVET-AL0216](https://jvet-experts.org/doc_end_user/current_document.php?id=15543) [AHG9] Lens Optical Correction SEI – floating point parameters representation [G. Teniou, S. Wenger, A. Hinds (Tencent)]

[JVET-AL0226](https://jvet-experts.org/doc_end_user/current_document.php?id=15553) AHG9: Proposed segmentation plane test sequences (AUX\_SEGMENT) [E. Thomas, E. Potetsianakis, E. Alexiou, M.-L. Champel (Xiaomi)]

[JVET-AL0286](https://jvet-experts.org/doc_end_user/current_document.php?id=15613) AHG9: On dual-lens optical correction SEI message [A. Karabutov, E. Alshina (Huawei)] [late]

## Additional SEI message aspects (10+1)

Contributions in this area were discussed during XXXX–XXXX and XXXX–XXXX on XXday XX March 2025 (chaired by XXX).

[JVET-AL0069](https://jvet-experts.org/doc_end_user/current_document.php?id=15375) AHG9/AHG18: Error recovery SEI message [J. Boyce, M. M. Hannuksela (Nokia)]

[JVET-AL0073](https://jvet-experts.org/doc_end_user/current_document.php?id=15379) AHG9/AHG18: Loss recovery information SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AL0092](https://jvet-experts.org/doc_end_user/current_document.php?id=15417) AHG9: Confidence information SEI message [J. Boyce, T. Biatek, M. M. Hannuksela (Nokia)]

[JVET-AL0127](https://jvet-experts.org/doc_end_user/current_document.php?id=15452) AHG9: Danmu information SEI message [J. Xu, Y.-K. Wang, L. Zhang (Bytedance)]

[JVET-AL0133](https://jvet-experts.org/doc_end_user/current_document.php?id=15458) AHG9: Signaling of thumbnail information [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AL0211](https://jvet-experts.org/doc_end_user/current_document.php?id=15536) AHG9: Resolution nesting for FGC SEI message [R. Skupin, Y. Sanchez, A. Wieckowski, T. M. Borges, C. Hellge, T. Schierl (Fraunhofer HHI)]

*Aspect on potential need for new SEI – JVET- AL0211 also relates to clause 2.2 study of VSEI v4*

[JVET-AL0212](https://jvet-experts.org/doc_end_user/current_document.php?id=15539) AHG9/AHG15: Depth-adaptive picture scaling information SEI [V. Zakharchenko, T. Biatek, J. Boyce (Nokia)]

[JVET-AL0219](https://jvet-experts.org/doc_end_user/current_document.php?id=15546) AHG9: Colour mapping information SEI [J. Boyce, T. Biatek, M. M. Hannuksela (Nokia)]

[JVET-AL0224](https://jvet-experts.org/doc_end_user/current_document.php?id=15551) AHG9: Auxiliary sampling alignment information SEI [V. Zakharchenko, J. Boyce, D. Rusanovskyy, M. M. Hannuksela (Nokia)]

[JVET-AL0301](https://jvet-experts.org/doc_end_user/current_document.php?id=15628) AHG9: VSEI specification changes to reference the 3rd edition of video CICP [J. Xu, Y.-K. Wang (Bytedance)] [late]

[JVET-AL0302](https://jvet-experts.org/doc_end_user/current_document.php?id=15629) Updates of the enhanced colour format information SEI message [D. Podborski, A.M. Tourapis (Apple)] [late]

## Non-SEI HLS aspects (0)

Kept as template for future use.

# Plenary meetings, joint meetings, BoG reports, and liaison communications

## General

The following topics were discussed in JVET plenary XXday XX April XXXX–1345:

* Scheduling for the remaining week (further detail on scheduling is recorded in section 2.12).
* Report from EE/HLS tracks and review/follow-up discussion on documents from sections XX.

Specific discussion on some general issues related to HLS was as follows:

…

## MPEG information sharing meetings

Information sharing sessions with other WGs and AGs of the MPEG community were held on Monday 31 March 0500–0800, Wednesday 2 April 0500–0600, and Friday 4 April 2100–2300.

The status and plans for the work in the MPEG WGs and AGs was reviewed at these information sharing sessions.

## Joint meetings

### Joint session XXXX-XXXX XXday X April on next generation video standardization: MPEG WG 2 / Requirements, MPEG WG 5 / JVET and VCEG (ITU-T Q6/21)

(These notes were recorded by XXX)

The session was chaired by Jörn Ostermann (AG 2 Convenor), Igor Curcio (WG 2 Convenor), Gary Sullivan (Q6/21 Rapporteur), and Jens-Rainer Ohm (JVET chair).

…

## BoGs (0)

Not break-out groups were established at this meeting to conduct discussion and develop recommendations on particular subjects (this section retained for future use).

## Liaison communications (0)

The following liaison statements were received at this meeting (section retained as a template for future use).

…

The liaison response WG 5 N XXX was reviewed in JVET on XXday XX at XXXX-XXXX. The draft reply was also presented in the MPEG AG 3 Communication meeting XXday XX at 1500-1800.

# Project planning

## Software timeline (update)

ECM 16.0 software (including all adoptions) was planned to be available 3 weeks after the meeting (12 February).

The NNVC 12.0 codebase software was planned to be available 3 weeks after the meeting (12 February).

Extensions on top of VTM23.6 software will be released as appropriate (integration and updates of SEI messages included in JVET-AK2006 by the current meeting).

Updates on top of HM18.0 and JM19.1 software will be released as appropriate (e.g., integration and updates of SEI messages included in JVET-AK1006 and JVET-AK1017 by the current meeting).

As a general rule in software development, a person who is executing a merge shall not be from the same company as the person who submitted that merge request.

## Core experiment and exploration experiment planning

An EE on neural network-based video coding was established, as recorded in output document JVET-AL2023.

An EE on enhanced compression technology beyond VVC capability using techniques other than neural-network technology was also established, as recorded in output document JVET-AL2024.

Initial versions of these documents were presented and approved.

