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| **Joint Video Experts Team (JVET)**  **of ITU-T SG21 WP3/21 and ISO/IEC JTC 1/SC 29**  40th Meeting: Geneva, CH, 3–12 October 2025 | Document: JVET-AN\_notes\_d3 |

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| *Title:* | **Meeting Report of the 40th Meeting of the Joint Video Experts Team (JVET), Geneva, 3 – 12 October 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 fortieth meeting during 3 – 12 October 2025 at the ITU headquarters facilities in Geneva, Switzerland. The meeting was held as a physical meeting with remote participation, provided on best-effort basis for experts who were unable to travel.

For ISO/IEC purposes, JVET is alternatively designated ISO/IEC JTC 1/‌SC 29/‌WG 5, and this was the twentieth 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 1400 hours CEST (UTC+2) on Friday 3 October 2025. Meeting sessions were held on all days including the weekend days of Saturday and Sunday 4, 5, 11 and 12 October 2025, until the meeting was closed at approximately XXXX hours CEST on Sunday 12 October 2025. Approximately XXX people attended the JVET meeting (XXX in person and XXX remotely), and approximately XXX input documents (not counting crosschecks, reports, and summary documents), 18 AHG reports, 2 EE summary reports, X BoG report(s), and X incoming liaison document(s) were discussed. The meeting took place in a collocated fashion with a meeting of SG21 – one of the two parent bodies of the JVET, under whose auspices this JVET meeting was held. Various SC29 Working Groups and Advisory Groups were also meeting in Geneva with partial temporal overlap – where WG 5 is representing the Joint Video Experts Team and its activities from the perspective of the SC 29 parent body. 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. In the latter context, the evaluation of responses received on the Joint Call for Evidence on video compression with capability beyond VVC was a major activity at his meeting.

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

a) JVET documents

* JVET-AM1005 Future CICP extensions (Draft 1)
* JVET-AM1006 HEVC additional profiles and SEI messages (Draft 4)
* JVET-AM1008 Conformance testing for HEVC multiview extended and monochrome profiles
* JVET-AM1017 Support for additional VSEI messages in AVC (Draft 3), also issued as WG 5 DAM N 363
* JVET-AM1018 HEVC with extensions and corrections (Draft 2)
* JVET-AM2005 Additions and corrections for VVC version 4 (Draft 13)
* JVET-AM2006 Additional SEI messages for VSEI version 4 (Draft 7)
* JVET-AM2019 Description of algorithms version 12 and software version 14 in neural network-based video coding (NNVC)
* JVET-AM2021 Verification test plan for VVC multilayer coding (update 6)
* JVET-AM2023 Exploration experiment on neural network-based video coding (EE1)
* JVET-AM2024 Exploration experiment on enhanced compression beyond VVC capability (EE2)
* JVET-AM2025 Algorithm description of Enhanced Compression Model 18 (ECM 18)
* JVET-AM2026 Joint Call for Evidence on video compression with capability beyond VVC, also issued as WG 5 N 367
* JVET-AL2032 Technologies under consideration for future extensions of VSEI (version 9)
* JVET-AL2038 White paper on VSEI, also issued as AG 3 N 209

b) documents produced as WG 5 documents only:

* WG 5 N 362 Disposition of comments received on ISO/IEC 14496-10:202x (11th ed.) CDAM 1
* WG 5 N 364 Disposition of comments received on CD ISO/IEC 23090-15:202x (3rd ed.)
* WG 5 N 365 Text of DIS ISO/IEC 23090-15:202x (3rd ed.) Conformance testing for versatile video
* WG 5 N 366 Disposition of comments received on DIS ISO/IEC 23090-16:202x (2nd ed.) Reference software for versatile video coding

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

* JVET-AM1005 Future CICP extensions (Draft 1)
* JVET-AM1006 HEVC additional profiles and SEI messages (Draft 4)
* JVET-AM1008 Conformance testing for HEVC multiview extended and monochrome profiles
* JVET-AM1017 Support for additional VSEI messages in AVC (Draft 3), also issued as WG 5 DAM N 363
* JVET-AM1018 HEVC with extensions and corrections (Draft 2)
* JVET-AM2005 Additions and corrections for VVC version 4 (Draft 13)
* JVET-AM2006 Additional SEI messages for VSEI version 4 (Draft 7)
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* JVET-AM2025 Algorithm description of Enhanced Compression Model 18 (ECM 18)
* JVET-AM2026 Joint Call for Evidence on video compression with capability beyond VVC, also issued as WG 5 N 367
* JVET-AL2032 Technologies under consideration for future extensions of VSEI (version 9)
* JVET-AL2038 White paper on VSEI, also issued as AG 3 N 209

The following X draft ITU-T Recommendations and Supplements were forwarded by JVET and Q6/21 for ITU-T Consent or Agreement (update):

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

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 (update):

* WG 5 N 362 Disposition of comments received on ISO/IEC 14496-10:202x (11th ed.) CDAM 1
* WG 5 N 364 Disposition of comments received on CD ISO/IEC 23090-15:202x (3rd ed.)
* WG 5 N 365 Text of DIS ISO/IEC 23090-15:202x (3rd ed.) Conformance testing for versatile video
* WG 5 N 366 Disposition of comments received on DIS ISO/IEC 23090-16:202x (2nd ed.) Reference software for versatile video coding

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 ten JVET meetings were planned for 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 13 – 22 January 2027 under ISO/IEC JTC 1/‌SC 29 auspices in Brisbane, AU; during April 2027 under ITU-T SG21 auspices, date and location t.b.d.; during 7 – 16 July 2027 under ISO/IEC JTC 1/‌SC 29 auspices in Tampere, FI; during 20 – 29 October 2027 under ISO/IEC JTC 1/‌SC 29 auspices in Shenzhen, CN; during January 2028 under ITU-T SG21 auspices, date and location t.b.d.; and during April 2028 under ISO/IEC JTC 1/‌SC 29 auspices, date and location t.b.d.

The document distribution site <https://jvet-experts.org/> was used for distribution of all documents. 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. JVET documents are also provided via <http://wftp3.itu.int/av-arch/jvet-site/>, but as this is cannot currently be maintained as a mirror with the jvet-experts.org site, documents are typically only made available with a delay of two or three meeting cycles, to avoid that late uploads of output documents would be missing.

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 fortieth meeting during 3 – 12 October 2025 at the ITU headquarters facilities in Geneva, Switzerland. The meeting was held as a physical meeting with remote participation, provided on best-effort basis for experts who were unable to travel.

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 had issued a call for evidence on video compression with capability beyond existing standards, with responses evaluated during the current meeting.

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, consisting of two parts, (B1) in-person attendees as recorded by a sign-in sheet circulated in meeting rooms, (B2) remote attendees 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_10_AN_Geneva/>.

## Primary goals

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

a) JVET documents

* JVET-AM1005 Future CICP extensions (Draft 1)
* JVET-AM1006 HEVC additional profiles and SEI messages (Draft 4)
* JVET-AM1008 Conformance testing for HEVC multiview extended and monochrome profiles
* JVET-AM1017 Support for additional VSEI messages in AVC (Draft 3), also issued as WG 5 DAM N 363
* JVET-AM1018 HEVC with extensions and corrections (Draft 2)
* JVET-AM2005 Additions and corrections for VVC version 4 (Draft 13)
* JVET-AM2006 Additional SEI messages for VSEI version 4 (Draft 7)
* JVET-AM2019 Description of algorithms version 12 and software version 14 in neural network-based video coding (NNVC)
* JVET-AM2021 Verification test plan for VVC multilayer coding (update 6)
* JVET-AM2023 Exploration experiment on neural network-based video coding (EE1)
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* JVET-AM2025 Algorithm description of Enhanced Compression Model 18 (ECM 18)
* JVET-AM2026 Joint Call for Evidence on video compression with capability beyond VVC, also issued as WG 5 N 367
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b) documents produced as WG 5 documents only:

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* WG 5 N 366 Disposition of comments received on DIS ISO/IEC 23090-16:202x (2nd ed.) Reference software for versatile video coding

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 KST timezone (local time in Daejeon), 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, or other experts that were appointed to chair parallel sessions. It is indicated who took the notes in review of a given category (or individual documents în a category), and by which day and time the review was conducted. 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 Friday, 26 September 2025. Any documents uploaded after 1159 hours Paris/Geneva time on Saturday 27 September 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-AN0270 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-AN0XXX (a proposal on …), uploaded 09-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-AN0XXX (a study on …), uploaded 09-XX,
* …

All cross-verification reports at this meeting (except for JVET-AN0082, JVET-AN165, JVET-AN166, and JVET-AN243) 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-AN0051, JVET-AN0159, JVET-AN0179, JVET-AN0268, JVET-AN0273, JVET-AN0285, JVET-AN0290, JVET-AN0320, JVET-AN0326, JVET-AN0355,… .

The following cross-verification report(s) were still missing by the end of the meeting, but were uploaded later: JVET-AN0XXX, …. The following report(s) had not become available yet three weeks after the end of the meeting: JVET-AN0XXX, … . 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 not apply to any contributions. (did apply to document(s) JVET-AN0XXX, being initially empty of results and flagged as late in the list above, based on the time of the first reasonable document upload | sentence kept for future use).

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-AM1000, the Future CICP extensions (draft 1) JVET-AM1005, the HEVC additional profiles and SEI messages (draft 4) JVET-AM1006, the Conformance testing for HEVC multiview extended and monochrome profiles JVET-AM1008, the Support for additional SEI messages in AVC (draft 3) JVET-AM1017, the HEVC with extensions and corrections (draft 2) JVET-AM1018, the Additions and corrections for VVC version 4 (Draft 13) JVET-AM2005, the Additional SEI messages for VSEI version 4 (Draft 7) JVET-AM2006, the Description of algorithms version 12 and software version 14 in neural network-based video coding (NNVC) JVET-AM2019, the Verification test plan for VVC multilayer coding (update 6) JVET-AM2021, the Description of the EE on Neural Network-based Video Coding JVET-AM2023, the Description of the EE on Enhanced Compression beyond VVC capability JVET-AM2024, the Algorithm description of Enhanced Compression Model 18 (ECM 18) JVET-AM2025, the Joint Call for Evidence on video compression with capability beyond VVC JVET-AM2026, the Technologies under consideration for future extensions of VSEI (version 9) JVET-AM2032, and the White paper on VSEI JVET-AM2038, 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 (kept for future use). The software implementations of VTM version 23.11, ECM version 18.0, and NNVC version 14.0 were also approved.

It was further noted that some editorial modifications were necessary on the WG 5 versions of standard deliverables, to be compliant with the ISO/IEC rules.

Only minor editorial issues were found in the meeting report JVET-AM1000; 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 Annexes B1 and B2 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 assessment of implementation complexity of video coding technology
* Consideration of contributions submitted as responses to the Joint Call for Evidence on video compression with capability beyond VVC, assessment of results collected in the context of the CfE, and planning of next steps towards a possible Call for Proposals on 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 times of meeting sessions followed the needs of the face-to-face meeting, with highest priority given to the aim of achieving the goals of the meeting. Typical meeting hours were expected to be 0900-2000 CEST with coffee breaks and lunch breaks as appropriate, however some early morning or late-night sessions were anticipated to be necessary. Sessions were announced in the online JVET calendar in advance as far as possible, but it was agreed that some activities (such as breakout sessions) could be held at short notice.

## ISO, IEC and ITU-T 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 1348 (as of 2 Oct. 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 (update)

* 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 14496-10:2025 (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; published 2025-07-10
  + Amendment to support some SEI messages of VSEI v4 requested at 37th meeting 2025-01, registered to work programme 2025-01-25, CDAM issued at 38th meeting 2025-04, consultation initiated 2025-04-23, closed 2025-06-18, ready to issue DAM at the current meeting
  + 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, closed 2025-03-29, DAM issued at 38th meeting 2025-04, pending DAM ballot to be initiated
  + 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, CD issued at 38th meeting 2025-04, consultation initiated 2025-05-05, pending closure 2025-06-30 during the current meeting, can issue DIS by the end of the current meeting
  + 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, closed 2025-06-01, ready to issue FDIS or proceed to publication 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, DAM issued at 38th meeting 2025-04, pending DAM ballot to be initiated
* 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)
  + ITU-T H-Series Supplement 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)
  + ITU-T H-Series Supplement 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)
  + ITU-T H-Series Supplement 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)
  + ITU-T H-Series Supplement 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 H.Sup21 (ex H.Sup-FGST), Agreement 2025-01-24 by ITU-T SG21, pre-publication 2025-03-26, pending final publication
  + ISO/IEC TR 23002-9 (Ed. 2) 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 TR 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, DTR issued at 38th meeting 2025-04, pending DTR ballot to be initiated
  + 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 (or soon afterwards, as a temporary problem was reported and fixed around 8 May 2025):
  + 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 (public availability requested 2024-04)
  + 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 (public availability requested 2024-04)
* 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 (not requested 2024-04)
* 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 current 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 (update)

* AVC ISO/IEC 14496-10:2025/CDAM 1 to support some SEI messages of VSEI v4 requested at 37th meeting 2025-01, registered to work programme 2025-01-25, CDAM issued at 38th meeting 2025-04, consultation initiated 2025-04-23, closed 2025-06-18, ready to issue DAM at the current meeting
* HEVC ISO/IEC 23008-2:2025/DAM 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, closed 2025-03-29, DAM issued at 38th meeting 2025-04, pending DAM ballot to be initiated
* 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, DAM issued at 38th meeting 2025-04, pending DAM ballot to be initiated
* VVC conformance ISO/IEC 23090-15 (Ed. 3) project requested at 37th meeting, project registered in work programme 2025-01-25, CD issued at 38th meeting 2025-04, consultation initiated 2025-05-05, pending closure 2025-06-30 during the current meeting, can issue DIS by the end of the current meeting
* 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, closed 2025-06-01, ready to issue FDIS or proceed to publication 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, DAM issued at 38th meeting 2025-04, pending DAM ballot to be initiated
* ISO/IEC TR 23002-9 (Ed. 2) Film grain synthesis technology for video applications – Edition 2 planned but not yet in formal work programme of ISO/IEC
* H.Sup-MACVC | ISO/IEC TR 23888-3 (Ed. 1) Optimization of encoders and receiving systems for machine analysis of coded video content – ISO/IEC TR 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, DTR issued at 38th meeting 2025-04, pending DTR ballot to be initiated (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 Friday 3 October at 1430-XXXX CEST 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 higher than for last meeting (approximately 230 vs. 200 by the time of opening the meeting) – parallel sessions were announced to be necessary.
  + Start of parallel sessions (HLS and EE review) Saturday morning
  + Expert viewing of CfE submissions to be conducted Saturday, Sunday and Monday
  + JVET will not meet during the WP3/21 plenary on Monday 6 Oct. 1415-1545 CEST (revisit: can JVET meet in parallel with SG21 Mon morning?). JVET might likely meet during the MPEG information exchange sessions on Tuesday 7 Oct. (0900-1200 CEST) and Thursday 9 Oct. (0900-1000 CEST), both of them held in CICG. It is planned to approve WG 5 recommendations before the MPEG information exchange on Saturday 11 Oct. (1400-1600 CEST, in ITU/Popov) where those should be presented. JVET will however continue working until Sunday 12 Oct. evening (depending on workload).
  + SG21 workshop on Friday 1400-1830 “Embodied AI and Media Technology Standards” (<https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2025/1010/Pages/default.aspx>). The current plan is that they use half of room C and JVET uses the other half. Another option would be that JVET meets in smaller rooms (e.g., breakout) during that time. The problem is that if Room C is in split mode Friday afternoon, that will stay over the weekend which would be undesirable for the last two days.
* Future non-virtual meetings will be held as hybrid meetings with best-effort remote access (when under ISO/IEC SC 29 auspices) or as physical meetings with remote participation (when under ITU-T SG21 auspices). In terms of practical arrangements, this is identical.
* Plans for subsequent non-virtual meetings were reviewed: April 2026 (Santa Eulària), July 2026 (Geneva), October 2026 (Hangzhou), January 2027 (Brisbane), April 2027 (likely Geneva), July 2027 (Tampere), October 2027 (Shenzhen), January 2028 (likely Geneva).
* The January 2026 meeting remains planned to be virtual.
* Depending on the status of preparing future standardization activities, it may be necessary to extend the duration of meetings, or plan for AHG meeting days prior to the regular meeting (e.g., for analysis of CfE/CfP submissions)
* Significant workload was expected at this meeting for AHG17 activities – to evaluate responses to the the Call for Evidence and plan subsequent steps. Before starting discussion, the viewing of CfE submissions needs to be conducted (Sat.-Mon.). Up to 336 volunteers are needed for viewing sessions (but experts can participate in multiple sessions). Review of EE1/EE2 needs to be done in parallel. Joint meetings with parent bodies are also expected next week on this topic.
* 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-AM1000 were reviewed (which was finalized during early September, but sufficiently mature drafts had been available before in the ITU ftp site). 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 again be recorded via the traditional sign-in sheet, in addition to the list of web registrations made via ITU. Participants were asked to correct their affiliation and email in cases where these changed (also in the ITU account). Remote attendance (of those not present in person) will be recorded via the zoom reports. It is therefore important to follow the conventions of naming as mentioned before. Participants who cannot be correctly identified will not appear in the attendance sheet.
* 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. As for now, the JVET chair took action of correcting those cases in the document registry.
* 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.
* 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. JVET documents can only be made available with a delay of at least one meeting cycle, as often newer versions (in particular of output documents) are still uploaded later
* The following ballot results had become available through the SC 29 secretariat:
  + DAM HEVC [mxxxxx](https://dms.mpeg.expert/doc_end_user/current_document.php?id=99765&id_meeting=203)
  + DAM VVC [mxxxxx](https://dms.mpeg.expert/doc_end_user/current_document.php?id=99765&id_meeting=203)
  + DAM VSEI [mxxxxx](https://dms.mpeg.expert/doc_end_user/current_document.php?id=99765&id_meeting=203)
* It is planned to issue FDIS of new editions for HEVC, VVC and VSEI at this meeting, and also submit them for ITU-T consent on the next versions of H.265, H.266 and H.274.
* It was originally planned to submit the supplement on machine analysis for ITU-T approval. As ballot comments will only arrive in November, which might make it necessary second DTR would need to be issued, the ITU version should be deferred until July 2026.
* The AVC amendment (support for additional VSEI messages) is currently under DAM ballot which will close before the January 2026 meeting. An FDIS on the next edition could be planned for January or April, and the next H.264 version be submitted in April 2026.
* The 3rd edition of VVC conformance is currently under DIS ballot. Submission to consent on next version of H.266.1 should be done at the current meeting.
* Plans for generating the next versions of reference software for AVC, HEVC and VVC (which would need to support new SEI messages from VSEIv4) need to be developed. Earliest target date for ITU-T consent would be April 2026 – should requests be made for ISO? For AVC, it might also be useful to generate a new part of ISO/IEC 14496.
* The primary goals of the meeting were:
  + Generate next versions/editions of VSEI, VVC and HEVC
  + VVC conformance for ITU consent
  + Evaluation of CfE results, and further steps
  + TuC on VSEI and CICP
  + Exploration Experiments
    - Neural network-based video coding
    - Enhanced compression beyond VVC
  + Liaison communication – any?
  + VVC white paper update (remove VSEI, some update of the 2021 version)
* 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). Another potential joint meeting may be necessary on Gaussian splatting (SEI proposal) with WGs 4 and 7.
* As a follow-up to communication after previous meetings, parent bodies need to conduct further discussion about future JVET management structures.
* Principles of standards development were discussed.
* Scheduling of sessions was discussed – see under sections 2.6 and 2.12.