## 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/VTM 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:

* Normative contributions (relating to changes in bitstream/decoder) shall include draft specification text
* Proposals shall contain all details relevant for understanding and be self-contained. In cases where the document is a follow-up of a previous contribution, the overall concept and the novelties should be highlighted at minimum
* Coding tool and encoder optimization proposals shall contain Excel sheets that allow assessment on a per-sequence basis
* Algorithm description text is strongly encouraged for non-normative contributions that are intended to be included in model description documents (VTM, ECM, etc.), and that is required for inclusion in TR drafts.
* Early upload deadline to enable substantial study prior to the meeting
* Using a clock timer to ensure efficient proposal presentations (5 min) and discussions (not exercised currently)

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 that those rules which had been set up or refined during the 12th JVET meeting should be observed. In particular, for some CEs of some previous meetings, results were available late, and some changes in the experimental setup had not been sufficiently 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 a draft standard by the next meeting or in the near future.
* “Exploration experiments” (EEs) are also coordinated experiments. These are conducted on technology which is not foreseen to become part of a draft standard in the near future. The investigating methodology for assessment of such technology can also be an important part of an EE. (Further general rules for EEs, as far as deviating from the CE rules below, should be discussed in a future meeting. For the current meeting, procedures as described in the EE description document are deemed to be sufficient.)
* 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 that 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 as described below).
* During the experiment, revisions of the experiment plans can be made, but not substantial changes to the proposed technology. Withdrawing parts of experiments that were intended to show the individual benefits of a tool or parts of a tool is strongly discouraged. Combination tests may not be considered in such cases. Any changes made to individual tools in a combination shall be documented.
* 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 mandatory to report encoder optimizations made for the benefit of a tool, and if an equivalent optimization could be applied on the anchor, a comparison against the improved anchor shall be provided.
* A new proposal can be included in a CE based on group decision, regardless if an independent party has already performed a cross-check in the meeting when it was first proposed.

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 for SDR video are described in the prior output document JVET-T2010.

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”, “enhanced”, 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.

The CE development workflow is described at (the following links don’t seem to exist anymore):

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

CE read access is available using shared accounts: One account exists for MPEG members, which uses the usual MPEG account data. A second account exists for VCEG members with account information available in the TIES informal ftp area (IFA) system at:

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

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 was 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 be marked as “withdrawn”.

T2 = Test model software release + 2 weeks: 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 minus 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 contribution 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 straightforward 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, JVET would like to see comprehensive cross-checking done, with analysis of whether the description matches the software, and a recommendation of the value of the tool and 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 into a standard or test model.

Availability of specification text is important to have a detailed understanding of the technology and also to judge what its impact on the complexity of the specification will be. There must also be sufficient time to study this in detail. CE contributions without sufficiently mature draft specification 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.

# Establishment of ad hoc groups (update)

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)).

Chairs of AHGs were asked to send draft mandates to JRO before XXXX on X Apr., preferably copy from the table below and sending in a word file with changemarks.

Review of AHG plans was conducted during the plenary on XXday X Apr. 2025 at XXXX–XXXX.