## Scheduling of discussions

The times of the meeting sessions followed the needs of the onsite meeting arrangements, with highest priority given to the aim of achieving the goals of the meeting. Typical meeting hours were in the range of 0900-2000 CEST with coffee breaks and lunch breaks as appropriate, however some early morning or late-night sessions were noted to potentially be necessary. Sessions were announced in the JVET calendar as far as possible in advance, although it was acknowledged that some activities (such as breakout sessions) might be held at short notice.

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:

Coffee breaks were regularly scheduled at 1030 and 1630.

* Fri. 3 Oct., 1st day
  + Afternoon session:
    - 1400–1510 Opening remarks, review of practices, agenda, IPR policy reminder
    - 1510–1850 Reports of AHGs 1-18
* Sat. 4 Oct., 2nd day
  + Sessions with coffee/lunch break as appropriate:
    - 0900–1930 Experts viewing of CfE submissions (compression performance category)
    - 0900–2000 Review all EE1 5.1.x categories, 4.1, 4.2, 4.3 (Popov room)
    - 0900–1930 HLS track:6.1, 6.2 (Rm. A, chaired by Jill Boyce)
* Sun. 5 Oct., 3rd day
  + Sessions with coffee/lunch break as appropriate:
    - 0900–1930 Experts viewing of CfE submissions (encoding runtime category)
    - 0900–1930 Review EE2 5.2.1, 5.2.3, 5.2.4.1 categories (Popov room)
    - 0900–1930 HLS track: 6.2, 6.3 (Rm. A, chaired by Jill Boyce)
* Mon. 6 Oct., 4th day
  + 0900–1830 Experts viewing of CfE submissions (encoding runtime category and functionality category)
  + Morning sessions:
    - 0900–1400 Review 5.2.4 remaining (Room C)
    - 0900–1300 HLS track: 6.5, 6.2 revisits, 6.3 (CICG 14, chaired by Jill Boyce)
  + Afternoon sessions (no session during WP3/21 plenary):
    - 1600–1700 Review 4.4, 4.11, 4.13, 4.14, 4.15, 4.18 (Room C)
    - 1600–2000 HLS track: Remaining 6.x (CICG 14, chaired by Jill Boyce)
    - 1800–2000 Review remaining 5.2.4, 5.2.5 (Room C, chaired by Y. Ye)
* Tue. 7 Oct., 5th day
  + 0900–XXXX MPEG information sharing session
  + Morning sessions:
    - XXXX–XXXX TBD
    - …
  + Afternoon sessions:
    - XXXX–XXXX TBD
    - …
* Wed. 8 Oct., 6th day
  + Morning sessions:
    - XXXX–XXXX TBD
    - …
  + Afternoon sessions:
    - XXXX–XXXX TBD
    - …
* Thu. 9 Oct., 7th day
  + 0900–1015 MPEG information sharing session
  + Morning sessions:
    - XXXX–XXXX TBD
    - …
  + Afternoon sessions:
    - XXXX–XXXX TBD
    - …
* Fri. 10 Oct., 8th day
  + Morning sessions:
    - XXXX–XXXX TBD
    - …
  + Afternoon sessions:
    - XXXX–XXXX TBD
    - …
* Sat. 11 Oct., 9th day
  + XXXX–XXXX JVET plenary:
    - CfE results and further planning
    - Planning of output docs
    - Establishment of AHGs
    - Review of WG 5 meeting recommendations
  + 1400–1600 MPEG information sharing session
  + XXXX–XXXX JVET remaining business
* Sun. 10 Oct., 10th day
  + XXXX–XXXX JVET remaining business
  + XXXX–XXXX JVET plenary:
    - EE review
    - Final approval of output docs
    - Software timeline
    - Future planning, a.o.b.
    - Closing of meeting

## Contribution topic overview

The approximate subject categories and quantity of contributions per category for the meeting were summarized as follows (note that the noted document counts do not include crosschecks and 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: Deployment and advertisement of standards (1)
  + AHG2: Text development and errata reporting (1)
  + AHG3: Software development (1)
  + AHG3: Test conditions and metrics (2)
  + AHG4: Subjective quality testing and verification testing (1)
  + AHG4: Test and training material (2)
  + AHG5: Conformance test development (0)
  + AHG7: ECM tool assessment (6)
  + AHG8: Optimization of encoders and receiving systems for machine analysis of coded video content (0)
  + AHG10: Encoding algorithm optimization (0)
  + AHG13: Film grain synthesis (1)
  + Implementation studies (0)
  + Profile/tier/level specification (1)
  + AHG15: Gaming content compression (2)
  + AHG16: Generative face video (1)
  + AHG17: CfE on video coding technology (17)
  + AHG18: Ultra-low latency and error resilience (8)
  + CICP (1)
* Low-level tool technology proposals (section 5) with subtopics (number counts excluding BoG and summary reports)
  + AHG11/AHG14 and EE1: Neural network-based video coding (26) (section 5.1)
  + AHG6/AHG12 and EE2: Enhanced compression beyond VVC capability (70) (section 5.2)
* AHG9: High-level syntax (HLS) proposals (section 6) with subtopics
  + Aspects of SEI messages in VSEI, VVC, HEVC and AVC (7) (section 6.1)
  + Aspects of SEI messages in VSEI v4 (30) (section 6.2)
  + SEI messages in TuC for VSEI (47) (section 6.3)
  + SEI messages on other topics (6) (section 6.4)
  + SEI software and showcases (1) (section 6.5)
  + Non-SEI HLS aspects (1) (section 6.6)
* Joint meetings, plenary discussions, BoG reports (X) liaison (X), 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 XXXX–XXXX on Friday 3 Oct. 2025 (chaired by JRO).

[JVET-AN0001](https://jvet-experts.org/doc_end_user/current_document.php?id=16254) JVET AHG report: Project Management (AHG1) [J.-R. Ohm (chair), G. J. Sullivan (vice chair)]

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

The number of subscribers (on the day before the beginning of the current meeting) was 1348 (compared to 1315 by the time of the previous meeting). Furthermore, the previous lists of joint teams (which were still kept open as archives) had the following number of subscribers:

* JCT-VC – 1158 subscribers
* JCT-3V – 680 subscribers
* JVT-experts – 2077 subscribers

It is likely that many subscriptions of these latter three reflectors would have become obsolete, as no emails are being sent over them any more, and therefore automatic removal of addresses causing permanent bounces by being invalid (as it happens with the main JVET reflector) cannot be executed by the reflector management system.

**Goals and activity**

The work of the JVET overall had proceeded well in the interim period with increased 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 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_06_AM_Daejeon/>). 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, for JVET 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-AM1005 Future CICP extensions (Draft 1) [Posted 2025-08-01]
* JVET-AM1006 HEVC additional profiles and SEI messages (Draft 4) [Posted 2025-07-23]
* JVET-AM1008 Conformance testing for HEVC multiview extended and monochrome profiles [Posted 2025-07-25]
* JVET-AM1017 Support for additional VSEI messages in AVC (Draft 3), also issued as WG 5 DAM N 363 [Posted 2025-08-01, last update 2025-08-08]
* JVET-AM1018 HEVC with extensions and corrections (Draft 2) [Posted 2025-07-23]
* JVET-AM2005 Additions and corrections for VVC version 4 (Draft 13) [Posted 2025-10-03]
* JVET-AM2006 Additional SEI messages for VSEI version 4 (Draft 7) [Posted 2025-07-23]
* JVET-AM2019 Description of algorithms version 12 and software version 14 in neural network-based video coding (NNVC) [Posted 2025-07-28, last update 2025-08-02]
* JVET-AM2021 Verification test plan for VVC multilayer coding (update 6) [Posted 2025-09-15]
* JVET-AM2023 Exploration experiment on neural network-based video coding (EE1) [Posted 2025-07-03, last update 2025-08-04]
* JVET-AM2024 Exploration experiment on enhanced compression beyond VVC capability (EE2) [Posted 2025-07-03, last update 2025-08-08]
* JVET-AM2025 Algorithm description of Enhanced Compression Model 18 (ECM 18) [Posted 2025-09-24]
* JVET-AM2026 Joint Call for Evidence on video compression with capability beyond VVC, also issued as WG 5 N 367 [Posted 2025-07-05, last update 2025-08-09]
* JVET-AL2032 Technologies under consideration for future extensions of VSEI (version 9) [Posted 2025-08-27, last update 2025-09-08]
* JVET-AL2038 White paper on VSEI, also issued as AG 3 N 209 [Posted 2025-07-25]

It is noted that the following output document from the 38th JVET meeting also became available:

* JVET-AL2020 Film grain synthesis technology for video applications ed. 2 (Draft 3)

The eighteen *ad hoc* groups had made progress, and reports from those activities had been submitted. Numerous teleconferences had been held by AHGs. Furthermore, two exploration experiments (EE) on neural network-based video coding and on enhanced compression beyond VVC capability were conducted, and 5 submissions were received as responses to the Joint Call for Evidence on video compression with capability beyond VVC.

The arrangements for the 40th meeting had been announced in the JVET reflector, in the JVET logistics document (<https://www.itu.int/wftp3/av-arch/jvet-site/2025_10_AN_Geneva/JVET-AN_Logistics.docx>), and in the WG 5 calling notice (N 369) and agenda (N 370) for the 21st 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.

More than 230 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 40th meeting had been made publicly available on the ITU-hosted ftp site as <http://wftp3.itu.int/av-arch/jvet-site/2025_10_AN_Geneva/JVET-AN_notes_d0.docx>.

Further discussion needs to be conducted with the parent bodies about future JVET management structures, considering that substantially higher workload could be expected in upcoming standardization activities.

**Recommendations**

* The AHG recommends its continuation.

[JVET-AN0002](https://jvet-experts.org/doc_end_user/current_document.php?id=16255) 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)]

1. **Ad hoc group activity**

**Output documents produced**

**JVET-AM1006 HEVC additional profiles and SEI messages (draft 4) [Y.-K. Wang, B. Bross, S. Deshpande, G. J. Sullivan, A. Tourapis]**

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 12 new SEI messages, namely the SEI processing order, processing order nesting, encoder optimization information, source picture timing information, modality information, digitally signed content initialization, digitally signed content selection, and digitally signed content verification, generative face video, generative face video enhancement, AI usage restrictions, and packed regions information 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 extensions and corrections to the previous version of the HEVC standard.

**Changes that have been integrated for the 39th JVET meeting in June-July 2025:**

1. JVET-AM0048 AHG9/AHG2: Miscellaneous changes for HEVC
2. JVET-AM0121 AHG9: On the SEI processing order SEI message
3. JVET-AM0324 Correction to the Alpha Channel Information SEI message processing order
4. Changed all instances of "BtDepth" to "BitDepthVal".
5. Changed "generative face video enhancement" to "generative face enhancement", to avoid one SEI message name etc. being a subset of another SEI message name etc.
6. JVET-AM0118 AHG9: Digital signing of selected SEI messages
7. JVET-AM0166 AHG9: Miscellaneous aspects in VSEI v4. Item 4 – Constraint for PON SEI message on prefix and suffix SEI messages.

**JVET-AM1017 Support for additional SEI messages in AVC (draft 3) [B. Bross, J. Boyce, G. J. Sullivan, Y.-K. Wang]**

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 39th JVET meeting in June 2025:**

1. DoCR US-003: Update SEI message lists in sections F.13.2, G.13.2, H.13.2
2. Changed all instances of "BtDepth" to "BitDepthVal".
3. Changed "generative face video enhancement" to "generative face enhancement", to avoid one SEI message name etc. being a subset of another SEI message name etc.
4. Fixes for formatting and ISO/IEC terminology

**JVET-AM2005 Additions and corrections for VVC version 4 (Draft 13) [G. J. Sullivan, B. Bross, M. M. Hannuksela, Y.-K. Wang]**

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 that have been integrated for the 39th JVET meeting in June-July 2025:**

1. JVET-AM0118 AHG9: Digital signing of selected SEI messages
2. JVET-AM0121 AHG9: On the SEI processing order SEI message
3. Changed all instances of "BtDepth" to "BitDepthVal".
4. Changed "generative face video enhancement" to "generative face enhancement", to avoid one SEI message name etc. being a subset of another SEI message name etc.
5. JVET-AM0174 AHG9: On general SEI payload constraints.

JVET-AM0166 AHG9: Miscellaneous aspects in VSEI v4. Item 4 – Constraint for PON SEI message on prefix and suffix SEI messages.

**JVET-AM2006 Additional SEI messages for VSEI version 4 (Draft 7) [J. Boyce, J. Chen, S. Deshpande, M. M. Hannuksela, S. McCarthy, G. J. Sullivan, H. Tan, Y.-K. Wang]**

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 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.

**Changes that have been integrated:**

*A description of the contributions reflected in this document relative to JVET-AL2006:*

Multiple SEI messages

* [JVET-AM0047](https://jvet-experts.org/doc_end_user/current_document.php?id=15694) AHG9: Miscellaneous changes for VSEI
* Changed all instances of "BtDepth" to "BitDepthVal".
* [JVET-AM0052](https://jvet-experts.org/doc_end_user/current_document.php?id=15699) AHG9: Editorial changes for VSEI
* [JVET-AM0165](https://jvet-experts.org/doc_end_user/current_document.php?id=15812) AHG9: On value range and reserved values for syntax elements in VSEI v4
* [JVET-AM0166](https://jvet-experts.org/doc_end_user/current_document.php?id=15813) AHG9: Miscellaneous aspects in VSEI v4 . Item 4 needs to be implemented in the VVC and HEVC interface spec draft.
* [JVET-AM0189](https://jvet-experts.org/doc_end_user/current_document.php?id=15836) AHG9: On semantics of persistence flag of SEI messages in VSEI v4 and v3
* [JVET-AM0191](https://jvet-experts.org/doc_end_user/current_document.php?id=15838) AHG9: Editorial updates for VSEI v4

SEI processing order (SPO) and processing order nesting (PON)

* [JVET-AM0121](https://jvet-experts.org/doc_end_user/current_document.php?id=15768) AHG9: On the SEI processing order SEI message
* [JVET-AM0292](https://jvet-experts.org/doc_end_user/current_document.php?id=15960) AHG9/AHG2: On the semantics of po\_num\_bits\_in\_prefix\_indication\_minus1[ i ] and po\_sei\_prefix\_data\_bit[ i ][ j ]
* [JVET-AM0321](https://jvet-experts.org/doc_end_user/current_document.php?id=15989) AHG9: On SEI message types indicated by an SPO SEI message
* [JVET-AM0081](https://jvet-experts.org/doc_end_user/current_document.php?id=15728) AHG9: On the PON dependency constraint
* [JVET-AM0082](https://jvet-experts.org/doc_end_user/current_document.php?id=15729) AHG9: On the PON nested FGC SEI message

AI usage restrictions (AUR)

* [JVET-AM0117](https://jvet-experts.org/doc_end_user/current_document.php?id=15764) AHG9: On the AI usage restrictions SEI message
* [JVET-AM0112](https://jvet-experts.org/doc_end_user/current_document.php?id=15759) AHG9: On AI usage restrictions SEI message
* [JVET-AM0152](https://jvet-experts.org/doc_end_user/current_document.php?id=15799) AHG9: AI usage restrictions for entities other than decoded pictures

Digitally signed content (DSC)

* [JVET-AM0118](https://jvet-experts.org/doc_end_user/current_document.php?id=15765) AHG9: Digital signing of selected SEI messages
* [JVET-AM0119](https://jvet-experts.org/doc_end_user/current_document.php?id=15766) AHG9: On start and end flags of digitally signed
* [JVET-AM0164](https://jvet-experts.org/doc_end_user/current_document.php?id=15811) AHG9: On DSC SEI
* [JVET-AM0190](https://jvet-experts.org/doc_end_user/current_document.php?id=15837) AHG9: On implicit association mode in digitally-signed content SEI messages in VSEI v4
* [JVET-AM0210](https://jvet-experts.org/doc_end_user/current_document.php?id=15857) AHG9: On miscellaneous aspects in digitally-signed content SEI messages in VSEI v4 draft

Generative face video (GFV) and generative face enhancement (GFE)

* [JVET-AM0334](https://jvet-experts.org/doc_end_user/current_document.php?id=16002) AHG9: Common specification text for GFV SEI message
* Changed "generative face video enhancement" to "generative face enhancement", and "gfve" to "gfe", to avoid one SEI message name etc. being a subset of another SEI message name etc.