|  |  |  |
| --- | --- | --- |
| **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 and experiment studies. * Report on project status to JVET reflector. * Provide a report to the next meeting on project coordination status. * Supervise processing and delivery of output documents | J.-R. Ohm (chair), G. J. Sullivan (vice‑chair) | N |
| **Draft text and test model algorithm description editing (AHG2)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Produce and finalize draft text outputs of the meeting (JVET-AK1006, JVET-AK1017, JVET-AK2005 and JVET-AK2006). * Collect reports of errata for the VVC, VSEI, HEVC, AVC, CICP, and the published related technical reports and produce the JVET-AK1004 errata output collection. * Coordinate with the test model software development AhG to address issues relating to mismatches between software and text. * Collect and consider errata reports on the texts. | B. Bross, C. Rosewarne (co-chairs), F. Bossen, A. Browne, S. Kim, S. Liu, J.‑R. Ohm, G. J. Sullivan, A. Tourapis, 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 models (VTM, HM, SCM, SHM, HTM, MFC, MFCD, JM, JSVM, JMVM, 3DV-ATM, 360Lib, and HDRTools) software and associated configuration files. * Produce documentation of software usage for distribution with the software. * Enable software support for recently standardized additional SEI messages (for both VTM and HM), and SEI messages in TuC (the latter in a separate branch of VTM). * Discuss and make recommendations on the software development process. * Perform comparative tests of test model behaviour using common test conditions, including HDR, high bit depth and high bit rate. * Suggest configuration files for additional testing of tools. * Investigate how to minimize the number of separate codebases maintained for group reference software. * 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. * Prepare drafts of merged and updated CTC documents for HM and VTM, as applicable. | F. Bossen, X. Li, K. Sühring (co-chairs), E. François, Y. He, K. Sharman, V. Seregin, A. Tourapis (vice‑chairs) | N |
| **Test material and visual assessment (AHG4)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Consider plans for additional verification testing of VVC capability, particularly target conducting tests for VVC multi-layer features, and update the test plan accordingly. * Maintain the video sequence test material database for testing the VVC and HEVC standards and potential future extensions, as well as exploration activities. * Study coding performance and characteristics of available and proposed video test material. * Identify and recommend appropriate test material for testing the VVC standard and potential future extensions, as well as exploration activities. * Identify and characterize missing types of video material, solicit contributions, collect, and make available a variety of video sequence test material, in coordination with other AHGs, as appropriate. * Maintain and update the directory structure for the test sequence repository, as necessary. * Collect information about test sequences that have been made available by other organizations. * Prepare and conduct expert viewing for purposes of subjective quality evaluation. * Coordinate with AG 5 in studying and developing further methods of subjective quality evaluation, e.g. based on crowd sourcing. * Coordinate with AHG15 on investigating sequences with gaming content, and make such sequences available for study. * Coordinate with AHG17 on investigating sequences outside of CTC, and making arrangements for viewing at the AHG meeting. * Prepare availability of viewing equipment and facilities arrangements for future meetings. | V. Baroncini, T. Suzuki, M. Wien (co-chairs), W. Husak, S. Iwamura, P. de Lagrange, S. Liu, X. Meng, S. Puri, A. Segall, S. Wenger (vice-chairs) | N |
| **Conformance testing (AHG5)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Prepare for a new edition of VVC conformance with new multi-layer streams (JVET-AI2028) and corrections of the existing streams. * Study the draft conformance bitstreams for new HEVC multiview profiles in JVET-AI1008, and further develop related conformance bitstreams. * Coordinate with AHG3 on implementation of the new HEVC multiview profiles. * Study the requirements of VVC, HEVC, and AVC conformance testing to ensure interoperability. * Maintain and update the conformance bitstream database, and contribute to report problems, and suggest actions to resolve these. * Study additional testing methodologies to fulfil the needs for VVC conformance testing. | I. Moccagatta (chair), F. Bossen, T. Ikai, S. Iwamura, H.-J. Jhu, K. Kawamura, P. de Lagrange, S. Paluri, K. Sühring, Y. Yu (vice‑chairs) | N |
| **ECM software development (AHG6)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Coordinate development of the ECM software and associated configuration files. * Produce documentation of software usage for distribution with the software. * Prepare and deliver ECM-16.0 software version (and potential updates), corresponding VTM anchor, and the reference configuration encodings according to the ECM common test conditions. * Investigate encoder speedup and other software optimization such as reduction of memory consumption. * Coordinate with ECM algorithm description editors to identify any mismatches between software and text, make further updates and cleanups to the software as appropriate. | V. Seregin (chair), J. Chen, R. Chernyak, F. Le Léannec, K. Zhang (vice-chairs) | N |
| **ECM tool assessment (AHG7)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Investigate methodology of tool assessment, such as the aspects of memory access and bandwidth, number of maximum processing cycles, block decoding dependencies, number of context coded bins, pipeline and parallelization. * Coordinate with AHG6 on resolving tool-off test related software issues (missing tool controls and software bugs). * Prepare configuration files and generate bitstreams and results of tool-on/tool-off testing. * Prepare reporting of tool assessment results. * Coordinate with AHG17 to collect simulation results on non-CTC sequences (e.g., those used in previous verification tests), and identify a set of non-CTC sequences that would be appropriate for additional testing. * Develop methodology of more reliable runtime measurement | X. Li (chair), L.-F. Chen, Z. Deng, J. Gan, E. François, R. Ishimoto, H.-J. Jhu, J. Lainema, X. Li, J. Pardo, A. Stein, H. Wang (vice‑chairs) | Y (tel., 2 weeks notice) |
| **Optimization of encoders and receiving systems for machine analysis of coded video content (AHG8)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Solicit and study non-normative encoder and receiving systems technologies that enhance performance of machine analysis tasks on coded video content. * Identify and collect test materials that are suitable to be used by JVET for machine analysis tasks. * Discuss improvements on the evaluation framework, including evaluation procedures and methodologies. * Coordinate software development and experiments on optimization of encoders and receiving systems for machine analysis of coded video content, including combinations of proposed technologies. * Maintain the software implementation examples and develop tool combination examples in the repository, including sufficient documentation in terms of operation and performance. * Evaluate proposed technologies and their suitability for machine analysis applications. * Propose improvements to JVET-AK2030 on optimization of encoders and receiving systems for machine analysis of coded video content. * Study the potential of using SEI messages for the purpose of machine analysis in coordination with AHG9. * Investigate the impact of using different machine task models in the evaluation of the compression performance of tools optimized for machine analysis tasks. * Coordinate with WG 4 VCM AHG on aspects such as unified common test conditions, evaluation metrics, test and training materials, usage of SEI messages, and on studying characteristics and requirements of machine analysis tasks, etc. Provide WG 4 VCM with AHG software and scripts to experiment non-normative tools and tool combination examples, and provide bitstreams generated by running a dense set of QP points for each sequence by uploading to the mpeg.expert repository. | S. Liu, J. Ström, S. Wang, M. Zhou (AHG chairs) | Y (tel., 2 weeks notice, joint with WG 4 AHG) |
| **SEI message studies (AHG9)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study the SEI messages in VSEI, VVC, HEVC and AVC. * Study JVET-AK1006, JVET-AK1017, JVET-AK2005, and JVET-AK2006, identify any issues and propose solutions as appropriate. * Study JVET-AK2032, and propose improvements. * Collect software and showcase information for SEI messages, including encoder and decoder implementations and bitstreams for demonstration and testing. * Identify potential needs for additional SEI messages, including the study of SEI messages defined in HEVC and AVC for potential use in the VVC context. * Study the alignments of the same SEI messages in different standards. * Coordinate with AHG8 and WG 4 to study mechanisms for signalling metadata in the context of machine analysis of coded video content. * Coordinate with AHG3 for software support of SEI messages for JM, HM, and VTM. | S. McCarthy, Y.-K. Wang (co-chairs), J. Boyce, T. Chujoh, S. Deshpande, C. Fogg, M. M. Hannuksela, P. de Lagrange, G. J. Sullivan, H. Tan, A. Tourapis, S. Wenger, P. Wu (vice-chairs) | N |
| **Encoding algorithm optimization (AHG10)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study the impact of using techniques such as tool adaptation and configuration, and perceptually optimized adaptive quantization for encoder optimization. * Study the impact of non-normative techniques of preprocessing for the benefit of encoder optimization. * Study encoding techniques of optimization for objective quality metrics and their relationship to subjective quality. * Study optimized encoding for reference picture resampling and scalability modes in VTM, and coordinate with AHG4 on improving encoders and test settings for multi-layer verification testing. * Study optimized encoding and suitable test settings for noisy materials, such as sequences containing film grain. * Study optimized encoding and tool combinations for low latency and for low complexity. * Consider neural network-based encoding optimization technologies for video coding standards. * Investigate other methods of improving objective and/or subjective quality, including adaptive coding structures and multi-pass encoding. * Study methods of rate control and rate-distortion optimization and their impact on performance, subjective and objective quality. * Study the potential of defining default or alternate software configuration settings and test conditions optimized for either subjective quality, higher objective quality, or encoding with improved complexity/performance tradeoff, and coordinate such efforts with AHG3 and AHG6. * Study the effect of varying configuration parameters depending on temporal layer, such as those related to deblocking, partitioning, chroma QP. | K. Andersson, P. de Lagrange, A. Duenas (co-chairs), T. Ikai, T. Solovyev, A. Tourapis (vice chairs) | Y (tel., 2 weeks notice) |