Packed regions info (PRI)

* [JVET-AM0211](https://jvet-experts.org/doc_end_user/current_document.php?id=15858) AHG9: On the packed regions information SEI message
* [JVET-AM0075](https://jvet-experts.org/doc_end_user/current_document.php?id=15722) AHG9: On packed regions information SEI message

1. **Related input contributions**

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

* (none)

1. **Remaining VVC spec tickets**

Closed since JVET-AM0002 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.
* [#1652](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1652) Incorrect heading style in JVET-S2001-v17.

New (since JVET-AM0002 was reported)

* (none)

1. **Remaining HEVC spec tickets**

Closed since JVET-AM0002 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-AM0002 was reported):

* (none)

1. **Recommendations**

The AHG recommends to:

* Approve JVET-AM1004, JVET-AM1017, JVET-AL2005, and JVET-AM2006 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 is noted that currently, no need is seen for an update of bug collection doc JVET-AL1004.

[JVET-AN0003](https://jvet-experts.org/doc_end_user/current_document.php?id=16256) 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 23.11](https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/-/releases/VTM-23.11) (July 2025)
* [VTM-22.2-TuC4.0](https://vcgit.hhi.fraunhofer.de/jvet-tuc/VVCSoftware_VTM/-/releases/VTM-22.2-TuC4.0) (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 when available.

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 23.11 was tagged on July. 4, 2025. VTM 23.12 is expected during the 40th JVET meeting. VTM 23.11 was not followed up with a macro cleanup version. Macros will be cleaned up after VTM 23.12.

VTM 23.11 was tagged on July 4, 2025. Changes include:

* JVET-AJ0183: Implementation of syntax element eoi\_src\_pic\_flag in Encoder Optimization Information SEI message
* JVET-AK0287: Signal flags in DSCI SEI to indicate substream dependency
* JVET-AL0123/AL0310: Signalling changes to the EOI SEI message
* JVET-AK0140: Packed Regions Info SEI
* JVET-AL0301: Specify constraints on syntax elements related to matrix\_coeffs
* JVET-AJ0060: multilayer adaptation of Packed regions information SEI message
* Introduce cfg parameter to remove dependency on GOP size when determining `pps\_init\_qp\_minus26`
* JVET-AL0324, AL0070: updates of PRI SEI message
* JVET-AL0339: Spatial Resolution for the FGC SEI message
* JVET-AL0075: Add nnpfa\_selected\_input\_flag to NNPFA SEI
* JVET-AK0326 and JVET-AI0070: Updated NNPF SEI messages
* JVET-AL0117: On association of NAL units to DSC verification substreams
* Faster temporal prefilter
* Faster CRC32C computation
* JVET-AL0056: Constraint for quant threshold delta in EOI SEI message
* JVET-AL0067: OMI SEI constraints
* Improved implementation of hash search
* Fix incorrect constant in ISP search
* WG03 N01464: Implementation of attenuation maps as new green metadata type
* JVET-AK0114: Implementation of AI-Usage Restrictions SEI message
* JVET-AJ0105: Complexity Info in SPO SEI message
* JVET-AM0280: Decoder memory printout
* Update for high performance cfg files
* add self-contained cfg for CfE
* JVET-AM0200: reduced run time configurations
* Update version number to 23.11

VTM 23.12 is expected to be tagged during the 40th JVET meeting. Changes are expected to include:

* Fix memory leak when RPR is used
* Fix a link error of parcat when JVET\_J0090\_MEMORY\_BANDWITH\_MEASURE is on
* Initialize pointer to VPS of a pilot Slice object
* Correctly set input chroma format when reading a y4m file
* Avoid recomputing LMCS parameters when using debugBitstream by copying APS info (same as AFL APSs)
* Fix trace output of coded block flag (CBF)
* JVET-AM0227: Fix CABAC statistics collection
* JVET-AJ0258: Image Format Metadata SEI
* New enum for splits - removes magic numbers from CtxSplit
* Increase minimum required CMake version
* DSC: fix detection of last picture
* JVET-AK0206: Digitally signed content ID
* remove dead code in EncModeCtrl.h
* DSC: Align DSCI syntax with spec
* JVET-AL0222: Digitally signed content intended start and end flags
* JVET-AL0066: Add sample tolerance value to OMI SEI
* JVET-AM0164: move dsci\_key\_source\_uri and increase length of dscv\_signature\_length\_in\_octets\_minus1
* JVET-AL0058: Change aur\_context to fixed length
* JVET-AM0334: Update to GFV SEI chroma key syntax
* JVET-AK0281: AUR SEI message in SPO SEI message
* JVET-AM0117: aur\_sei\_exclusion\_flag

***CTC Performance***

The VTM 23.11 shows some improvements compared to VTM 23.9/23.10 due to MR2840, which enables DeblockingFilterOffsetInPPS, and faster code with reduced memory usage due to improvements in temporal prefilter and hash ME.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | |
|  | **Over VTM-23.9** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.00% | 0.00% | 0.00% | 97% | 100% |
| Class A2 | 0.00% | 0.00% | 0.00% | 99% | 99% |
| Class B | 0.00% | 0.00% | 0.00% | 99% | 98% |
| Class C | 0.00% | 0.00% | 0.00% | 99% | 98% |
| Class E | 0.00% | 0.00% | 0.00% | 97% | 97% |
| **Overall** | 0.00% | 0.00% | 0.00% | 99% | 98% |
| Class D | 0.00% | 0.00% | 0.00% | 98% | 90% |
| Class F | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class TGM | 0.00% | 0.00% | 0.00% | 98% | 97% |
|  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | |
|  | **Over VTM-23.9** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.00% | 0.00% | 0.00% | 98% | 102% |
| Class A2 | -0.01% | -0.01% | -0.01% | 98% | 103% |
| Class B | -0.01% | -0.01% | -0.01% | 97% | 99% |
| Class C | -0.02% | -0.02% | -0.02% | 96% | 95% |
| Class E |  |  |  |  |  |
| **Overall** | -0.01% | -0.01% | -0.01% | 97% | 99% |
| Class D | -0.06% | -0.07% | -0.07% | 97% | 95% |
| Class F | -0.03% | -0.03% | -0.03% | 96% | 95% |
| Class TGM | -0.01% | -0.01% | -0.01% | 99% | 99% |
|  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | |
|  | **Over VTM-23.9** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -0.01% | -0.01% | -0.01% | 98% | 99% |
| Class C | -0.02% | -0.02% | -0.02% | 98% | 100% |
| Class E | -0.11% | -0.11% | -0.10% | 95% | 104% |
| **Overall** | -0.04% | -0.04% | -0.04% | 97% | 100% |
| Class D | -0.06% | -0.05% | -0.05% | 97% | 100% |
| Class F | -0.04% | -0.04% | -0.04% | 96% | 101% |
| Class TGM | -0.01% | -0.01% | -0.01% | 97% | 98% |
|  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | |
|  | **Over VTM-23.9** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -0.01% | -0.01% | -0.01% | 96% | 97% |
| Class C | -0.01% | -0.01% | -0.01% | 98% | 103% |
| Class E | -0.09% | -0.09% | -0.08% | 94% | 101% |
| **Overall** | -0.03% | -0.03% | -0.03% | 96% | 100% |
| Class D | -0.04% | -0.03% | -0.03% | 97% | 95% |
| Class F | -0.02% | -0.03% | -0.03% | 96% | 98% |
| Class TGM | -0.01% | -0.01% | -0.01% | 95% | 94% |

For the HDR CTCs, coding performance of VTM 23.11 compared to VTM 23.10 are reported in table below. Slight variations are observed in RA. Encoding run time seems to be slightly reduced. Decoding run time is almost not changed.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access** | | | | | | | | | |
|  | **Over VTM23.10** | | | | | | | | | |
|  |  |  | **wPSNR** |  |  | **PSNR** |  |  |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -0.03% | -0.03% | -0.03% | -0.03% | -0.03% | -0.03% | -0.03% | -0.03% | 97% | 97% |
| Class H2 |  |  |  |  |  | -0.01% | -0.01% | -0.01% | 96% | 101% |
| **Overall** | -0.03% | -0.03% | -0.03% | -0.03% | -0.03% | -0.02% | -0.02% | -0.02% | 96% | 99% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **All Intra** | | | | | | | | | |
|  | **Over VTM23.10** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 98% | 101% |
| Class H2 |  |  |  |  |  | 0.00% | 0.00% | 0.00% | 98% | 102% |
| **Overall** | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 98% | 101% |

Coding performance of VTM 23.11 compared to HM 18.0 are reported in table below.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access** | | | | | | | | | |
|  | **Over HM18.0** | | | | | | | | | |
|  |  |  | **wPSNR** |  |  | **PSNR** |  |  |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -39.49% | -37.66% | -36.75% | -54.96% | -48.52% | -33.76% | -49.45% | -40.94% | 255% | 79% |
| Class H2 |  |  |  |  |  | -31.99% | -57.73% | -63.35% | 220% | 79% |
| **Overall** | -39.49% | -37.66% | -36.75% | -54.96% | -48.52% | -33.12% | -52.46% | -49.09% | 241% | 79% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **All Intra** | | | | | | | | | |
|  | **Over HM18.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -41.44% | -27.31% | -26.79% | -57.73% | -52.77% | -24.00% | -52.92% | -45.07% | 1511% | 103% |
| Class H2 |  |  |  |  |  | -21.76% | -47.23% | -50.60% | 1225% | 96% |
| **Overall** | -41.44% | -27.31% | -26.79% | -57.73% | -52.77% | -23.18% | -50.85% | -47.08% | 1400% | 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>

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 40th JVET meeting.

The following changes were merged into the TuC branch:

* JVET-AG0328: FGR SEI message

The following merge requests were submitted and are pending:

* JVET-AM0086: PHOTOSENSITIVE CONTENT ADDITIONAL INFORMATION
* JVET-AL0219
* JVET-AK0142: "AHG9: Display Rectangles SEI"
* 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:

* JVET-AE0101: implement phase indication SEI message
* Update auto-build from VTM build definition
* Update copyright headers to include 2025
* JVET-AK0107: Modality Information SEI
* JVET-AK0194: Digitally Signed Content SEI messages
* Fix building on ARM
* Enable build on macOS/arm
* Modify semantics of IntraPeriod to enable autosetting based on frame rate
* Fix yuv output when bitdepth is changed between sequence
* Add missing initialization in TComPPS and TComScalingList (fix asan/msan errors)

The following MRs are pending [with status indicated]:

* JVET-AL0059: Packed regions information SEI (pending reviewing)
* JVET-AL0148: implementation of GFV and GFVE SEI messages (pending review)
* Avoid reading SEI content when payloadSize = 0 (one issue remains)
* JVET-AL0062: AI usage restrictions SEI message (pending review)
* JVET-AK2006: Add support for SPTI SEI message (pending review/rebasing)
* JVET-AL0061: Import encoder optimization information SEI Message form VTM (pending review)
* JVET-AL0148: implementation of GFV and GFVE SEI messages (pending review)
* 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 40th 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**

Two new versions (0.25 and 0.26) of HDRTools have been tagged.

Version 0.25 includes the following changes:

* Update HDRMontage to support temporal interleaving
* Fixes to TIFF files with Alpha
* support for absolute crop
* Compute metrics with files of different bitdepth

Version 0.26 includes the following changes:

* fixes computation of WTPSNR metric to match VTM software when EnableJVETPSNR=1
* fixes build on recent gcc versions (13 and above)

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 (pending review)
* 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)
* JVET-AL0148: Add support for Generative Face Video (GFV) and Generative Face Video Enhancement (GFVE) SEI messages(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-AL2010 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. **Related proposals**

JVET-AN0292 proposes to add multi-view functionality to HM. Mutli-view HEVC is usually supported by HTM. It is asserted that range extension support in HTM is very limited but required for the new multi-view profiles. It is asserted that it was easier to port multi-view functionality to HM instead if range extension to HTM.

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.

Numerous merge requests for adding new SEI messages to JM and HM had not yet been integrated due to lack of time of software coordinators. This should be used later as basis for issuing new versions of AVC and HEVC reference software.

Further discussion on JVET-AN0292 about harmonization of HM and HTM – see section 4.3. It was mentioned that also document JVET-AN0048 reports activities on harmonizing HM and SHM

[JVET-AN0004](https://jvet-experts.org/doc_end_user/current_document.php?id=16257) 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)]

1. **Preparations *for the Joint Call for Evidence on video compression with capability beyond VVC***

AHG4 supported the activities of AHG17 and prepared for the on-site testing activity.

1. ***Test sequences***

The set of JVET test sequences is hosted at <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. The password for the site is updated after each meeting with the Zoom password for that meeting. The tentative schedule for the changes is as follows:

* After the April meeting, password changes on 1st of June
* After the July meeting, password changes on 1st of September
* After the October meeting, password changes on 1st of December.
* After the January meeting, password changes on 1st of March.

1. **Related contributions**

(listing document directly related to AHG4 as well as documents related to testing activities and test material)

|  |  |  |
| --- | --- | --- |
| [JVET-AN0048](https://jvet-experts.org/doc_end_user/current_document.php?id=16032) | AHG4: teleconference on VVC multilayer testing | P. de Lagrange (InterDigital) |
| [JVET-AN0053](https://jvet-experts.org/doc_end_user/current_document.php?id=16037) | AHG4/AHG15/AHG17: 4K gaming sequences featuring “Black Myth: Wukong” | [J. Sauer](mailto:johannes.sauer@huawei.com), [Y. Zhao](mailto:yin.zhao@huawei.com), Y. Sun, J. Zhou, E. Alshina (Huawei) |
| [JVET-AN0177](https://jvet-experts.org/doc_end_user/current_document.php?id=16161) | AHG4/AHG17: Response to the call for new HDR materials for future video coding development | [J. Wang](mailto:blindwang@zju.edu.cn), [J. Zhang](mailto:jiaqi.zhang@zju.edu.cn), [L. Yu (ZJU)](mailto:yul@zju.edu.cn) |
| [JVET-AN0298](https://jvet-experts.org/doc_end_user/current_document.php?id=16302) | AHG4: proposed updates for VVC multi-layer verification test plan | P. de Lagrange (InterDigital) |

It is noted that JVET-AN0048 includes new test sequences which were explored in the context of the VVC ML testing activity, some of which are available both in SDR and HDR.

1. **Recommendations**

The AHG recommends:

* To conduct the viewing tests for the Joint Call for Evidence on video compression with capability beyond VVC with the test points recommended by AHG17.
* 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.

[JVET-AN0005](https://jvet-experts.org/doc_end_user/current_document.php?id=16258) 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)]

1. **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 39th and the 40th meetings.

1. **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:**
  + CD: 2025-04-15
  + DIS: 2025-07-25
  + FDIS: 2026-02-20
  + IS: 2026-06-30
  + H.266.1 V3 Consent 2025-10

1. **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
  + No changes between 39th and the 40th meeting.
* conformance bitstreams for VVC operation range extensions:
  + 57 bitstream categories have been identified
  + 128 bitstreams of 57 identified categories have been provided, cross-checked and made available
  + No changes between the 39th and 40th 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 the 39th and 40th 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 39th and 40th meeting
  + 2 HEVC Multiview Extended bitstreams have been provided, cross-checked, and made available, no changes between 39th and 40th meeting
  + 2 HEVC Multiview Main 10 bitstreams have been provided, cross-checked and made available, no changes between 39th and 40th meeting.

1. **Activities and Discussion**

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

VVC activities:

The streams are available at ​ <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVC3rdEd/DIS/>. No change in bitstreams and/or packages.

VVC operation range extensions activities:

The streams are available at ​ <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVC3rdEd/DIS/>. No change in bitstreams and/or packages.

VVC Multilayer activities:

The streams are available at ​ <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVC3rdEd/DIS/>. No change in bitstreams and/or packages.

HEVC Multiview supporting extended bit depth activities:

The 6 packages are available at <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/HEVCMultiview/> No change in bitstreams and/or packages.

It has been reported that code is available to extend the HM encoder and decoder to support all the HEVC multiview profiles, including the 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). No update on the generation of corresponding conformance streams.

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.

1. **Contributions**

JVET-AN0292 Multiview HEVC Reference SW implementation status [S. Choi, S. Paluri, D. Podborski, A. Tourapis (Apple)].

JVET-AN0293 Multiview 4:4:4 profiles for HEVC [S. Choi, S. Paluri, D. Podborski, E. Asbun, A. Tourapis (Apple)].