| **Neural network-based video coding (AHG11)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Evaluate and quantify the performance improvement potential of NN-based video coding technologies compared to existing video coding standards such as VVC, including both individual coding tools, architectures and content adaptation with NN parameters overfitting. * Establish logistics of training data sets, including list, location and md5sums. Generate and distribute anchor encoding, and develop supporting software as needed. * Study potential improvements of the NNVC CTC document JVET-AJ2016. * Study the impact of training (including the impact of loss functions) on the performance of candidate technologies and identify suitable material for testing and training. * Analyse complexity characteristics for technologies under study, including transformers, perform complexity analysis, and develop complexity reductions of candidate technology. * Discuss and propose improved metrics to perform complexity analysis of NN architectures, in particular also considering the impact of sparse models. * Finalize and discuss the EE on neural network-based video coding. * Promote the call for training materials, distribute it, and actively communicate with content owners. * Coordinate with other groups, including SC 29/AG 5 on the evaluation and assessment of visual quality, and AHG12 on the interaction with ECM coding tools. If possible, prepare encodings with combinations of tools included in the NNVC software for visual quality assessment at the next meeting. * Coordinate with AHG14 on items related to NNVC software development and study the impact of training set extension. | E. Alshina, F. Galpin, S. Liu, A. Segall (co-chairs), J. Li, Y. Li, R.-L. Liao, M. Santamaria, T. Shao, M. Wien, P. Wu (vice chairs) | Y (tel., 2 weeks notice), first on Feb. 5, second on March 5 |
| **Enhanced compression beyond VVC capability (AHG12)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Solicit and study non-neural-network video coding tools with enhanced compression capabilities beyond VVC. * Discuss and propose refinements to the ECM16 algorithm description JVET-AK2025. * Coordinate with AHG7 to study the performance and complexity tradeoff of these video coding tools. * Coordinate with AHG6 on ECM software development. * Support AHG6 in generating anchors according to the test conditions in JVET-AI2017. * Analyse the results of exploration experiments described in JVET-AK2024 in coordination with the EE coordinators. * Coordinate with AHG11 to study the interaction with neural network-based coding tools. | M. Karczewicz, Y. Ye, L. Zhang (co-chairs), B. Bross, R. Chernyak, X. Li, K. Naser, Y. Yu (vice-chairs) | N |
| **Film grain technologies (AHG13)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study the benefits and characteristics of film grain technologies, including autoregressive and frequency-filtering technologies. * Discuss and propose refinements to the draft of the TR 2nd ed. JVET-AK2020. * Study alternative film grain models and their associated documentation. * Discuss and enumerate updates, improvements, and additions for the second edition of the technical report. * In consultation with AHG4, study and define content characteristics and test conditions that are desirable for the study and testing of film grain technologies, and perform an assessment of newly available test materials in that regard. * Investigate metrics for measuring film grain fidelity in itself, or as present in a video. * Discuss the potential need for film grain conformance guidelines. * Given the study of desirable content characteristics, solicit or create new test material for further determining the operational characteristics of, testing, and developing any related technologies. * Study preprocessing and encoder technologies for determining values for FGC (Film Grain Characteristics) SEI message syntax elements. * Identify potential need for additional film grain technology and signalling, if needed. * Coordinate development of film grain technology software and configuration files. * Coordinate with AG 5 on improving the plan for subjective quality testing of the FGC SEI message JVET-AJ2022, and conduct preparations for such testing. * Coordinate with AHG3 for software support of the FGC SEI message. | W. Husak, P. de Lagrange (co-chairs), A. Duenas, X. Meng, A. Segall, G. Teniou, A. Tourapis (vice-chairs) | Y (tel., 2 weeks notice) |
| **NNVC software development (AHG14)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Coordinate development of the NNVC software and associated configuration files. * Prepare and deliver NNVC-12.0 software version (and potential updates), and provide reference configuration encodings according to the NNVC common test conditions as described in JVET-AJ2016. Study the impact of the addition of new dataset on the already integrated models. * Investigate and bridge coding performance of NNVC VTM anchor compared to the latest VTM version and/or VTM anchor in ECM software. * Investigate combinations of tools included in the NNVC software, prepare and release anchor data for all configurations of the software, including anchors for High and Low Operation Point (HOP/LOP) and Very Low Operation Point (VLOP) configurations. * Study and maintain the SADL (Small Adhoc Deep-Learning Library). Identify gaps in functionality and develop improvements as needed. * Coordinate with NNVC algorithm and software description (JVET-AK2019) editors to identify any mismatches between software and description document, suggest further updates to the description document as appropriate. * Coordinate with AHG11 on items related to NNVC activities. | F. Galpin (chair), R. Chang, Yue Li, Yun Li, M. Santamaria, J. N. Shingala, Z. Xie (vice chairs) | Y (tel., 2 weeks notice), first on Feb. 5, second on March 5 |
| **Gaming content compression (AHG15)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Identify gaming content application scenarios and their requirements for codec operation. * Identify and characterize required types of content; solicit contributions, collect, and make a variety of gaming content available, in coordination with AHG4 and AG 5. * Produce VTM and ECM anchor encodings according to CTC JVET-AJ2027, and provide test results at the next meeting. * Develop and maintain interfaces for supporting use cases of camera parameters and depth maps in gaming applications, including mechanisms for efficient transporting these elements in the coded video bitstream. * Evaluate JVET test models (such as ECM, VTM, NNVC, etc.) under the proposed test conditions. * Investigate possibilities to enhance compression capability for gaming content. * Study conversion of depth maps using integer representation, and identifying efficient bit-depth resolution of depth maps to support identified use-cases that will be an input to compression. * Solicit contributions from industry on typical bitrate/quality/resolution used for gaming content compression. | S. Puri, J. Sauer (co-chairs), R. Chernyak, A. Duenas, L. Wang, V. Zakharchenko (vice chairs) | Y (tel., 2 weeks notice) |
| **Generative face video compression (AHG16)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Maintain GFVC software tools, associated configuration files, and software usage documentation. * Study the extension of GFVC software capability to handle video content with higher resolutions. * Identify and study additional test content, including content with higher resolutions, suitable for use in GFVC performance evaluation. * Study GFVC performance under test conditions defined in JVET-AJ2035, as well as performance on additional test content, and wider bitrate ranges. * Coordinate with AHG9 on further development of the GFV and GFVE SEI messages in JVET-AK2006. | Y. Ye (chair), H.-B. Teo, Z. Lyu, S. McCarthy, S. Wang (vice chairs) | N |
| **Testing of video coding technology beyond CTC (AHG17)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Identify test sequences extending the represented range of applications (i.e. beyond those defined in common test conditions documents JVET-AK2010, JVET-AC2011 and JVET-AI2017) and investigate their suitability for use in visual quality assessments. * Prepare encoded bitstreams from the identified test sequences using same VTM and ECM versions as previously. * Make preparations for subjective viewing at the hybrid AHG meeting (for on-site participants). * Develop the output document JVET-AK2026. * Arrange and conduct a hybrid AHG meeting (with remote participation for group discussions), and prepare logistics according to JVET-AK2039. | M. Wien (chair), E. Alshina, V. Baroncini, P. de Lagrange, Y. Ye (vice chairs) | Y   * tel., 2 weeks notice, first on Feb. 6 * hybrid, March 10-12 in Aachen, DE |
| **Ultra-low latency and packet loss resilience (AHG18)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Investigate and identify test conditions, evaluation criteria and evaluation methodology, supporting a set of end-to-end latency targets in a range of 25-100 ms. * Investigate creation of practical simulation software based on VTM, including network transmission aspects, and conduct performance evaluation. * Identify potential requirements and feasibility of standard based technologies to support ultra-low delay requirements, including packet loss resilient decoding. * Investigate packet loss resilient technologies beyond VVC supporting ultra-low delay coding for interactive and live broadcasting scenarios. | S. Ikonin, S. Wenger, V. Zakharchenko (co-chairs), S. Deshpande, S. Fößel, C. Kim, X. Ma, S. Puri, J. Ström (vice-chairs) | Y (tel., 2 weeks notice) |