1. **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.

1. **Recommendations**

The AHG recommends the following:

* Maintain and update the conformance bitstream database and contribute to report problems in JVET document 1004.
* Study the draft conformance bitstreams for new HEVC multiview profiles in JVET-AM1008, and continue the generation, cross-checking, and documentation of the conformance streams for the HEVC Multiview profiles supporting extended bit depth, the HEVC Multiview Main 10 profile, and 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).
* Study DIS of VVC conformance 3rd edition and suggest improvements to JVET-AL2028, as appropriate.

It ws reminded to deliver the 3rd edition of VVC conformance for ITU consent by Oct.15.

[JVET-AN0006](https://jvet-experts.org/doc_end_user/current_document.php?id=16259) JVET AHG report: ECM software development (AHG6) [V. Seregin (chair), J. Chen, R. Chernyak, F. Le Léannec, K. Zhang (vice-chairs)]

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-18.0:

JVET-AM0056: Predictive Transform Coefficient Coding (PTCC) [MR 933]

JVET-AM0106: Chained mv candidates in AMVP and merge (Test 2.1b) [MR 932]

JVET-AM0163: Block prediction with cubic interpolation filter in TIMD (Test 1.7a) [MR 934]

JVET-AM0215: Regression-based GPM intra-inter prediction modification (Test 2.2a) [MR 936]

JVET-AM0068 for fixing encoding side of JVET-AE0102 and JVET-AG0100 [MR 935]

JVET-AM0104: EE2-related: On reference sample filtering for TIMD [MR 938]

JVET-AM0063: On ALF-CCCM (Test 4.3c) [MR 937]

JVET-AM0157: Harmonization of SGPM-BV and LIC (Test 1.8) [MR 946]

JVET-AM0216: Fixes for 12-bit internal bit depth in ECM [MR 947]

JVET-AM0231: NNLF encoder optimizations (Test 4.5c) [MR 944]

JVET-AM0307: combination of EE2-1.2c, EE2-1.6a and EE2-1.3 (Test 1.12) [MR 941]

JVET-AM0209: Chroma ALF and CCALF with reused CTB control (Test 4.2) [MR 945]

JVET-AM0221: TMRL tool-off bug fix [MR 950]

JVET-AM0295: External memory bandwidth evaluation [MR 949]

Add self-contained cfg for CfE [MR 940]

Fixes:

Fix parameters rewriting in SPS for AE0159, AG0112, AK0095 (#111) [MR 931]

Fix #22 and #77: solve encoder crash when --DepQuant=0 [MR 942]

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

JVET-AM0280: encoder and decoder memory print for VTM11\_ANC [MR 939]

ECM-18.0 and VTM-11.0ecm18.0 were tagged on August 4, 2025.

***CTC Performance***

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

ECM-18.0 performance over ECM-17.0 anchor is summarized in the tables below.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | |
|  | **Over ECM-17.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -0.07% | 0.13% | 0.29% | 103.6% | 104.6% | 101.4% | 101.6% |
| Class A2 | -0.28% | 0.12% | 0.11% | 103.2% | 102.2% | 101.5% | 101.9% |
| Class B | -0.20% | 0.06% | 0.07% | 102.8% | 103.5% | 102.7% | 101.5% |
| Class C | -0.21% | -0.11% | -0.13% | 101.3% | 104.2% | 101.6% | 100.8% |
| Class E | -0.21% | -0.36% | -0.24% | 100.2% | 102.9% | 97.9% | 100.6% |
| **Overall** | -0.19% | -0.02% | 0.02% | 102.2% | 103.5% | 101.2% | 101.3% |
| Class D | -0.10% | 0.13% | -0.07% | 103.1% | 107.1% | 101.0% | 100.3% |
| Class F | -0.66% | -0.56% | -0.42% | 103.3% | 104.8% | 101.8% | 101.0% |
| Class TGM | -0.62% | -0.49% | -0.47% | 98.2% | 102.9% | 100.3% | 101.4% |
|  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | |
|  | **Over ECM-17.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -0.12% | -0.49% | -0.38% | 100.0% | 99.9% | 100.8% | 100.6% |
| Class A2 | -0.22% | -0.32% | -0.51% | 95.6% | 95.2% | 100.7% | 101.1% |
| Class B | -0.16% | -0.92% | -0.53% | 99.1% | 100.5% | 100.6% | 101.0% |
| Class C | -0.07% | -0.84% | -0.72% | 97.9% | 97.8% | 101.0% | 100.7% |
| Class E |  |  |  |  |  |  |  |
| **Overall** | -0.14% | -0.69% | -0.55% | 98.3% | 98.6% | 100.7% | 100.9% |
| Class D | -0.03% | -0.81% | -1.32% | 101.2% | 102.4% | 101.2% | 100.3% |
| Class F | -0.48% | -1.06% | -0.63% | 103.4% | 104.8% | 101.0% | 101.0% |
| Class TGM | -0.50% | -0.66% | -0.87% | 95.8% | 100.1% | 101.2% | 101.0% |
|  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | |
|  | **Over ECM-17.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -0.11% | -1.20% | -0.44% | 98.2% | 96.1% | 100.6% | 100.7% |
| Class C | -0.10% | -0.85% | -0.44% | 99.1% | 100.6% | 101.0% | 100.5% |
| Class E | -0.23% | 0.46% | 0.32% | 98.8% | 100.5% | 100.7% | 100.5% |
| **Overall** | -0.13% | -0.67% | -0.25% | 98.6% | 98.7% | 100.8% | 100.6% |
| Class D | 0.20% | -1.86% | -0.92% | 101.4% | 99.8% | 101.3% | 100.2% |
| Class F | -0.74% | -0.58% | -0.58% | 100.4% | 97.6% | 100.2% | 100.9% |
| Class TGM | -0.49% | -0.88% | -1.09% | 97.1% | 100.1% | 101.3% | 100.4% |
|  |  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | | |
|  | **Over ECM-17.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -0.19% | -1.16% | -0.92% | 95.9% | 95.1% | 100.6% | 100.8% |
| Class C | -0.11% | -0.97% | -0.81% | 99.3% | 101.7% | 101.0% | 100.7% |
| Class E | -0.02% | -0.99% | -0.08% | 101.9% | 102.4% | 100.7% | 100.5% |
| **Overall** | -0.12% | -1.05% | -0.68% | 98.5% | 99.1% | 100.7% | 100.7% |
| Class D | -0.05% | -0.87% | -2.16% | 98.7% | 98.7% | 100.9% | 100.3% |
| Class F | -0.64% | -0.95% | -0.89% | 104.3% | 98.3% | 100.8% | 100.6% |
| Class TGM | -0.29% | -0.75% | -1.02% | 96.1% | 94.3% | 99.7% | 100.8% |

The below tables show ECM-18.0 performance comparing to VTM-11.0ecm18.0 anchor.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | |
|  | **Over VTM-11.0ecm18.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -14.82% | -16.49% | -27.44% | 1202.2% | 577.9% | 236.6% | 325.9% |
| Class A2 | -21.47% | -24.85% | -29.07% | 1119.5% | 624.0% | 237.6% | 325.3% |
| Class B | -15.06% | -23.15% | -21.18% | 1086.0% | 627.5% | 181.0% | 355.2% |
| Class C | -15.19% | -12.08% | -13.23% | 1026.3% | 583.6% | 121.7% | 394.4% |
| Class E | -19.58% | -23.35% | -21.51% | 992.5% | 615.0% | 139.3% | 381.4% |
| **Overall** | -16.87% | -19.90% | -21.83% | 1080.0% | 606.4% | 173.6% | 357.4% |
| Class D | -12.92% | -8.80% | -9.64% | 1013.4% | 663.9% | 109.3% | 414.2% |
| Class F | -30.84% | -34.56% | -34.60% | 688.3% | 658.9% | 125.9% | 374.2% |
| Class TGM | -43.72% | -49.31% | -48.60% | 513.1% | 658.7% | 149.7% | 351.4% |
|  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | |
|  | **Over VTM-11.0ecm18.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -27.52% | -25.12% | -37.22% | 1205.3% | 1195.4% | 153.0% | 247.5% |
| Class A2 | -30.81% | -34.98% | -40.50% | 1103.1% | 1346.4% | 152.7% | 246.9% |
| Class B | -25.42% | -34.33% | -31.10% | 999.4% | 1197.0% | 144.5% | 267.5% |
| Class C | -27.12% | -24.29% | -25.03% | 1064.9% | 1294.1% | 116.8% | 321.1% |
| Class E |  |  |  |  |  |  |  |
| **Overall** | -27.37% | -29.94% | -32.58% | 1076.3% | 1250.9% | 139.7% | 272.1% |
| Class D | -27.81% | -24.52% | -25.81% | 1003.1% | 1417.7% | 104.9% | 360.3% |
| Class F | -33.60% | -36.80% | -37.37% | 851.2% | 853.5% | 121.7% | 296.3% |
| Class TGM | -43.07% | -48.90% | -48.87% | 693.7% | 676.2% | 125.7% | 281.3% |
|  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | |
|  | **Over VTM-11.0ecm18.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -22.61% | -40.61% | -35.58% | 976.7% | 1030.5% | 166.8% | 266.9% |
| Class C | -25.00% | -28.31% | -30.38% | 937.3% | 1074.8% | 125.2% | 316.1% |
| Class E | -22.74% | -29.72% | -28.28% | 965.0% | 712.7% | 139.7% | 296.8% |
| **Overall** | -23.44% | -33.79% | -32.02% | 960.5% | 953.0% | 145.0% | 290.0% |
| Class D | -26.46% | -29.97% | -31.37% | 938.9% | 1175.1% | 110.5% | 352.6% |
| Class F | -31.37% | -41.12% | -41.47% | 859.7% | 808.4% | 129.6% | 295.0% |
| Class TGM | -41.36% | -51.49% | -51.48% | 691.5% | 643.3% | 125.2% | 281.6% |
|  |  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | | |
|  | **Over VTM-11.0ecm18.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -20.59% | -48.71% | -44.40% | 846.1% | 954.0% | 171.8% | 293.3% |
| Class C | -23.15% | -37.36% | -38.79% | 797.4% | 1112.7% | 126.4% | 344.7% |
| Class E | -20.95% | -38.22% | -37.17% | 859.0% | 674.0% | 143.6% | 318.3% |
| **Overall** | -21.53% | -42.30% | -40.72% | 832.7% | 920.7% | 148.3% | 315.9% |
| Class D | -25.84% | -40.19% | -41.26% | 768.1% | 1094.3% | 110.8% | 374.4% |
| Class F | -29.58% | -46.43% | -46.91% | 811.4% | 771.7% | 130.6% | 319.2% |
| Class TGM | -39.54% | -53.82% | -53.53% | 718.9% | 626.2% | 126.0% | 294.8% |

1. **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 | 16 |  |
| 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.

1. **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-AN0007](https://jvet-experts.org/doc_end_user/current_document.php?id=16260) 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)]

1. **Conference call on Complexity Analysis**

An input document was uploaded as JVET-N0043. The call was on August 19, 2025 Tuesday UTC 14:00-15:29. The report was uploaded as JVET-AN0044.

1. **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.

|  |  |  |
| --- | --- | --- |
| 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)) | Xiang Li  ([xlxiangli@google.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-18.0 was used in the AHG7 tool off tests. The cfg files used are included in the ECM software package.

***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-18.0** | | | | | | **Over VTM-11ecm18** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 0.00% | 0.00% | 0.00% | 101.2% | 100.1% | 100.2% | -14.82% | -16.49% | -27.45% | 1073.6% | 587.2% |
| Class A2 | 0.00% | 0.00% | 0.00% | 99.5% | 98.5% | 100.2% | -21.47% | -24.85% | -29.07% | 1010.9% | 627.9% |
| Class B | 0.00% | 0.00% | 0.00% | 99.4% | 98.3% | 100.0% | -15.06% | -23.15% | -21.18% | 1009.7% | 696.3% |
| Class C | -0.01% | -0.01% | -0.01% | 99.9% | 98.4% | 101.8% | -15.20% | -12.09% | -13.23% | 966.1% | 661.7% |
| Class E | -0.01% | -0.01% | -0.01% | 99.6% | 97.0% | 101.0% | -19.60% | -23.36% | -21.52% | 938.1% | 732.0% |
| **Overall** | -0.01% | -0.01% | -0.01% | 99.9% | 98.4% | 100.6% | -16.88% | -19.90% | -21.83% | 998.0% | 663.3% |
| Class D | -0.04% | -0.04% | -0.04% | 100.0% | 99.2% | 99.9% | -12.96% | -8.83% | -9.67% | 923.6% | 667.2% |
| Class F | -0.01% | -0.01% | -0.01% | 99.0% | 98.3% | 102.9% | -30.85% | -34.57% | -34.61% | 642.0% | 711.2% |
| Class TGM | -0.01% | 0.00% | 0.00% | 99.2% | 96.6% | 104.7% | -43.72% | -49.31% | -48.60% | 515.3% | 734.0% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-18.0** | | | | | | **Over VTM-11ecm18** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 4.92% | 4.80% | 5.01% | 81.5% | 68.6% | 100.0% | -23.92% | -21.75% | -33.92% | 969.7% | 951.7% |
| Class A2 | 5.74% | 5.65% | 6.00% | 81.0% | 62.4% | 100% | -26.84% | -31.37% | -36.91% | 922.5% | 1056.1% |
| Class B | 4.58% | 4.67% | 4.66% | 77.1% | 61.8% | 99.9% | -21.97% | -31.21% | -27.84% | 767.8% | 965.4% |
| Class C | 5.01% | 5.28% | 5.62% | 72.3% | 57.8% | 100.0% | -23.43% | -20.28% | -20.78% | 752.6% | 1023.7% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 4.99% | 5.05% | 5.25% | 77.4% | 62.1% | 100% | -23.72% | -26.44% | -28.99% | 830.2% | 995.5% |
| Class D | 4.08% | 4.12% | 4.28% | 72.1% | 55.7% | 100.0% | -24.81% | -21.34% | -22.53% | 689.5% | 1034.3% |
| Class F | 3.76% | 3.86% | 3.96% | 85.5% | 71.6% | 100.0% | -31.00% | -34.27% | -34.79% | 714.4% | 786.3% |
| Class TGM | 4.58% | 4.42% | 4.43% | 86.2% | 73.8% | 100.0% | -40.47% | -46.62% | -46.57% | 620.9% | 666.5% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | | | | |
|  | **Over ECM-18.0** | | | | | | **Over VTM-11ecm18** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 5.80% | 6.38% | 6.42% | 69.8% | 55.4% | 100% | -18.09% | -36.84% | -31.52% | 704.1% | 798.9% |
| Class C | 5.72% | 5.83% | 6.11% | 67.2% | 50.1% | 100% | -20.71% | -24.18% | -26.16% | 652.3% | 782.8% |
| Class E | 6.02% | 6.49% | 7.09% | 75.6% | 64.4% | 102% | -18.09% | -25.21% | -23.18% | 717.4% | 730.9% |
| **Overall (Ref)** | 5.83% | 6.23% | 6.49% | 70.3% | 55.6% | 101% | -18.96% | -29.71% | -27.65% | 689.6% | 776.1% |
| Class D | 5.10% | 5.60% | 5.73% | 68.2% | 51.3% | 100% | -22.70% | -25.97% | -27.52% | 643.3% | 814.3% |
| Class F | 5.73% | 5.31% | 4.65% | 82.1% | 64.2% | 100% | -27.37% | -37.93% | -38.40% | 692.6% | 691.6% |
| Class TGM | 6.56% | 6.41% | 6.56% | 85.1% | 65.6% | 100% | -37.47% | -48.19% | -48.07% | 637.5% | 573.2% |
|  |  |  |  |  |  |  |  |  |  |  |  |

***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 ECM-18.0** | | | | | | **Over VTM-11.0ecm18.0** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 0.18% | 0.58% | 0.62% | 94.9% | 96.9% | 100% | -14.66% | -16.07% | -26.98% | 1121.5% | 546.9% |
| Class A2 | 0.23% | 0.42% | 0.48% | 94.1% | 97.1% | 100% | -21.29% | -24.55% | -28.75% | 1074.0% | 581.5% |
| Class B | 0.18% | 0.48% | 0.59% | 93.4% | 96.2% | 98% | -14.90% | -22.79% | -20.71% | 1029.5% | 591.6% |
| Class C | 0.15% | 0.30% | 0.43% | 91.9% | 95.2% | 99% | -15.06% | -11.82% | -12.85% | 982.5% | 532.0% |
| Class E | 0.26% | 0.72% | 0.53% | 93.9% | 96.3% | 102% | -19.37% | -22.83% | -21.09% | 977.3% | 616.0% |
| **Overall** | 0.19% | 0.49% | 0.53% | 93.5% | 96.3% | 99% | -16.71% | -19.53% | -21.41% | 1031.8% | 572.5% |
| Class D | 0.11% | 0.34% | 0.38% | 91.1% | 94.8% | 99% | -12.83% | -8.49% | -9.30% | 939.3% | 508.6% |
| Class F | 0.51% | 0.50% | 0.50% | 93.7% | 98.5% | 100% | -30.50% | -34.25% | -34.32% | 607.0% | 560.3% |
| Class TGM | 0.36% | 0.38% | 0.34% | 94.4% | 100.9% | 100% | -43.50% | -49.12% | -48.43% | 503.6% | 632.0% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-18.0** | | | | | | **Over VTM-11.0ecm18.0** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 2.39% | 1.56% | 2.24% | 85.6% | 96.4% | 100% | -25.78% | -23.92% | -35.84% | 1001.1% | 1294.6% |
| Class A2 | 1.44% | 1.26% | 1.76% | 84.9% | 97.2% | 100% | -29.80% | -34.15% | -39.41% | 953.0% | 1578.7% |
| Class B | 1.48% | 1.24% | 1.33% | 85.8% | 96.2% | 99% | -24.31% | -33.45% | -30.12% | 841.3% | 1442.6% |
| Class C | 1.09% | 1.19% | 1.01% | 85.2% | 94.3% | 99% | -26.33% | -23.40% | -24.28% | 887.7% | 1620.2% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 1.55% | 1.29% | 1.51% | 85.4% | 95.9% | 99% | -26.24% | -29.00% | -31.56% | 905.9% | 1482.6% |
| Class D | 0.54% | 0.94% | 0.58% | 84.7% | 94.7% | 99% | -27.42% | -23.82% | -25.33% | 821.5% | 1735.4% |
| Class F | 2.00% | 2.19% | 1.93% | 88.6% | 96.0% | 98% | -32.27% | -35.42% | -36.11% | 712.6% | 980.5% |
| Class TGM | 3.27% | 4.82% | 5.06% | 91.0% | 99.2% | 100% | -41.33% | -46.72% | -46.57% | 637.5% | 872.6% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | | | | |
|  | **Over ECM-18.0** | | | | | | **Over VTM-11.0ecm18.0** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 1.88% | 3.55% | 3.17% | 80.6% | 92.6% | 100% | -21.15% | -38.58% | -33.52% | 798.4% | 1000.7% |
| Class C | 1.59% | 2.39% | 2.79% | 81.4% | 90.4% | 99% | -23.86% | -26.70% | -28.46% | 774.5% | 1069.6% |
| Class E | 1.30% | 1.64% | 3.41% | 84.1% | 94.8% | 99% | -21.73% | -28.53% | -25.69% | 744.7% | 691.0% |
| **Overall (Ref)** | 1.64% | 2.69% | 3.10% | 81.7% | 92.4% | 99% | -22.20% | -32.11% | -29.88% | 776.7% | 932.7% |
| Class D | 0.66% | 2.66% | 2.96% | 78.1% | 93.7% | 98% | -25.95% | -28.16% | -29.28% | 742.7% | 1216.4% |
| Class F | 2.69% | 2.24% | 1.47% | 86.2% | 96.1% | 99% | -29.54% | -39.95% | -40.44% | 698.3% | 708.0% |
| Class TGM | 2.61% | 6.24% | 7.16% | 89.7% | 97.1% | 100% | -39.93% | -48.83% | -48.63% | 639.5% | 592.9% |

***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 ECM18** | | | | | | **Over VTM11ecm18** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 1.23% | 4.24% | 6.53% | 71.3% | 90.0% | 100% | -13.77% | -13.27% | -23.17% | 822.0% | 487.9% |
| Class A2 | 2.70% | 7.11% | 6.74% | 71.3% | 81.3% | 100% | -19.29% | -19.95% | -24.82% | 793.6% | 477.5% |
| Class B | 2.74% | 5.57% | 5.78% | 68.2% | 78.5% | 101% | -12.77% | -19.31% | -16.88% | 739.4% | 506.4% |
| Class C | 2.59% | 3.02% | 3.44% | 68.7% | 74.9% | 99% | -13.05% | -9.54% | -10.34% | 705.9% | 471.7% |
| Class E | 3.78% | 4.88% | 4.57% | 69.4% | 78.2% | 100% | -16.54% | -19.79% | -17.97% | 700.8% | 523.0% |
| **Overall** | 2.62% | 4.92% | 5.34% | 69.5% | 79.9% | 100% | -14.71% | -16.32% | -17.98% | 747.0% | 493.2% |
| Class D | 1.64% | 2.09% | 2.52% | 69.1% | 79.4% | 100% | -11.50% | -6.92% | -7.37% | 690.6% | 565.2% |
| Class F | 7.24% | 8.08% | 8.07% | 71.9% | 67.5% | 99% | -26.07% | -29.76% | -29.75% | 454.9% | 436.7% |
| Class TGM | 12.49% | 14.41% | 14.86% | 77.1% | 56.4% | 100% | -36.83% | -42.19% | -41.18% | 404.4% | 367.7% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM18** | | | | | | **Over VTM11ecm18** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 1.05% | 2.33% | 5.96% | 93.1% | 99.5% | 100% | -26.76% | -23.43% | -34.25% | 1060.9% | 1138.3% |
| Class A2 | 1.65% | 3.93% | 3.86% | 93.6% | 98.6% | 100% | -29.67% | -32.54% | -38.26% | 1029.2% | 1361.4% |
| Class B | 1.41% | 4.90% | 4.61% | 91.2% | 98.8% | 100% | -24.37% | -31.11% | -27.96% | 864.6% | 1202.3% |
| Class C | 1.04% | 1.87% | 2.02% | 92.4% | 98.6% | 100% | -26.35% | -22.84% | -23.46% | 950.5% | 1354.3% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 1.29% | 3.39% | 4.04% | 92.4% | 98.9% | 100% | -26.44% | -27.66% | -30.08% | 956.5% | 1258.5% |
| Class D | 0.86% | 1.64% | 2.31% | 92.3% | 99.5% | 100% | -27.19% | -23.26% | -23.98% | 886.5% | 1480.0% |
| Class F | 4.82% | 5.39% | 5.45% | 90.3% | 90.8% | 99% | -30.64% | -33.80% | -34.31% | 730.9% | 764.0% |
| Class TGM | 7.64% | 9.30% | 9.74% | 94.0% | 92.8% | 100% | -38.74% | -44.21% | -43.96% | 650.3% | 659.7% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | | | | |
|  | **Over ECM18** | | | | | | **Over VTM11ecm18** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 0.52% | 1.95% | 1.56% | 94.2% | 98.6% | 100% | -22.21% | -39.56% | -34.74% | 925.1% | 1114.7% |
| Class C | 0.51% | 1.13% | 1.02% | 94.0% | 100.2% | 100% | -24.62% | -27.49% | -29.67% | 875.7% | 1142.5% |
| Class E | 1.13% | 2.72% | 1.98% | 95.3% | 96.5% | 100% | -21.84% | -27.81% | -26.71% | 859.8% | 737.1% |
| **Overall (Ref)** | 0.67% | 1.87% | 1.48% | 94.4% | 98.6% | 100% | -22.92% | -32.60% | -31.04% | 891.9% | 1013.5% |
| Class D | 0.23% | 0.68% | 0.77% | 96.2% | 104.6% | 100% | -26.30% | -29.57% | -31.01% | 915.7% | 1286.4% |
| Class F | 3.94% | 4.77% | 5.33% | 90.4% | 98.7% | 100% | -28.82% | -38.69% | -38.82% | 762.5% | 752.1% |
| Class TGM | 5.13% | 6.25% | 6.77% | 93.0% | 96.2% | 100% | -38.37% | -48.66% | -48.45% | 661.4% | 632.6% |

***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-18-0** | | | | | | **Over VTM-11-ECM18** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 1.45% | 5.47% | 5.99% | 84.8% | 90.5% | 100% | -13.58% | -12.20% | -23.24% | 1017.5% | 530.1% |
| Class A2 | 1.67% | 5.38% | 5.95% | 82.6% | 92.8% | 100% | -20.20% | -21.14% | -25.30% | 931.7% | 575.5% |
| Class B | 0.99% | 5.16% | 5.19% | 85.9% | 94.3% | 98% | -14.23% | -19.65% | -17.33% | 963.0% | 633.7% |
| Class C | 0.97% | 3.27% | 3.37% | 86.0% | 93.0% | 99% | -14.38% | -9.34% | -10.42% | 921.9% | 579.9% |
| Class E | 1.51% | 6.42% | 5.34% | 86.9% | 96.1% | 103% | -18.38% | -18.83% | -17.49% | 921.1% | 658.5% |
| **Overall** | 1.26% | 5.04% | 5.07% | 85.4% | 93.4% | 100% | -15.84% | -16.23% | -18.13% | 950.2% | 597.3% |
| Class D | 0.90% | 2.54% | 2.97% | 85.4% | 90.1% | 100% | -12.15% | -6.50% | -6.94% | 884.3% | 606.3% |
| Class F | 1.31% | 4.49% | 4.75% | 92.1% | 95.2% | 99% | -29.95% | -31.80% | -31.68% | 608.3% | 625.3% |
| Class TGM | 2.19% | 4.16% | 4.30% | 93.7% | 97.2% | 100% | -42.55% | -47.30% | -46.51% | 496.3% | 645.6% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-18-0** | | | | | | **Over VTM-11-ECM18** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 1.85% | 2.98% | 5.01% | 94.4% | 99.7% | 100% | -26.19% | -22.96% | -34.45% | 1142.4% | 1197.4% |
| Class A2 | 1.30% | 3.57% | 3.81% | 95.8% | 100.1% | 100% | -29.90% | -32.74% | -38.29% | 1110.5% | 1445.2% |
| Class B | 0.99% | 3.53% | 3.25% | 95.3% | 99.4% | 100% | -24.69% | -32.10% | -28.98% | 972.1% | 1280.8% |
| Class C | 1.08% | 1.86% | 1.84% | 96.0% | 98.7% | 100% | -26.33% | -22.88% | -23.63% | 1067.2% | 1438.2% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 1.25% | 2.98% | 3.34% | 95.4% | 99.4% | 100% | -26.47% | -27.94% | -30.51% | 1057.1% | 1335.2% |
| Class D | 0.95% | 2.20% | 2.68% | 95.7% | 98.0% | 100% | -27.11% | -22.88% | -23.72% | 1008.8% | 1565.0% |
| Class F | 1.33% | 2.99% | 2.96% | 100.9% | 98.8% | 99% | -32.79% | -35.10% | -35.63% | 828.7% | 876.4% |
| Class TGM | 0.87% | 1.67% | 1.59% | 98.7% | 99.3% | 99% | -42.61% | -48.07% | -48.11% | 695.5% | 723.8% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | | | | |
|  | **Over ECM-18-0** | | | | | | **Over VTM-11-ECM18** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 1.03% | 1.55% | 0.93% | 98.0% | 99.3% | 100% | -21.81% | -39.76% | -35.12% | 1003.0% | 1132.0% |
| Class C | 1.28% | 0.87% | 0.44% | 97.0% | 97.8% | 99% | -24.05% | -27.73% | -30.15% | 974.1% | 1161.2% |
| Class E | 1.07% | 3.91% | 2.22% | 98.5% | 99.5% | 100% | -21.90% | -26.95% | -26.69% | 925.4% | 742.4% |
| **Overall (Ref)** | 1.12% | 1.91% | 1.09% | 97.8% | 98.8% | 100% | -22.58% | -32.55% | -31.35% | 973.5% | 1027.4% |
| Class D | 1.03% | 0.31% | 0.34% | 98.7% | 100.4% | 99% | -25.65% | -29.79% | -31.33% | 992.3% | 1344.2% |
| Class F | 1.53% | 1.60% | 1.22% | 98.0% | 99.6% | 100% | -30.33% | -40.36% | -40.73% | 825.7% | 776.4% |
| Class TGM | 0.49% | 1.20% | 1.34% | 98.2% | 97.9% | 99% | -41.06% | -50.85% | -50.85% | 709.4% | 624.4% |

***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-18.0** | | | | | | **Over VTM-11.0ecm18.0** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 4.47% | 4.72% | 4.60% | 77.9% | 85.2% | 90% | -10.95% | -12.55% | -24.14% | 798.6% | 432.1% |
| Class A2 | 3.66% | 3.23% | 3.79% | 80.0% | 89.5% | 90% | -18.57% | -22.50% | -26.54% | 791.0% | 505.5% |
| Class B | 4.32% | 4.01% | 4.55% | 79.6% | 89.0% | 79% | -11.38% | -20.19% | -17.64% | 788.7% | 539.6% |
| Class C | 6.22% | 4.42% | 5.15% | 79.6% | 92.1% | 92% | -10.08% | -8.32% | -8.97% | 760.8% | 552.4% |
| Class E | 6.11% | 5.48% | 4.39% | 80.8% | 88.8% | 87% | -14.67% | -19.30% | -18.10% | 742.6% | 569.8% |
| **Overall** | 4.95% | 4.34% | 4.54% | 79.6% | 89.1% | 87% | -12.77% | -16.52% | -18.35% | 776.6% | 521.8% |
| Class D | 5.08% | 4.39% | 5.66% | 78.3% | 90.8% | 98% | -8.50% | -4.76% | -4.50% | 714.4% | 568.2% |
| Class F | 4.27% | 2.78% | 3.13% | 88.0% | 89.6% | 88% | -27.70% | -32.52% | -32.35% | 563.6% | 572.3% |
| Class TGM | 0.58% | 0.57% | 0.56% | 89.1% | 89.6% | 83% | -43.38% | -49.03% | -48.34% | 458.9% | 597.4% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-18.0** | | | | | | **Over VTM-11.0ecm18.0** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 3.87% | 2.78% | 3.56% | 93.6% | 91.3% | 96% | -24.74% | -22.97% | -35.19% | 1060.2% | 1033.2% |
| Class A2 | 3.40% | 2.25% | 2.81% | 94.2% | 92.6% | 96% | -28.47% | -33.54% | -38.82% | 1028.3% | 1295.5% |
| Class B | 4.16% | 2.93% | 3.42% | 92.8% | 92.4% | 84% | -22.33% | -32.45% | -28.79% | 889.2% | 1161.6% |
| Class C | 5.28% | 3.49% | 4.00% | 95.8% | 94.6% | 92% | -23.25% | -21.68% | -22.03% | 964.1% | 1396.7% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 4.25% | 2.91% | 3.48% | 94.0% | 92.8% | 91% | -24.28% | -27.90% | -30.27% | 968.9% | 1218.1% |
| Class D | 4.77% | 3.65% | 4.45% | 94.5% | 94.0% | 96% | -24.32% | -21.71% | -22.36% | 876.8% | 1501.9% |
| Class F | 3.28% | 2.55% | 2.41% | 88.0% | 91.5% | 89% | -31.27% | -35.06% | -35.68% | 706.3% | 761.0% |
| Class TGM | 0.76% | 0.80% | 0.75% | 87.1% | 83.0% | 88% | -42.60% | -48.49% | -48.50% | 598.4% | 580.8% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | | | | |
|  | **Over ECM-18.0** | | | | | | **Over VTM-11.0ecm18.0** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 3.40% | 1.30% | 1.45% | 94.3% | 88.7% | 82% | -20.00% | -39.88% | -34.81% | 908.5% | 1005.3% |
| Class C | 4.97% | 1.67% | 2.16% | 96.2% | 90.5% | 90% | -21.30% | -27.16% | -28.93% | 885.0% | 1117.4% |
| Class E | 4.36% | 3.38% | 1.22% | 89.5% | 91.1% | 91% | -19.36% | -27.37% | -27.37% | 789.0% | 734.0% |
| **Overall (Ref)** | 4.16% | 1.94% | 1.63% | 93.7% | 89.9% | 87% | -20.27% | -32.51% | -30.99% | 869.4% | 962.6% |
| Class D | 4.38% | 2.34% | 2.65% | 94.8% | 92.0% | 96% | -23.21% | -28.38% | -29.67% | 862.5% | 1279.0% |
| Class F | 3.76% | 1.32% | 1.05% | 87.7% | 90.7% | 87% | -28.72% | -40.49% | -40.80% | 704.3% | 740.8% |
| Class TGM | 1.03% | 1.18% | 1.01% | 86.4% | 86.1% | 85% | -40.72% | -50.92% | -50.99% | 606.3% | 580.9% |