It was confirmed that the rules which can be found in document ISO/IEC JTC 1/‌SC 29/‌AG 2 [N 046](https://www.mpegstandards.org/wp-content/uploads/2022/01/ISO-IECJTC1-SC29-AG2_N0046_AhG.pdf) “Ad hoc group rules for MPEG AGs and WGs” (available at <https://www.mpegstandards.org/adhoc/>), are consistent with the operation mode of JVET AHGs. It is pointed out that JVET does not maintain separate AHG reflectors, such that any JVET member is implicitly a member of any AHG. This shall be mentioned in the related WG Recommendations. The list above was also issued as a separate WG 5 document (ISO/IEC JTC 1/‌SC 29/‌WG 5 N XXX) in order to make it easy to reference.

# Output documents (update)

The following documents were agreed to be produced or endorsed as outputs of the meeting. Names recorded below indicate the editors responsible for the document production. Where applicable, dates of planned finalization and corresponding parent-body document numbers are also noted.

It was reminded that in cases where the JVET document is also made available as a WG 5 output document, a separate version under the WG 5 document header should be generated. This version should be sent to GJS and JRO for upload.

The list of JVET ad hoc groups was also issued as a WG 5 output document WG 5 N XXX, as noted in section 9.

[JVET-AK1000](https://jvet-experts.org/doc_end_user/current_document.php?id=15331) Meeting Report of the 37th JVET Meeting [J.-R. Ohm] [WG 5 N 333] (2025-02-19)

Initial versions of the meeting notes (d0 … d8) were made available on a daily basis during the meeting.

Remains valid – not updated: [JVET-AC1001](https://jvet-experts.org/doc_end_user/current_document.php?id=12566) Guidelines for HM-based software development [K. Sühring, F. Bossen, X. Li (software coordinators)]

Remains valid – not updated: [JVET-Y1002](https://jvet-experts.org/doc_end_user/current_document.php?id=11463) High Efficiency Video Coding (HEVC) Test Model 16 (HM 16) Encoder Description Update 16 [C. Rosewarne (primary editor), K. Sharman, R. Sjöberg, G. J. Sullivan (co-editors)] [WG 5 [N 103](https://dms.mpeg.expert/doc_end_user/current_document.php?id=82085&id_meeting=189)]

Remains valid – not updated: [JVET-AH1003](https://jvet-experts.org/doc_end_user/current_document.php?id=14259) Coding-independent code points for video signal type identification (Draft 3) [G. J. Sullivan, A. Tourapis]

Primary editor: G. J. Sullivan.

[JVET-AK1004](https://jvet-experts.org/doc_end_user/current_document.php?id=15332) Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP [Y.-K. Wang, B. Bross, I. Moccagatta, C. Rosewarne, G. J. Sullivan] (2025-03-14, near next meeting)

Primary editor: Y.-K. Wang.

This includes changes from new bug tickets, some items removed that are resolved and put into corresponding output documents.

Remains valid – not updated: [JVET-AH1005](https://jvet-experts.org/doc_end_user/current_document.php?id=14261) Technology under consideration for future editions of CICP [E. Thomas, A. Tourapis] [WG 5 N 289)]

Can be removed in a future meeting, no activity since April 2024.

[JVET-AK1006](https://jvet-experts.org/doc_end_user/current_document.php?id=15333) HEVC additional profiles and SEI messages (draft 2) [Y.-K. Wang, B. Bross, S. Deshpande, G. J. Sullivan, A. Tourapis] [WG 5 CDAM N 336)] (2025-01-29)

Primary editor: Y.-K. Wang.

Changes agreed at this meeting:

…

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

Remains valid – not updated: [JCTVC-V1007](https://mpeg.expert/jct/files/JCTVC-V1007-v1.zip) SHVC Test Model 11 (SHM 11) Introduction and Encoder Description [G. Barroux, J. Boyce, J. Chen, M. M. Hannuksela, Y. Ye] [WG 11 N 15778]

Remains valid – not updated: [JVET-AI1008](https://jvet-experts.org/doc_end_user/current_document.php?id=14609) Conformance testing for HEVC multiview extended and monochrome profiles [I. Moccagatta, S. Paluri, A. Tourapis, Y.-K. Wang]

Remains valid – not updated: [JVET-AC1009](https://jvet-experts.org/doc_end_user/current_document.php?id=12569) Common test conditions for SHVC [K. Sühring]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JCTVC-O1010](https://mpeg.expert/jct/files/JCTVC-O1010-v1.zip) Guidelines for Conformance Testing Bitstream Preparation [T. Suzuki, W. Wan]

Remains valid – not updated: [JVET-AJ1011](https://jvet-experts.org/doc_end_user/current_document.php?id=14991) White paper on HEVC [B. Bross, J.-R. Ohm, G. J. Sullivan, Y.-K. Wang] [AG 3 N 174]

Remains valid – not updated: JVET-[AJ1012](https://jvet-experts.org/doc_end_user/current_document.php?id=14992) Overview of IT systems used in JVET [J.-R. Ohm, I. Moccagatta, K. Sühring, M. Wien]

Revisit: Potential update of bug tracking?