***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-18** | | | | | | **Over VTM-11-ECM18** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 9.60% | 19.75% | 25.21% | 36.7% | 41.4% | 89% | -6.58% | -0.96% | -10.54% | 357.6% | 172.5% |
| Class A2 | 11.28% | 22.49% | 23.37% | 36.9% | 37.8% | 90% | -12.57% | -9.15% | -14.04% | 343.0% | 173.4% |
| Class B | 10.31% | 20.87% | 20.31% | 35.5% | 35.3% | 85% | -6.30% | -8.65% | -5.84% | 378.9% | 211.1% |
| Class C | 11.48% | 13.50% | 14.84% | 35.5% | 36.1% | 96% | -5.69% | -0.58% | -0.72% | 385.4% | 223.5% |
| Class E | 15.48% | 22.79% | 19.60% | 36.3% | 39.1% | 96% | -7.15% | -6.83% | -6.34% | 382.1% | 251.6% |
| **Overall** | 11.47% | 19.64% | 20.30% | 36.1% | 37.5% | 91% | -7.40% | -5.35% | -6.93% | 371.0% | 206.0% |
| Class D | 8.99% | 11.66% | 13.20% | 35.7% | 38.8% | 97% | -5.11% | 1.81% | 2.33% | 372.9% | 266.2% |
| Class F | 19.14% | 23.57% | 24.48% | 48.9% | 37.2% | 94% | -17.91% | -20.18% | -19.45% | 284.2% | 229.5% |
| Class TGM | 20.17% | 24.86% | 26.00% | 54.8% | 38.1% | 89% | -32.66% | -37.03% | -35.67% | 267.6% | 240.1% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-18** | | | | | | **Over VTM-11-ECM18** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 15.97% | 16.45% | 24.88% | 54.7% | 57.3% | 95% | -16.00% | -13.08% | -22.98% | 514.0% | 453.0% |
| Class A2 | 15.75% | 19.84% | 21.07% | 55.0% | 54.9% | 94% | -19.96% | -22.47% | -28.11% | 492.6% | 519.8% |
| Class B | 14.33% | 20.85% | 20.86% | 50.6% | 56.0% | 82% | -14.70% | -20.84% | -16.82% | 487.8% | 625.6% |
| Class C | 14.94% | 15.60% | 16.82% | 48.0% | 50.1% | 90% | -16.17% | -12.53% | -12.40% | 514.6% | 658.0% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 15.10% | 18.37% | 20.63% | 51.6% | 54.4% | 89% | -16.40% | -17.40% | -19.13% | 501.0% | 572.8% |
| Class D | 12.05% | 13.85% | 15.71% | 45.9% | 48.4% | 95% | -18.97% | -13.99% | -13.95% | 475.6% | 684.8% |
| Class F | 18.99% | 21.46% | 21.97% | 52.0% | 57.1% | 89% | -21.17% | -23.80% | -24.05% | 432.0% | 442.6% |
| Class TGM | 20.67% | 25.30% | 26.03% | 55.4% | 52.5% | 89% | -31.43% | -36.28% | -35.92% | 394.0% | 355.4% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | | | | |
|  | **Over ECM-18** | | | | | | **Over VTM-11-ECM18** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 13.30% | 14.18% | 15.48% | 44.0% | 40.7% | 79% | -12.30% | -32.36% | -25.88% | 438.7% | 406.0% |
| Class C | 14.57% | 12.60% | 13.95% | 44.7% | 39.7% | 89% | -14.17% | -19.49% | -20.81% | 420.6% | 438.0% |
| Class E | 14.20% | 18.71% | 15.92% | 47.6% | 57.2% | 84% | -11.77% | -16.98% | -16.74% | 447.6% | 407.0% |
| **Overall (Ref)** | 13.95% | 14.78% | 15.08% | 45.1% | 44.0% | 83% | -12.79% | -24.23% | -21.91% | 434.7% | 416.6% |
| Class D | 11.98% | 11.24% | 13.23% | 40.8% | 40.5% | 94% | -17.58% | -22.21% | -22.39% | 408.1% | 483.2% |
| Class F | 18.53% | 16.60% | 17.60% | 50.4% | 48.9% | 87% | -18.72% | -31.81% | -31.34% | 399.0% | 342.7% |
| Class TGM | 19.22% | 25.26% | 26.76% | 57.0% | 45.4% | 84% | -30.13% | -39.69% | -39.31% | 416.3% | 273.0% |

***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.

1. **Issues**

***Resolved issues***

* #113, Decoder mismatch and encoder crash in RA for the current master tip (d3d7d951) with AHG7 group3 off
* #112, Current master tip (d3d7d95150) decoding mismatch with AHG7 group1-5 off
* #87, ECM-15.0 decoder crashes when "InterLFNST=0"
* #77, Encoder crash in RA with --DepQuant=0 --NumSignPred=0

***Open issues***

* #91, MaxTU setting
* #80, Compilation Issue ECM14.0 when disabling GPM reordering
* #78, Encoder crash in RA with --LMChroma=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

1. **Input contributions**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| [JVET-AN0043](https://jvet-experts.org/doc_end_user/current_document.php?id=16027) | m73918 | 2025-07-29 21:41:16 | 2025-07-31 23:57:14 | 2025-07-31 23:57:14 | AHG7: Preliminary tool analysis with the criteria in JVET-AM0042 | [X. Li (Google)](mailto:xlxiangli@google.com) |
| [JVET-AN0044](https://jvet-experts.org/doc_end_user/current_document.php?id=16028) | m73927 | 2025-08-19 0:10:35 | 2025-08-19 19:59:14 | 2025-08-19 19:59:14 | Report of AHG7 conference call on Complexity Analysis | [X. Li](mailto:xlxiangli@google.com) |
| [JVET-AN0119](https://jvet-experts.org/doc_end_user/current_document.php?id=16103) | m74144 | 2025-09-26 8:03:15 | 2025-09-26 11:30:54 | 2025-09-26 11:30:54 | AHG7: Analysis on group-off tests using Valgrind | [R. Ishimoto](mailto:ishimoto.ryo@mail.sharp), [F. Zheming](mailto:fan.zheming@mail.sharp), [T. Ikai (Sharp)](mailto:tomohiro.ikai@mail.sharp) |
| [JVET-AN0203](https://jvet-experts.org/doc_end_user/current_document.php?id=16187) | m74246 | 2025-09-26 14:58:02 | 2025-09-26 18:04:43 | 2025-09-26 18:04:43 | AHG7: On RGPM moved into group-2 | [P. Bordes](mailto:philippe.bordes@interdigital.com), K. Reuzé, E. Francois, K. Naser, F. Le Léannec (InterDigital) |
| [JVET-AN0223](https://jvet-experts.org/doc_end_user/current_document.php?id=16207) | m74273 | 2025-09-26 17:02:23 |  |  | AHG7: On bin to bit ratio in ECM | [T. N. Canh](mailto:canh.nguyen@dolby.com), [P. Yin](mailto:pyin@dolby.com), S. McCarthy (Dolby), [J. N. Shingala (Ittiam)](mailto:jay.shingala@ittiam.com) |
| [JVET-AN0253](https://jvet-experts.org/doc_end_user/current_document.php?id=16237) | m74304 | 2025-09-26 21:55:26 | 2025-09-26 22:06:04 | 2025-09-26 22:06:04 | AHG7: On Memory Bandwidth Measurement | [X. Li (Google)](mailto:xlxiangli@google.com), [Y. Kim (Samsung)](mailto:yearly.kim@samsung.com), [J. Pardo (Huawei)](mailto:johan.esprit.pardo1@huawei.com), [R. Ishimoto (Sharp)](mailto:ishimoto.ryo@mail.sharp), [L.-F. Chen (Tencent)](mailto:lienfeichen@global.tencent.com) |
| [JVET-AN0317](https://jvet-experts.org/doc_end_user/current_document.php?id=16321) | m74735 | 2025-10-02 19:25:25 | 2025-10-02 19:29:42 | 2025-10-02 19:29:42 | AHG7: Preliminary tool analysis with the criteria in JVET-AM0042 – Update on IntraTMP | [K. Naser](mailto:karam.naser@interdigital.com), T. Dumas, M. Radosavljevic (InterDigital) |

1. **Recommendations**

* Continue and improve tool assessment
* Resolve identified software issues related to the tool assessment
* Review all the input documents

Review of AHG7 related input documents should be conducted early – possible BoG to develop an out document on tool complexity criteria from JVET-AN0044 and other documents.

[JVET-AN0008](https://jvet-experts.org/doc_end_user/current_document.php?id=16261) 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)]

The AHG 8 used the main JVET reflector, jvet@lists.rwth-aachen.de, for email discussion. Between the last and this meeting, there was no AHG8 email sent to the main reflector. There is one AHG8/AHG9 input contribution to this meeting. The current focus is on finalization of TR (v1).

***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.

***Technical Report***

There was no update on the Draft Technical Report (DTR), i.e., JVET-AL2030 “Optimization of encoders and receiving systems for machine analysis of coded video content (draft 9)”.

1. **Input contributions**

There are two input contributions related to AHG 8 mandates (by the time this report is uploaded) including this report.

* JVET-AN0008 JVET AHG report: Optimization of encoders and receiving systems for machine analysis of coded video content (AHG8)
* JVET-AN0208 AHG8/AHG9: Depth-aware optimization for Encoder optimization information SEI message

1. **Recommendations**

The AHG recommends to:

* Review input contributions.
* Continue improving the on-going TR document based on feedback towards finalization.

It was initially assessed that the input contribution on EOI SEI does not have impact on the way it is referred in the TR.

[JVET-AN0009](https://jvet-experts.org/doc_end_user/current_document.php?id=16262) JVET AHG report: SEI message studies (AHG9) [S. McCarthy, J. Boyce, Y.-K. Wang (co-chairs), T. Chujoh, S. Deshpande, M. M. Hannuksela, P. de Lagrange, G. J. Sullivan, H. Tan, A. Tourapis, S. Wenger, P. Wu (vice-chairs)]

A total of 89 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 AHG8 and AHG11.

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

***Study the SEI messages in VSEI, VVC, HEVC and AVC (4)***

[JVET-AN0071](https://jvet-experts.org/doc_end_user/current_document.php?id=16055) AHG9: On HEVC Omnidirectional viewport SEI in HEVC [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0072](https://jvet-experts.org/doc_end_user/current_document.php?id=16056) AHG9: On 3DRD, MAI and Alternative Depth information SEI messages in HEVC and VSEI [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0076](https://jvet-experts.org/doc_end_user/current_document.php?id=16060) AHG9: On floating point signaling in SEI [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

*JVET- AN0076 also relates to JVET-AM2006 (VSEI) and in JVET-AM2032 TuC for VSEI*

[JVET-AN0107](https://jvet-experts.org/doc_end_user/current_document.php?id=16091) AHG9: On scalable-nested DSCI SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

*JVET- AN0107 also relates to the DSC SEI messages in JVET-AM2032 TuC for VSEI*

***Study JVET-AM1006 HEVC (2)***

[JVET-AN0059](https://jvet-experts.org/doc_end_user/current_document.php?id=16043) AHG9: On the SPO and PON SEI messages in VSEI version 4 and in the AVC, HEVC, and VVC interface text [M. M. Hannuksela, F. Cricri (Nokia)]

*JVET- AN0059 also relates to JVET-AM1017 (AVC), JVET-AM2005 (VVC), and JVET-AM2006 (VSEI)*

[JVET-AN0185](https://jvet-experts.org/doc_end_user/current_document.php?id=16169) AHG9: Miscellaneous on VSEI codec interfaces [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

*JVET-AN0185 also relates to the NNPF, SPO, and DSC SEI messages*

***Study JVET-AM1017 AVC (2)***

[JVET-AN0059](https://jvet-experts.org/doc_end_user/current_document.php?id=16043) AHG9: On the SPO and PON SEI messages in VSEI version 4 and in the AVC, HEVC, and VVC interface text [M. M. Hannuksela, F. Cricri (Nokia)]

*JVET- AN0059 also relates to JVET-AM1006 (HEVC), JVET-AM2005 (VVC) ), and JVET-AM2006 (VSEI)*

[JVET-AN0185](https://jvet-experts.org/doc_end_user/current_document.php?id=16169) AHG9: Miscellaneous on VSEI codec interfaces [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

*JVET-AN0185 also relates to the NNPF, SPO, and DSC SEI messages*

***Study JVET-AM2005 VVC (3)***

[JVET-AN0059](https://jvet-experts.org/doc_end_user/current_document.php?id=16043) AHG9: On the SPO and PON SEI messages in VSEI version 4 and in the AVC, HEVC, and VVC interface text [M. M. Hannuksela, F. Cricri (Nokia)]

*JVET- AN0059 also relates to JVET-AM1006 (HEVC), JVET-AM1017 (AVC), and JVET-AM2006 (VSEI)*

[JVET-AN0162](https://jvet-experts.org/doc_end_user/current_document.php?id=16146) AHG9: On subpicture sub-bitstream extraction in VVC [H. Tan, J. Lee, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AN0185](https://jvet-experts.org/doc_end_user/current_document.php?id=16169) AHG9: Miscellaneous on VSEI codec interfaces [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

*JVET-AN0185 also relates to the NNPF, SPO, and DSC SEI messages*

***Study JVET-AM2006 VSEI (32)***

**Editorial *(4)***

[JVET-AN0067](https://jvet-experts.org/doc_end_user/current_document.php?id=16051) AHG9: Comments on Neural-network Post-filter in VSEI V4 and V3 [S. Deshpande (Sharp)]

*JVET-AN0067 also relates to the NNPF SEI messages*

[JVET-AN0133](https://jvet-experts.org/doc_end_user/current_document.php?id=16117) AHG9: Miscellaneous editorial changes for the VSEI v4 draft [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0156](https://jvet-experts.org/doc_end_user/current_document.php?id=16140) AHG9: Text fixes and cleanup for GFV and GFE SEI messages [J. Chen, Y. Ye, B. Chen (Alibaba)]

*JVET-AN0156 also relates to the GFV SEI messages*

[JVET-AN0186](https://jvet-experts.org/doc_end_user/current_document.php?id=16170) AHG9: Editorial updates for VSEI v4 [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

**Specification of syntax functions and descriptors *(3)***

[JVET-AN0134](https://jvet-experts.org/doc_end_user/current_document.php?id=16118) AHG9: On the SEI message payload extension in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0076](https://jvet-experts.org/doc_end_user/current_document.php?id=16060) AHG9: On floating point signaling in SEI [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

*JVET- AN0076 also relates to VSEI, VVC, HEVC and AVC*

[JVET-AN0242](https://jvet-experts.org/doc_end_user/current_document.php?id=16226) AHG9: Signalling of floating-point values in VSEI and graphics rendering information SEI [V. Zakharchenko, J. Boyce (Nokia)]

*JVET- AN0242 also relates to the GRI messages*

**Film grain characteristics SEI message *(1)***

[JVET-AN0229](https://jvet-experts.org/doc_end_user/current_document.php?id=16213) AHG9: On the film grain characteristics SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

**NNPF SEI messages *(6)***

[JVET-AN0058](https://jvet-experts.org/doc_end_user/current_document.php?id=16042) AHG9: On the NNPF SEI messages in VSEI version 4 [M. M. Hannuksela, F. Cricri (Nokia)]

[JVET-AN0063](https://jvet-experts.org/doc_end_user/current_document.php?id=16047) AHG9: On the NNPF SEI messages in VSEI v4 [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0064](https://jvet-experts.org/doc_end_user/current_document.php?id=16048) AHG9: On the resampling constraint in VSEI v4 [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

*JVET- AN0064 also relates to the PRI SEI message*

[JVET-AN0067](https://jvet-experts.org/doc_end_user/current_document.php?id=16051) AHG9: Comments on Neural-network Post-filter in VSEI V4 and V3 [S. Deshpande (Sharp)]

*JVET-AN0067 also relates to editorial aspects of JVET-AM2006*

[JVET-AN0140](https://jvet-experts.org/doc_end_user/current_document.php?id=16124) AHG9: On the image format metadata SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0185](https://jvet-experts.org/doc_end_user/current_document.php?id=16169) AHG9: Miscellaneous on VSEI codec interfaces [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

*JVET-AN0185 also relates to the SPO and DSC SEI messages and interface text in JVET-AM1006, JVET-AM1017, and JVET-AM2006*

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

[JVET-AN0059](https://jvet-experts.org/doc_end_user/current_document.php?id=16043) AHG9: On the SPO and PON SEI messages in VSEI version 4 and in the AVC, HEVC, and VVC interface text [M. M. Hannuksela, F. Cricri (Nokia)]

*JVET- AN0059 also relates to the JVET-AM1006 (HEVC), JVET-AM1017 (AVC), and JVET-AM2005 (VVC)*

[JVET-AN0065](https://jvet-experts.org/doc_end_user/current_document.php?id=16049) AHG9: On the SPO and PON SEI message in VSEI v4 [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0181](https://jvet-experts.org/doc_end_user/current_document.php?id=16165) AHG9: On process SEI messages in processing chain in SPO SEI message [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

[JVET-AN0184](https://jvet-experts.org/doc_end_user/current_document.php?id=16168) AHG9: Miscellaneous on VSEI v4 draft [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

*JVET- AN0184 also relates to the EOI and SPTI SEI messages*

[JVET-AN0185](https://jvet-experts.org/doc_end_user/current_document.php?id=16169) AHG9: Miscellaneous on VSEI codec interfaces [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

*JVET-AN0185 also relates to the NNPF and DSC SEI messages and interface text in JVET-AM1006, JVET-AM1017, and JVET-AM2006*

**Encoder optimization information SEI message *(1)***

[JVET-AN0184](https://jvet-experts.org/doc_end_user/current_document.php?id=16168) AHG9: Miscellaneous on VSEI v4 draft [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

*JVET- AN0184 also relates to the SPO, PON, and SPTI SEI messages*

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

[JVET-AN0184](https://jvet-experts.org/doc_end_user/current_document.php?id=16168) AHG9: Miscellaneous on VSEI v4 draft [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

*JVET- AN0184 also relates to the SPO. PON, and EOI SEI messages*

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

[JVET-AN0060](https://jvet-experts.org/doc_end_user/current_document.php?id=16044) AHG9: On the OMI SEI message in VSEI version 4 [M. M. Hannuksela, J. Boyce (Nokia)]

[JVET-AN0135](https://jvet-experts.org/doc_end_user/current_document.php?id=16119) AHG9: On the object mask information SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0161](https://jvet-experts.org/doc_end_user/current_document.php?id=16145) AHG9: On OMI SEI message [H. Tan, J. Lee, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

**Modality information SEI message *(2)***

[JVET-AN0073](https://jvet-experts.org/doc_end_user/current_document.php?id=16057) AHG9: On MI SEI message in VSEI version 4 [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0138](https://jvet-experts.org/doc_end_user/current_document.php?id=16122) AHG9: On the modality information SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

**Text description information SEI message *(2)***

[JVET-AN0061](https://jvet-experts.org/doc_end_user/current_document.php?id=16045) AHG9: On the text description information SEI message in VSEI version 4 [M. M. Hannuksela (Nokia)]