Remains valid – not updated: [JCT3V-G1003](https://mpeg.expert/jct3v/files/JCT3V-G1003-v2.zip) 3D-AVC Test Model 9 [D. Rusanovskyy, F. C. Chen, L. Zhang, T. Suzuki] [WG 11 N 14239]

Remains valid – not updated: [JCT3V-K1003](https://mpeg.expert/jct3v/files/JCT3V-K1003-v1.zip) Test Model 11 of 3D-HEVC and MV-HEVC [Y. Chen, G. Tech, K. Wegner, S. Yea] [WG 11 N 15141]

Remains valid – not updated: [JVET-AE1013](https://jvet-experts.org/doc_end_user/current_document.php?id=13268) Common test conditions of 3DV experiments [K. Sühring, M. Wien]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated [JCTVC-V1014](https://mpeg.expert/jct/files/JCTVC-V1014-v1.zip) Screen Content Coding Test Model 7 Encoder Description (SCM 7) [R. Joshi, J. Xu, R. Cohen, S. Liu, Y. Ye] [WG 11 N 16049]

Remains valid – not updated: [JVET-AC1015](https://jvet-experts.org/doc_end_user/current_document.php?id=12571) Common test conditions for SCM-based screen content coding [K. Sühring]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-AH1016](https://jvet-experts.org/doc_end_user/current_document.php?id=14264) AVC with extensions and corrections (draft 3) [B. Bross, T. Ikai, G. J. Sullivan, A. Tourapis, Y.-K. Wang]

Primary editor: B. Bross.

[JVET-AK1017](https://jvet-experts.org/doc_end_user/current_document.php?id=15334) Support for additional SEI messages in AVC (draft 1) [B. Bross, J. Boyce, G. J. Sullivan, Y.-K. Wang] (2025-02-14)

Primary editor: B. Bross

Changes agreed at this meeting:

…

Resolved bug fixes carried over from JVET-AJ1004 were also to be included.

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

No output: JVET-Axx1018 through JVET-Axx1099

Remains valid – not updated [JVET-AA1100](https://jvet-experts.org/doc_end_user/current_document.php?id=11944) Common Test Conditions for HM Video Coding Experiments [K. Sühring, K. Sharman]

This specifies only the CTC for non-4:2:0 colour formats. The corresponding document for VVC is JVET-T2013, with no unification yet.

Links to test sequences need to be updated due to the change of the content server.

No output: JVET-Axx2001

Remains valid – not updated: [JVET-AH2002](https://jvet-experts.org/doc_end_user/current_document.php?id=14265) Algorithm description for Versatile Video Coding and Test Model 22 (VTM 22) [Y. Ye, A. Browne, S. Kim] [WG 5 N 284]

Primary editor: Y. Ye.

New elements from notes elsewhere in this report:

* …

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

It was suggested that editorial improvements submitted as input to the next meeting would be welcome.

Remains valid – not updated: [JVET-AJ2003](https://jvet-experts.org/doc_end_user/current_document.php?id=14993) Guidelines for VTM-based software development [F. Bossen, X. Li, K. Sühring]

Remains valid – not updated: [JVET-T2004](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10542) Algorithm descriptions of projection format conversion and video quality metrics in 360Lib (Version 12) [Y. Ye, J. Boyce]

[JVET-AK2005](https://jvet-experts.org/doc_end_user/current_document.php?id=15335) Additions and corrections for VVC version 4 (Draft 11) [G. J. Sullivan, B. Bross, M. M. Hannuksela, Y.-K. Wang] [WG 5 preliminary DAM update N 337)] (2025-03-14)

A DoC WG 5 N XXX on the CDAM was approved … .

Changes agreed at this meeting:

…

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

Primary editor: G. J. Sullivan.

[JVET-AK2006](https://jvet-experts.org/doc_end_user/current_document.php?id=15336) Additional SEI messages for VSEI version 4 (Draft 5) [J. Boyce, J. Chen, S. Deshpande, M. M. Hannuksela, S. McCarthy, G. J. Sullivan, H. Tan, Y.-K. Wang] [WG 5 preliminary DAM update N 335)] (2025-03-14)

A DoC WG 5 N XXX on the CDAM was approved …

Changes agreed at this meeting:

…

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

Primary editor: J. Boyce.

Remains valid – not updated: [JVET-AJ2007](https://jvet-experts.org/doc_end_user/current_document.php?id=14996) Guidelines for NNVC software development [F. Galpin, S. Eadie, L. Wang, Z. Xie, Y. Li]

Remains valid – not updated: [JVET-X2008](https://jvet-experts.org/doc_end_user/current_document.php?id=11228) Conformance testing for versatile video coding (Draft 7) [J. Boyce, F. Bossen, K. Kawamura, I. Moccagatta, W. Wan]

The document number was planned to be re-used for a 3rd edition in ITU , once that is submitted to ITU-T (could be in October 2025).

Remains valid – not updated: [JVET-AJ2009](https://jvet-experts.org/doc_end_user/current_document.php?id=14997) Reference software for versatile video coding 2nd edition (Draft 2) [F. Bossen, K. Sühring, X. Li] [WG 5 DIS N 322)]

Software relating to H.266.2 and ISO/IEC 23090-16 can be found at <https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/-/tree/2nd-edition>.

Primary editor: F. Bossen.

[JVET-AK2010](https://jvet-experts.org/doc_end_user/current_document.php?id=15337) VTM and HM common test conditions and software reference configurations for SDR 4:2:0 10 bit video [F. Bossen, X. Li, V. Seregin, K. Sharman, K. Sühring] (2025-02-14)

Add alternative configurations (see discussion under JVET-AK0181). Also links to test sequences are updated due to the change of the content server.

Remains valid – not updated: [JVET-AC2011](https://jvet-experts.org/doc_end_user/current_document.php?id=12575) VTM and HM common test conditions and evaluation procedures for HDR/WCG video [A. Segall, E. François, W. Husak, S. Iwamura, D. Rusanovskyy]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-U2012](https://jvet-experts.org/doc_end_user/current_document.php?id=10681) JVET common test conditions and evaluation procedures for 360° video [Y. He, J. Boyce, K. Choi, J.-L. Lin]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-T2013](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10546) VTM common test conditions and software reference configurations for non-4:2:0 colour formats [Y.-H. Chao, Y.-C. Sun, J. Xu, X. Xu]

Links to test sequences need to be updated due to the change of the content server.