[JVET-AN0139](https://jvet-experts.org/doc_end_user/current_document.php?id=16123) AHG9: On the text description information SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

**Generative face video SEI messages *(2)***

[JVET-AN0141](https://jvet-experts.org/doc_end_user/current_document.php?id=16125) AHG9: On the generative face video SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0156](https://jvet-experts.org/doc_end_user/current_document.php?id=16140) AHG9: Text fixes and cleanup for GFV and GFE SEI messages [J. Chen, Y. Ye, B. Chen (Alibaba)]

*JVET- AN0156 also relates to editorial aspects for JVET-AM2006*

**Digitally signed content messages *(2)***

[JVET-AN0182](https://jvet-experts.org/doc_end_user/current_document.php?id=16166) AHG9: On DSC SEI messages in VSEI v4 draft [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

[JVET-AN0185](https://jvet-experts.org/doc_end_user/current_document.php?id=16169) AHG9: Miscellaneous on VSEI codec interfaces [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

*JVET-AN0185 also relates to the NNPF and SPO SEI messages and interface text in JVET-AM1006, JVET-AM1017, and JVET-AM2006*

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

[JVET-AN0062](https://jvet-experts.org/doc_end_user/current_document.php?id=16046) AHG9: On the AI usage restrictions SEI message in VSEI version 4 [M. M. Hannuksela, F. Cricri, K. Kammachi Sreedhar (Nokia)]

[JVET-AN0136](https://jvet-experts.org/doc_end_user/current_document.php?id=16120) AHG9: On the AI usage restrictions SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

**Packed regions information SEI message *(4)***

[JVET-AN0064](https://jvet-experts.org/doc_end_user/current_document.php?id=16048) AHG9: On the resampling constraint in VSEI v4 [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

*JVET- AN0064 also relates to the NNPFC SEI message*

[JVET-AN0180](https://jvet-experts.org/doc_end_user/current_document.php?id=16164) AHG9: On PRI SEI message in processing chain [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

[JVET-AN0183](https://jvet-experts.org/doc_end_user/current_document.php?id=16167) AHG9: On PRI SEI message in VSEI v4 draft [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

[JVET-AN0310](https://jvet-experts.org/doc_end_user/current_document.php?id=16314) AHG9: On PRI ID [Y. Li (SJTU), Y.-K. Wang (Bytedance), K. Yang, Y. Xu (SJTU)]

**Image format metadata SEI message *(1)***

[JVET-AN0137](https://jvet-experts.org/doc_end_user/current_document.php?id=16121) AHG9: On the image format metadata SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

***Study JVET-AM2032 TuC for VSEI (48)***

**Scalability dimension information SEI message *(2)***

[JVET-AN0235](https://jvet-experts.org/doc_end_user/current_document.php?id=16219) AHG9: on the SDI SEI message dependency [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

*JVET- AN0235 also relates to the FGRC, GRI, and PSI SEI messages*

[JVET-AN0265](https://jvet-experts.org/doc_end_user/current_document.php?id=16251) AHG9: On confidence auxiliary layer design [E. Thomas, E. Potetsianakis, E. Alexiou, M.-L. Champel (Xiaomi)]

**Shutter interval information SEI message *(1)***

[JVET-AN0145](https://jvet-experts.org/doc_end_user/current_document.php?id=16129) AHG9: On the shutter interval information extension in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

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

[JVET-AN0068](https://jvet-experts.org/doc_end_user/current_document.php?id=16052) AHG9: On Neural-network Post-filter Information Signaling and Semantics [S. Deshpande (Sharp)]

[JVET-AN0176](https://jvet-experts.org/doc_end_user/current_document.php?id=16160) AHG9: On multi-purpose NNPFs [C-H. Demarty, E. François, A. Ak (InterDigital)]

[JVET-AN0264](https://jvet-experts.org/doc_end_user/current_document.php?id=16249) AHG9: Support for implicit representations with the Gaussian splatting information SEI message [S. Lee, S. Sasse, Y. Sanchez, R. Skupin, T. M. Borges, C. Hellge, T. Schierl (Fraunhofer HHI)]

*JVET- AN0264 also relates to the Gaussian splatting information SEI message*

**SEI processing order and processing order nesting SEI messages (*1*)**

[JVET-AN0108](https://jvet-experts.org/doc_end_user/current_document.php?id=16092) AHG9: On the SPO SEI message extension complexity information [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

**Encoder optimization information SEI message *(1)***

[JVET-AN0208](https://jvet-experts.org/doc_end_user/current_document.php?id=16192) AHG8/AHG9: Depth-aware optimization for Encoder optimization information SEI message [G. Teniou, S. Wenger, A. Hinds, J. Ricard]

**Digitally signed content messages *(5)***

[JVET-AN0078](https://jvet-experts.org/doc_end_user/current_document.php?id=16062) AHG9: Digitally signed content (DSC): Comments on TuC [I. Sodagar, C. Fersch, S. McCarthy (Dolby)]

[JVET-AN0107](https://jvet-experts.org/doc_end_user/current_document.php?id=16091) AHG9: On scalable-nested DSCI SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

*JVET- AN0107 also relates to the study of SEI messages in VSEI, VVC, HEVC and AVC*

[JVET-AN0187](https://jvet-experts.org/doc_end_user/current_document.php?id=16171) AHG9: On DSC SEI messages for subpicture-based signing in TuC of VSEI [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

[JVET-AN0188](https://jvet-experts.org/doc_end_user/current_document.php?id=16172) AHG9: On signing parameter sets in DSC SEI messages for subpictures in TuC of VSEI [[J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)](mailto:jangw.lee@lge.com)]

[JVET-AN0210](https://jvet-experts.org/doc_end_user/current_document.php?id=16194) AHG9: On subpicture signing in the DSC SEI messages [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

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

[JVET-AN0069](https://jvet-experts.org/doc_end_user/current_document.php?id=16053) AHG9/AHG13: Updates for the film grain regions SEI message [E. Francois, F. Urban, P. de Lagrange, D. Doyen (InterDigital), G. Teniou (Tencent)]

[JVET-AN0146](https://jvet-experts.org/doc_end_user/current_document.php?id=16130) AHG9: On the film grain regions characteristics SEI message in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0235](https://jvet-experts.org/doc_end_user/current_document.php?id=16219) AHG9: on the SDI SEI message dependency [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

*JVET- AN0235 also relates to the SDI, GRI, and PSI SEI messages*

**Constituent rectangles SEI messages (*4)***

[JVET-AN0102](https://jvet-experts.org/doc_end_user/current_document.php?id=16086) AHG9: On the CR SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0116](https://jvet-experts.org/doc_end_user/current_document.php?id=16100) AHG9: On the colour mapping information SEI message [C. Kim, H. Tan, J. Lee, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AN0116 also relates to the BRI, ECFI, and CMI SEI messages*

[JVET-AN0149](https://jvet-experts.org/doc_end_user/current_document.php?id=16133) AHG9: On the constituent rectangles SEI message in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0160](https://jvet-experts.org/doc_end_user/current_document.php?id=16144) AHG9: On DR SEI, DOI SEI, and CR SEI messages [K. Abe, T. Nishi (Panasonic)]

*JVET- AN0160 also relates to the DOI and DR SEI messages*

**Quality metrics SEI message *(3)***

[JVET-AN0066](https://jvet-experts.org/doc_end_user/current_document.php?id=16050) AHG9: On the QM SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0246](https://jvet-experts.org/doc_end_user/current_document.php?id=16230) AHG9: Metric value range for quality metrics SEI [J. Boyce, M. M. Hannuksela, T. Biatek (Nokia)]

[JVET-AN0247](https://jvet-experts.org/doc_end_user/current_document.php?id=16231) AHG9: Quality metrics SEI for concatenated encoding [J. Boyce, T. Biatek, M. M. Hannuksela (Nokia)]

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

[JVET-AN0074](https://jvet-experts.org/doc_end_user/current_document.php?id=16058) AHG9: On Lens Optical Correction SEI [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

**Display overlays information SEI message *(7)***

[JVET-AN0104](https://jvet-experts.org/doc_end_user/current_document.php?id=16088) AHG9: On the DOI SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0105](https://jvet-experts.org/doc_end_user/current_document.php?id=16089) AHG9: On applying display overlay on CR target picture [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0117](https://jvet-experts.org/doc_end_user/current_document.php?id=16101) AHG9: On display overlays information SEI message [C. Kim, H. Tan, J. Lee, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AN0148](https://jvet-experts.org/doc_end_user/current_document.php?id=16132) AHG9: On the display overlays information SEI message in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0160](https://jvet-experts.org/doc_end_user/current_document.php?id=16144) AHG9: On DR SEI, DOI SEI, and CR SEI messages [K. Abe, T. Nishi (Panasonic)]

*JVET- AN0160 also relates to the CR and DR SEI messages*

[JVET-AN0207](https://jvet-experts.org/doc_end_user/current_document.php?id=16191) AHG9: Overlay purpose indicator for Display overlays information SEI message [G. Teniou, S. Wenger, A. Hinds]

[JVET-AN0248](https://jvet-experts.org/doc_end_user/current_document.php?id=16232) AHG9: Overlay set purpose indicator for Display overlays information SEI message [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

**Bitdepth range information SEI message *(2)***

[JVET-AN0116](https://jvet-experts.org/doc_end_user/current_document.php?id=16100) AHG9: On the colour mapping information SEI message [C. Kim, H. Tan, J. Lee, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AN0116 also relates to the CR, ECFI, and CMI SEI messages*

[JVET-AN0147](https://jvet-experts.org/doc_end_user/current_document.php?id=16131) AHG9: On the bitdepth range information SEI message in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

**Graphics rendering information SEI message *(4)***

[JVET-AN0144](https://jvet-experts.org/doc_end_user/current_document.php?id=16128) AHG9: On the graphics rendering information SEI message in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0230](https://jvet-experts.org/doc_end_user/current_document.php?id=16214) AHG9: on the GRI SEI message [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

[JVET-AN0235](https://jvet-experts.org/doc_end_user/current_document.php?id=16219) AHG9: on the SDI SEI message dependency [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

*JVET- AN0235 also relates to the SDI, FGRC, and PSI SEI messages*

[JVET-AN0242](https://jvet-experts.org/doc_end_user/current_document.php?id=16226) AHG9: Signalling of floating-point values in VSEI and graphics rendering information SEI [V. Zakharchenko, J. Boyce (Nokia)]

*JVET- AN0242 also relates to specification of syntax functions and descriptors*

**Enhanced colour information SEI message *(2)***

[JVET-AN0116](https://jvet-experts.org/doc_end_user/current_document.php?id=16100) AHG9: On the colour mapping information SEI message [C. Kim, H. Tan, J. Lee, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AN0116 also relates to the CR, BRI, and CMI SEI messages*

[JVET-AN0143](https://jvet-experts.org/doc_end_user/current_document.php?id=16127) AHG9: On the enhanced colour format information SEI message in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

**Display rectangles SEI message *(2)***

[JVET-AN0124](https://jvet-experts.org/doc_end_user/current_document.php?id=16108) AHG9: Additional features in display rectangles SEI message [R. Imichi, Y. Tokumo, T. Ikai (Sharp)]

[JVET-AN0160](https://jvet-experts.org/doc_end_user/current_document.php?id=16144) AHG9: On DR SEI, DOI SEI, and CR SEI messages [K. Abe, T. Nishi (Panasonic)]

*JVET- AN0160 also relates to the CR and DOI SEI messages*

**Danmu information SEI message *(5)***

[JVET-AN0115](https://jvet-experts.org/doc_end_user/current_document.php?id=16099) AHG9: On the danmu Information SEI message [C. Kim, H. Tan, J. Lee, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AN0232](https://jvet-experts.org/doc_end_user/current_document.php?id=16216) AHG9: on the Danmu SEI message [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

[JVET-AN0259](https://jvet-experts.org/doc_end_user/current_document.php?id=16244) AHG9: Enable the regional display in the Danmu information SEI message [S. Xie, P. Wu, W. Niu, Y. Gao, C. Huang (ZTE)]

[JVET-AN0261](https://jvet-experts.org/doc_end_user/current_document.php?id=16246) AHG9: Comments on the Danmu information SEI message [S. Xie, P. Wu, W. Niu, Y. Gao, C. Huang (ZTE)]

[JVET-AN0262](https://jvet-experts.org/doc_end_user/current_document.php?id=16247) AHG9: On danmu information SEI message [E. Thomas, E. Potetsianakis, E. Alexiou, M.-L. Champel (Xiaomi)]

**Colour mapping information SEI message *(4)***

[JVET-AN0116](https://jvet-experts.org/doc_end_user/current_document.php?id=16100) AHG9: On the colour mapping information SEI message [C. Kim, H. Tan, J. Lee, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AN0116 also relates to the CR, BRI, and ECFI SEI messages*

[JVET-AN0231](https://jvet-experts.org/doc_end_user/current_document.php?id=16215) AHG9: on the CMI SEI message [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

[JVET-AN0244](https://jvet-experts.org/doc_end_user/current_document.php?id=16228) AHG9: Prespecified colour maps for the colour mapping info SEI message [J. Boyce, M. M. Hannuksela, T. Biatek (Nokia)]

[JVET-AN0245](https://jvet-experts.org/doc_end_user/current_document.php?id=16229) AHG9: On colour mapping info SEI message [J. Boyce, M. M. Hannuksela, T. Biatek (Nokia)]

**Auxiliary sampling alignment information SEI message *(2)***

[JVET-AN0233](https://jvet-experts.org/doc_end_user/current_document.php?id=16217) AHG9: On ASAI SEI Message applied to primary and auxiliary layers [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

[JVET-AN0235](https://jvet-experts.org/doc_end_user/current_document.php?id=16219) AHG9: on the SDI SEI message dependency [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

*JVET- AN0235 also relates to the SDI, FGRC, GRI, and PSI SEI messages*

**Localization and mapping information SEI message *(4)***

[JVET-AN0075](https://jvet-experts.org/doc_end_user/current_document.php?id=16059) AHG9: On Localization and Mapping SEI [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0150](https://jvet-experts.org/doc_end_user/current_document.php?id=16134) AHG9: On the localization and mapping SEI message in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0167](https://jvet-experts.org/doc_end_user/current_document.php?id=16151) AHG9: On localization and mapping SEI message [C. Kim, H. Tan, J. Lee, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AN0260](https://jvet-experts.org/doc_end_user/current_document.php?id=16245) AHG9: Suggested modifications for the LAM SEI [V. Zakharchenko, J. Boyce (Nokia)]

***Collect software and showcase information for SEI messages (2)***

[JVET-AN0122](https://jvet-experts.org/doc_end_user/current_document.php?id=16106) AHG9/AHG11: Demo of real-time NNPF inference with banding reduction [S. Schwarz, H. Sethi, J. Funnell, M. Santamaria, R. Yang, F. Cricri, M.M. Hannuksela (Nokia)]

[JVET-AN0206](https://jvet-experts.org/doc_end_user/current_document.php?id=16190) AHG9: Gaussian Splat compression experiment platform [J. Ricard, G. Teniou, S. Wenger, A. Hinds]

*JVET- AN0206 also relates to identifying potential needs for additional SEI messages*

***Identify potential needs for additional SEI messages, including study of AVC and HEVC SEI messages for use in VVC (7)***

**Sample grouping SEI message *(1)***

[JVET-AN0077](https://jvet-experts.org/doc_end_user/current_document.php?id=16061) AHG9: Sample Grouping SEI message [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

**Gaussian splatting information SEI message *(4)***

[JVET-AN0100](https://jvet-experts.org/doc_end_user/current_document.php?id=16084) AHG9: Gaussian splatting information SEI message [Y. He, J. Jung, L. Kerofsky, G. Van der Auwera, M. Karczewicz (Qualcomm), J. Xu, Y.-K. Wang, L. Zhang (Bytedance Inc.)]

[JVET-AN0205](https://jvet-experts.org/doc_end_user/current_document.php?id=16189) AHG9: Gaussian Splat Information SEI message [J. Ricard, G. Teniou, S. Wenger, A. Hinds]

[JVET-AN0206](https://jvet-experts.org/doc_end_user/current_document.php?id=16190) AHG9: Gaussian Splat compression experiment platform [J. Ricard, G. Teniou, S. Wenger, A. Hinds]

*JVET- AN0206 also relates to software and showcase information for SEI messages*

[JVET-AN0264](https://jvet-experts.org/doc_end_user/current_document.php?id=16249) AHG9: Support for implicit representations with the Gaussian splatting information SEI message [S. Lee, S. Sasse, Y. Sanchez, R. Skupin, T. M. Borges, C. Hellge, T. Schierl (Fraunhofer HHI)]

*JVET- AN0264 also relates to NNPF SEI messages*

**Spatial and bit depth restoration information SEI message *(1)***

[JVET-AN0226](https://jvet-experts.org/doc_end_user/current_document.php?id=16210) AHG9: Spatial and bit depth restoration SEI message [X. Xu, M. Xu, S. Liu (Tencent)]

**Temporal resampling information SEI message *(1)***

[JVET-AN0227](https://jvet-experts.org/doc_end_user/current_document.php?id=16211) AHG9: Temporal resampling information SEI message [X. Xu, S. Liu (Tencent)]

**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.

It was emphasized again that,

“VSEI v4 is intended for FDIS and ITU-T consent at this meeting. There is a preference for design stability. Bug fixes and editorial improvements are OK. We intend to be cautious about adoptions that change the design. Small items with clear benefits may be considered. “

[JVET-AN0010](https://jvet-experts.org/doc_end_user/current_document.php?id=16263) JVET AHG report: Encoding algorithm optimization (AHG10) [K. Andersson, P. de Lagrange, A. Duenas (co-chairs), T. Ikai, T. Solovyev, A. Tourapis (vice chairs)]

Following contributions were identified relating to AHG10 and summarized in the following sections.