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]

Links to test sequences need to be updated due to the change of the content server.

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]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-AJ2016](https://jvet-experts.org/doc_end_user/current_document.php?id=14998) Common test conditions and evaluation procedures for neural network-based video coding technology [E. Alshina, F. Galpin, R.-L. Liao, S. Liu, A. Segall]

Remains valid – not updated: [JVET-AI2017](https://jvet-experts.org/doc_end_user/current_document.php?id=14615) Common test conditions and evaluation procedures for enhanced compression tool testing [M. Karczewicz, Y. Ye]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-AA2018](https://jvet-experts.org/doc_end_user/current_document.php?id=11949) Common test conditions for high bit depth and high bit rate video coding [A. Browne, T. Ikai, D. Rusanovskyy, X. Xiu, Y. Yu]

Links to test sequences need to be updated due to the change of the content server.

[JVET-AK2019](https://jvet-experts.org/doc_end_user/current_document.php?id=15338) Description of algorithms version 10 and software version 12 in neural network-based video coding (NNVC) [F. Galpin, Y. Li, D. Rusanovskyy, J. Ström, L. Wang] (2025-03-14)

New elements in text and software from notes elsewhere in this report:

* …

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

[JVET-AK2020](https://jvet-experts.org/doc_end_user/current_document.php?id=15339) Film grain synthesis technology for video applications ed. 2 (Draft 2) [W. Husak, P. de Lagrange, A. Norkin, A. Tourapis] (2025-03-14)

Draft 1 (the output of the last meeting) was submitted for ITU approval, only containing necessary bug fixes and clarifications on top of the TR already approved in ISO/IEC. This means that currently the ITU and ISO versions are slightly diverging. JVET-AK2020 contains some paragraphs only relevant for v2 of ISO (as those are already included in v1 of ITU), and other paragraphs adding additional aspects that would be relevant for v2 of both ISO and ITU. It is expected that by the time of finalization of v2, alignment of the twin text can be reached.

New elements: First thoughts on other content to be added (from JVET-AK0013), new: JVET-AK0169.

Remains valid – not updated: [JVET-AJ2021](https://jvet-experts.org/doc_end_user/current_document.php?id=15001) Verification test plan for VVC multilayer coding (update 5) [O. Chubach, P. de Lagrange, M. Wien]

Remains valid – not updated: [JVET-AJ2022](https://jvet-experts.org/doc_end_user/current_document.php?id=15002) Plan for subjective quality testing of the FGC SEI message (update 4) [P. de Lagrange, W. Husak, M. Radosavljević, M. Wien]

[JVET-AK2023](https://jvet-experts.org/doc_end_user/current_document.php?id=15330) Exploration experiment on neural network-based video coding (EE1) [E. Alshina, R. Chang, F. Galpin, Yue Li, Yun Li, M. Santamaria, J. Ström, Z. Xie (EE coordinators)] (2025-02-07)

An initial draft of this document was reviewed and approved at XXXX-XXXX on XXday X Apr.

This round of EE1 tests includes:

…

[JVET-AK2024](https://jvet-experts.org/doc_end_user/current_document.php?id=15329) Exploration experiment on enhanced compression beyond VVC capability (EE2) [V. Seregin, J. Chen, R. Chernyak, K. Naser, J. Ström, F. Wang, M. Winken, X. Xiu, K. Zhang (EE coordinators)] (2025-02-19)

An initial draft of this document was reviewed and approved at XXXX-XXXX on XXday X Apr .

This round of EE2 tests will include:

…

[JVET-AK2025](https://jvet-experts.org/doc_end_user/current_document.php?id=15340) Algorithm description of Enhanced Compression Model 16 (ECM 16) [M. Coban, R.-L. Liao, K. Naser, J. Ström, L. Zhang] (2025-03-14)

New elements from notes elsewhere in this report:

…

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

[**JVET-AK2026**](https://jvet-experts.org/doc_end_user/current_document.php?id=15341) **Testing of video coding technology beyond conditions of exploration experiments [M. Wien, Y. Ye, V. Baroncini, E. Alshina] (2025-02-07)**

Initial changes from discussion under JVET-AK0335, to be finalized in AHG telco (Feb. 6).

Remains valid – not updated: [JVET-AJ2027](https://jvet-experts.org/doc_end_user/current_document.php?id=15005) Common test conditions for gaming applications [J. Sauer, R. Chernyak, S. Puri, S. Thiebaud]

[JVET-AK2028](https://jvet-experts.org/doc_end_user/current_document.php?id=14621) Additional conformance bitstreams for VVC multilayer configurations [S. Iwamura, P. de Lagrange, I. Moccagatta]

For CD, WG 5 N XXX to be issued integrating these new bitstreams in ISO style, and deliver some corrected bitstreams.

AK2028 is only a delta text.

Remains valid – not updated: [JVET-AH2029](https://jvet-experts.org/doc_end_user/current_document.php?id=14274) Visual quality comparison of ECM/VTM encoding [V. Baroncini, J.-R. Ohm, M. Wien] [AG 5 N 118]

[JVET-AK2030](https://jvet-experts.org/doc_end_user/current_document.php?id=15342) Optimization of encoders and receiving systems for machine analysis of coded video content (Draft 8, for future updates) [S. Liu, J. Chen, J. Ström] (2025-03-14)

Primary editor: S. Liu.

Note: J. Ström was added as editor of ISO/IEC 23888-3 per recommendation of the 17th WG 5 meeting, but C. Hollmann should be recommended to be removed.

New elements from notes elsewhere in this report:

* …

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

Remains valid – not updated: [JVET-AI2031](https://jvet-experts.org/doc_end_user/current_document.php?id=14623) Common test conditions for optimization of encoders and receiving systems for machine analysis of coded video content [S. Liu, C. Hollmann]

[JVET-AK2032](https://jvet-experts.org/doc_end_user/current_document.php?id=15343) Technologies under consideration for future extensions of VSEI (version 7) [S. McCarthy, J. Boyce, J. Chen, S. Deshpande, M. M. Hannuksela, H. Tan, Y.-K. Wang] (2025-03-14)

New elements from notes elsewhere in this report:

…

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

It was agreed that MPI is not further changed, and will be removed upon completion of a corresponding MIV profile.

Remains valid – not updated: [JVET-AF2033](https://jvet-experts.org/doc_end_user/current_document.php?id=13593) Report of verification test on VVC multi-layer coding: Content layering [S. Iwamura, P. de Lagrange, M. Wien] [AG 5 N 105)]

Remains valid – not updated: [JVET-AI2034](https://jvet-experts.org/doc_end_user/current_document.php?id=14624) Call for new HDR materials for future video coding development [E. François, W. Husak, S. Iwamura, D. Rusanovskyy, A. Segall, M. Wien] [WG 5 N 312)]

Remains valid – not updated: [JVET-AJ2035](https://jvet-experts.org/doc_end_user/current_document.php?id=15008) Test conditions and evaluation procedures for generative face video coding [S. McCarthy, B. Chen]

Remains valid – not updated: [JVET-AG2036](https://jvet-experts.org/doc_end_user/current_document.php?id=13921) Call for training materials for neural network-based video coding tool development [E. Alshina, F. Galpin, S. Liu, M. Wien] [WG 5 N 266)]

Remains valid – not updated: [JVET-AJ2037](https://jvet-experts.org/doc_end_user/current_document.php?id=15009) Report on subjective quality testing of the FGC SEI message (AG 5 N 140) [P. de Lagrange, W. Husak, M. Wien] [AG 5 N 140)] (2024-12-31)

[JVET-AK2038](https://jvet-experts.org/doc_end_user/current_document.php?id=15344) Draft white paper on VSEI [J. Boyce, S. McCarthy, S. Deshpande, G. J. Sullivan, Y. Sanchez, Y.-K. Wang] (2025-03-21)

[JVET-AK2039](https://jvet-experts.org/doc_end_user/current_document.php?id=15345) Announcement of JVET AHG17 Meeting in Aachen, DE, 10-12 March 2025   
[J.-R. Ohm, M. Wien] (2025-02-07)

(number can be re-used)

# Future meeting plans, expressions of thanks, a.o.b., and closing of the meeting

The draft of the WG 5 recommendations (see Annex C) was reviewed and approved in JVET at XXXX-XXXX on XXday X Apr .

Future meeting plans were established with the following general guidelines (assuming face-to-face meetings):

* Meeting under ITU-T SG21 auspices when it meets (ordinarily starting meetings on the Tuesday or Wednesday of the first week and closing it on the Wednesday of the second week of the SG21 meeting – a total of 8-9 meeting days), and
* Otherwise meeting under ISO/IEC JTC 1/‌SC 29 auspices when its MPEG WGs meet (ordinarily starting meetings on the Thursday or Friday prior to the main week of such meetings and closing it on the same day as other MPEG WGs – a total of 8–9 meeting days).

In cases where an exceptionally high workload is expected for a meeting, an earlier starting date may be defined. In cases of online meetings, no sessions should be held on weekend days, such that meetings would typically start two days earlier.

Some specific future meeting plans (to be confirmed) were established as follows:

* During Thu. 26 June – Fri. 4 July 2025, 39th meeting under ISO/IEC JTC 1/‌SC 29 auspices in Daejeon, – KR, to be conducted as hybrid meeting,
* During 3 – 12 October 2025, 40th meeting under ITU-T SG21 auspices in Geneva, CH, to be conducted as hybrid meeting (starting Friday 3 Oct. afternoon for opening and AHG reports only),
* During 14 – 23 January 2026, 41st meeting under ISO/IEC JTC 1/‌SC 29 auspices, to be conducted as teleconference meeting,
* During 24 April – 1 May 2026, 42nd meeting under ISO/IEC JTC 1/‌SC 29 auspices in Santa Eulària, ES, to be conducted as hybrid meeting,
* During 7 – 15 July 2026, 43rd meeting under ITU-T SG21 auspices in Geneva, CH, to be conducted as hybrid meeting,
* During 14 – 23 October 2026, 44th meeting under ISO/IEC JTC 1/‌SC 29 auspices in Hangzhou, CN, to be conducted as hybrid meeting,
* During January 2027, 45th meeting under ISO/IEC JTC 1/‌SC 29 auspices, date and location t.b.d.
* During April 2027, 46th meeting under ITU-T SG21 auspices in XXXX, to be conducted as hybrid meeting.

The agreed document deadline for the 39th JVET meeting was planned to be Thursday 19 June 2025.

Netflix and University of Bristol were thanked for offering new video material that can be used for training neural network-based algorithms.

ABP, CMG, NERC-DTV and TCL were thanked for offering new HDR test material, Huawei and YouTube were thanked for offering test material showing user generated content.

TCL was thanked for providing 4K displays, and Fraunhofer HHI was thanked for providing play-out equipment used in the experts viewing in Geneva. Christian Lehmann was thanked for helping with the test setup. The experts who volunteered to participate in the viewing were also thanked.

Marius Preda was thanked for the service of managing and maintaining the document site jvet-experts.org. Institut Mines-Télécom was thanked for hosting the sites.

ITU was thanked for the excellent hosting of the 37th JVET meeting in Geneva. Simão Campos and Stefano Polidori were thanked for the help in preparation and organisation, and Kelya-Axelle Beke was thanked for managing the registrations. The following members of ITU staff were thanked for their dedication and daily help in the technical setup of meeting facilities: Gent Bajrami, Marc Antoine Zanou, Ilia Londo, and Paul Marko.

The 38th JVET meeting was closed at approximately XXXX hours UTC on Friday 4 April 2025.

# Annex A to JVET report: List of documents

Dates and times in the table below are in Paris/Geneva time (1 hr. ahead of UTC before 30 March, 2 hrs. afterwards). It is noted that, if title or authorship of a document deviates from the title or author list in the body of the report, the list of documents in this annex contains the correct title and authors.

# Annex B to JVET report: List of meeting participants

The remote participants of the thirty-eighth meeting of the JVET, according to the participation records from the Zoom teleconferencing tool used for the meeting sessions (approximately XXX people in total, not including those who attended only the joint sessions with other groups), were as follows:

1. …

# Annex C to JVET report: Recommendations of the 19th meeting of ISO/IEC JTC 1/SC 29/WG 5 MPEG Joint Video Experts Team with ITU-T SG21

**ISO/IEC JTC 1/SC 29/WG 5 N XXX**