***JVET-AN0052: [AHG17] [ Performance of GOP based RPR under CfE test conditions***

This document presents results for enabling GOP based RPR encoder control for VTM (option ‘--GOPBasedRPR=1’) on CfE test conditions. VVC standard supports RPR functionality, which allows changing the scaling factor for video during coding. When GOP based RPR is enabled the first picture in each GOP is down-sampled and up-sampled before coding. Decision on scaling factor is based on PSNR computed between pristine and distorted by down-/up-sampling. Scaling factor decided this way is used for the whole GOP. The BD-rate compared to corresponding anchor configuration is on average is reported to be about -5% for random access and -2% for low-delay configurations. The document proposes to enable GOP based RPR for CfE/CfP anchor.

***JVET-AN0189: AHG17/AHG10: On perceptual coding for next-generation video coding standard***

This document suggests considering perceptually oriented coding tools in the development of next-generation video coding standard. In the development of previous standards (e.g., VVC, HEVC), the CTC are mostly based on PSNR metric. This paradigm of developing a standard may have two limitations that perceptual tuning capability of the standard may not be well tested and verified, and CTC which emphasizes on PSNR may not encourage the development of normative perceptual optimization tools. The document recommends investigating in objective metrics with better correlation with human vision during the preparation of CfP, in AhG17 and perhaps with the help from AG5. The document also suggest that a call for objective quality metrics for video coding quality assessment may be issued to solicit more reliable metrics beyond what we have been familiar with.

***JVET-AN0190: AHG17/AHG10: On test model simulating hardware encoder***

This document recommends developing the next-generation video coding standard of a native design for hardware-friendly encoding. During previous standardization, hardware decoder complexity was emphasized more than hardware encoder complexity, partly because the standards specify the decoding process. A test model developed with an encoding configuration that mimics some key characteristics of hardware encoder (besides a configuration for simulating software encoder) may facilitate more accurate evaluation on the performance of coding tools in the context of hardware encoder implementation and solicit hardware encoding friendly coding technologies. The document also encourages to have experts with hardware encoder design expertise participating in the new standard and improving its hardware friendliness with their valuable comments and suggestions.

**Recommendation**

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

Review of the related documents in the context of CfE.

[JVET-AN0011](https://jvet-experts.org/doc_end_user/current_document.php?id=16264) JVET AHG report: Neural network-based video coding (AHG11) [E. Alshina, F. Galpin, S. Liu (co-chairs), J. Li, Y. Li, R.-L. Liao, M. Santamaria, T. Shao, M. Wien, P. Wu (vice chairs)]

***Common Test Conditions***

**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-14-VTM\_vs\_NNVC-14.xlsm

also distributed by AhG14 in JVET-AN0014 and intermediate report JVET-AN0042

***NNVC tools performance evaluation and bit-exact reproducibility of NN-based methods on various platforms***

Several of CfE responses include elements of NNVC (as well as not yet in NNVC new algorithms).

JVET-AN0085 (test 3) reports 2.8% (RA) and 1.9% (LDB) gain from LOP6 added on top of ‘ECMx5’.

JVET-AN0198 reports 9.4% (SDR UHD, SDR HD, UGC) gain over ‘ECM default’ from just NN-based two technologies (CV-based reference frame and transformers-based filter).

JVET-AN0212 reports 9.0% (RA) gain over VTM23.11 with RPR enabled from LOP6 and NN-Intra from NNVC (enabled together of RPR).

JVET-AN0267 (sub 2) reports 3.2% (RA) gain over NextSoftware2 configured at ×0.2 of VTM encoder speed, using VLOP-like in-loop filter.

Submission which includes elements from default configuration of NNVC (NN-Intra and LOP filter) typically were successfully decoded by cross-checker and md5sum of reconstructed YUV matched. But not default NNVC elements for various reasons caused problem during decoding or miss-match. From one hand side we see that with enough efforts robust decoding of NNVC tools is possible, but check of bit-exact reproducibility on different platform must become a part of evaluation process. Up-date of NNVC CTC can be recommended. A joint effort with AhG14 is recommended to address this topic.

***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-AN0023](https://jvet-experts.org/doc_end_user/current_document.php?id=16271) | EE1: Summary report of exploration experiment on neural network-based video coding | E. Alshina, R. Chang, F. Galpin, Yue Li, Yun Li, M. Santamaria, T. Shao, J. Ström, Z. Xie (EE coordinators) |

EE1 related contributions are cross-checks are summarized in EE1 summary report.

***Teleconferences***

The AHG conducted two joint teleconferences with AHG14 and EE1 during the interim period. The teleconferences were held on July 28 and August, 22. In those teleconferences, the following topics were discussed:

* NNVC14.0 and NNVC-14.1 software integration status
* NNVC14.0 anchor performance
* New RPR/NNSR “CTC” for reporting results
* Implementation of [JVET-AM0175](https://jvet-experts.org/doc_end_user/current_document.php?id=15822) DRF (deep reference frame)
* Hybrid plus E2E AI video codec framework development status report
* JVET-AM2019 finalization
* EE1 tests complexity parameters
* Potential NNVC-based CfE response

|  |  |  |
| --- | --- | --- |
| [JVET-AN0042](https://jvet-experts.org/doc_end_user/current_document.php?id=16026) | [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, except content adaptive tools that are from Nokia.

There were no changes in default configuration on NNVC SW. The main reason for slight reduction of performance and decreases of speed for NNVC-14 (compared to numbers reported for earlier version of NNVC) is a change of SW base to VTM23.11, which is faster and slightly better performing. Note that NNVC-14 is compared to new anchor VTM-23.11 whereas previous versions were compared to VTM-11.0 based version. Overall, NNVC-14 is about 30% faster than NNVC-13 for a slight decrease of performance (less than 0.1%).

Performance of VLOP filter improved after attention module ([JVET-AM0135](https://jvet-experts.org/doc_end_user/documents/39_Daejeon/wg11/JVET-AM0135-v1.zip)) was added into design.

New NNVC tool – Deep Reference Frame ([JVET-AM0175](https://jvet-experts.org/doc_end_user/current_document.php?id=15822)) was added into NNVC tool box.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test vs NNVC (configured as VTM)** | **Random Access cfg** | | | | | **kMAC/pxl** | | | | **Param (Mprm)** | | | |
| **Y** | U | V | Enc | Dec | **Total** | Filter | Intra | SR or DRF | **Total** | Filter | Intra | SR or DRF |
| NN-Intra & LOP filter (2 tools) | | | | | | | | | | | | | |
| NNVC-14.0 (LOP6) | **-8.0%** | **-14.9%** | **-13.5%** | **1.2** | **27** | **21.4** | **16.6** | **4.8** | **0** | **1.5** | **0.25** | **1.3** | **0** |
| NNVC-13.0 (LOP6) | **-8.2%** | -14.9% | -13.5% | **1.1** | **28** | **21.4** | **16.6** | **4.8** | **0** | **1.5** | **0.25** | **1.3** | **0** |
| NNVC-12.0 (LOP5) | **-8.2%** | -15.3% | -13.5% | 1.2 | 35 | **21.4** | 16.6 | 4.8 | 0 | **1.5** | 0.25 | 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** | 0.24 | 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 |
| NN-Intra & HOP filter (2 tools) | | | | | | | | | | | | | |
| NNVC-14.0 (HOP5) | -14.1% | -19.8% | -20.1% | 3.4 | 1180 | 471 | 466 | 4.8 | 0 | 2.7 | 1.41 | 1.3 | 0 |
| NNVC-10.0 (HOP5) | **-14.2%** | -19.5% | -19.9% | 2.6 | 1135 | **471** | 466 | 4.8 | 0 | **2.7** | 1.41 | 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** | 1.42 | 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-14.0 (VLOP4) | -6.1% | -7.5% | -6.0% | 1.1 | 14 | **9.9** | 5.09 | 4.8 | 0 | **1.3** | 0.07 | 1.3 | 0 |
| NNVC-11.0 (VLOP3) | **-5.8%** | -6.6% | -5.7% | 1.2 | 7 | **9.9** | 5.12 | 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 14.0 caLOP4-decp | **-8.6%** | -15.7% | -16.3% | 2.3 | 25 | **22** | 17.2 | 4.8 | 0 | **1.6** | 0.25 | 1.3 | 0 |
| NNVC 11.0 caLOP4 | **-8.5%** | -18.0% | -17.1% | 2.3 | 36 | **22** | 17.2 | 4.8 | 0 | **1.6** | 0.25 | 1.3 | 0 |
| NNVC-10.0 caLOP3 | **-8.2%** | -16.8% | -15.5% | 2.1 | 33 | **22.1** | 17.3 | 4.8 | 0 | **1.5** | 0.21 | 1.3 | 0 |
| NN-Intra & VLOP filter content adaptive (2 tools) | | | | | | | | | | | | | |
| NNVC-10.0 caVLOP | **-6.3%** | -7.8% | -6.6% | 2.2 | 34 | **10.2** | 5.4 | 4.8 | 0 | **1.3** | 0.02 | 1.3 | 0 |
| NN-Intra & LOP filter & adaptive resolution coding (3 tools) | | | | | | | | | | | | | |
| NNVC-14.0 NNSR | -8.6% | -13.7% | -12.5% | 1.1 | 24 | 26.1 | 16.8 | 4.8 | 4.7 | 1.6 | 0.05 | 1.3 | 0.2 |
| NNVC-14.0 RPR | **-8.6%** | -13.7% | -12.6% | 1.1 | 24 | **21.4** | 16.6 | 4.8 | 0 | **1.5** | 0.25 | 1.3 | 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 |
| NN-Intra & LOP filter & DRF (3 tools) | | | | | | | | | | | | | |
| NNVC-14.0 DRF | -9.8% | -15.9% | -14.2% | 1.7 | 604 | **441.4** | 16.6 | 4.8 | 420 | **7.7** | 0.25 | 1.3 | 6.1 |

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

***End-to-end AI coded reference picture***

In between the two meetings intensive debugging process of end-to-end AI coded reference picture implementation into NNVC was conducted. It appears that two different ways of implementation are possible:

* So-called multi-layer (fully reuses syntax and referencing mechanism of multi-layer VVC, including all high-level syntax needed for base layer independent decoding and rendering)
* So-called ‘single layer’ (as it was proposed in JVET-AL0196), in which end-to-end AI coded picture is intended to be used only as reference, so there is no high-level syntax needed for base layer independent decoding and rendering is required.

Two approaches converged and achieved the status that performance difference now is only high-level syntax of base layer. Decision about which approach to chose can be done only after discussion during the JVET meeting. It probably makes sense to keep both since they have different functionality and address different use cases, but align them in order to reduce deployment cost.

Related contributors need to be discussed together

|  |  |  |
| --- | --- | --- |
| [JVET-AN0202](https://jvet-experts.org/doc_end_user/current_document.php?id=16186) | [AHG11/AHG14] Comparison of Multi-Layer and Single-Layer Interfaces for Hybrid End-to-End Video Coding Frameworks | [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-AN0216](https://jvet-experts.org/doc_end_user/current_document.php?id=16200) | [AHG11] Update on 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, F. Galpin, P. de Lagrange (InterDigital) |
| [JVET-AN0224](https://jvet-experts.org/doc_end_user/current_document.php?id=16208) | [AHG11] A Hybrid Framework Integrating End-to-End Learned Intra-Frame 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-AN0225](https://jvet-experts.org/doc_end_user/current_document.php?id=16209) | [AHG11][AHG14]: Further Improvements on Hybrid Multilayer Framework for End-to-End Learned Intra Frame | [M. Aderdor](mailto:mouad.aderdor@huawei.com), [T. Solovyev](mailto:solovyev.timofey@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |

***NNVC implementation aspects***

Some trial implementation of NN-based filters on various devices are discussed in two contributions.

|  |  |  |
| --- | --- | --- |
| [JVET-AN0122](https://jvet-experts.org/doc_end_user/current_document.php?id=16106) | AHG9/AHG11: Demo of real-time NNPF inference with banding reduction | [S. Schwarz](mailto:sebastian.schwarz@nokia.com), H. Sethi, J. Funnell, M. Santamaria, R. Yang, F. Cricri, M.M. Hannuksela (Nokia) |
| [JVET-AN0257](https://jvet-experts.org/doc_end_user/current_document.php?id=16241) | [AHG11] CPU and GPU time comparison for NNVC models | [A. Karabutov](mailto:karabutov.alexander@huawei.com), E.Alshina (Huawei) |

***Test conditions***

Some practical suggestions on NNVC tools testing are done following two contributions

|  |  |  |
| --- | --- | --- |
| [JVET-AN0047](https://jvet-experts.org/doc_end_user/current_document.php?id=16031) | EE1-related: Automated environment information collection | [N. Le](mailto:nam.le@nokia.com), M. Santamaria, H. Zhang, F. Cricri (Nokia) |
| [JVET-AN0301](https://jvet-experts.org/doc_end_user/current_document.php?id=16305) | AhG17 Sharing experience of conducting JPEG AI Call for Proposals | E.Alshina |

***New design elements proposal***

During NNVC-based CfE response preparation several encoders only modifications which substantially reduce decoder complexity have been found. Also, four new proposals targeting NNVC performance improvement are submitted.

|  |  |  |
| --- | --- | --- |
| [JVET-AN0172](https://jvet-experts.org/doc_end_user/current_document.php?id=16156) | AHG11: Proposal of normative TDO method as an alternative option in NNVC | [H. Kwon](mailto:hspeedkwon@hanyang.ac.kr), [H. Ko (Hanyang Univ.)](mailto:hyunsuk@hanyang.ac.kr), [D. Kim](mailto:kimddng@etri.re.kr), [S.-C. Lim (ETRI)](mailto:sclim@etri.re.kr) |
| [JVET-AN0215](https://jvet-experts.org/doc_end_user/current_document.php?id=16199) | AhG11: Filter restriction depending on hierarchical depth | [F. Galpin](mailto:franck.galpin@interdigital.com), E. François (InterDigital) |
| [JVET-AN0255](https://jvet-experts.org/doc_end_user/current_document.php?id=16239) | AHG11: VLOP3 with new backbone block based on Spatial-Channel Mixing (SCM) | [H. Cho](mailto:gusehd1113@khu.ac.kr), [S. Bahk](mailto:clapd10@khu.ac.kr), [H. Y. Kim (KHU)](mailto:hykim.v@khu.ac.kr), [D. Kim](mailto:kimddng@etri.re.kr), [S.-C. Lim (ETRI)](mailto:sclim@etri.re.kr) |
| [JVET-AN0285](https://jvet-experts.org/doc_end_user/current_document.php?id=16289) | AHG11: In-loop filter with dynamic feature guidance for NNVC | [X.-T. Xie](mailto:xiatian_xie@hust.edu.cn), [W.-X. He](mailto:wxhe@hust.edu.cn), [T. Yang](mailto:y_tian@hust.edu.cn), [Y.-Q. Zhu](mailto:yiqingzhu@hust.edu.cn), [J.-S. Gong](mailto:jsgong@hust.edu.cn), [Q.-M. Wang](mailto:wangqimeng@hust.edu.cn), [Q. Liu (HUST)](mailto:q.liu@hust.edu.cn), [Z.-Y. Lv (vivo)](mailto:zhuoyi.lv@vivo.com) |
| [JVET-AN0209](https://jvet-experts.org/doc_end_user/current_document.php?id=16193) | AhG 11/AHG 14: Harmonization of Deep Reference Frame (DRF) with RPR in NNVC14.1 | [N. Bhaskar](mailto:nisha.bhaskar1@huawei.com), [T. Solovyev](mailto:Solovyev.timofey@huawei.com), [E. Alshina (Huawei)](mailto:Elena.alshina@huawei.com) |
| [JVET-AN0319](https://jvet-experts.org/doc_end_user/current_document.php?id=16323) | EE1-related: FlowWarp Operator for DRF Integer Inference Optimization | [N. Fu](mailto:nianxiangfu@whu.edu.cn), [X. Chen](mailto:xinxinchen@whu.edu.cn), [L. Qin](mailto:qinluyi@whu.edu.cn), [W. Zhang](mailto:wenzhuo@whu.edu.cn), [Z. Chen (Wuhan Univ.)](mailto:zzchen@whu.edu.cn) |

**Recommendations**

The AHG recommends:

* Review all input contributions.
* Continue investigating neural network-based video coding tools, including coding performance and complexity.
* Discuss and make decision on ‘multi-layer’ and ‘single layer’ implementations of hybrid codec using End-to-End AI coded pictures.
* Discuss device interoperability and decoder complexity of NNVC elements in CfE submissions.
* Recommend promising technologies for next EE1 round.

It was commented that, at this exploration stage of study, it may be less important how high-level enabling such functionality is achieved.

It was also commented that the term “hybrid” has a much wider use in describing an architecture that mixes conventional and NN-based technology.

[JVET-AN0012](https://jvet-experts.org/doc_end_user/current_document.php?id=16265) 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)]

**Activities**

The primary activity of the AHG was the “Exploration experiment on enhanced compression beyond VVC capability” (JVET-AM2024). The combined improvements of the ECM-18.0 over VTM-11.0ecm18.0 anchorfor AI, RA and LB configurations are:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | All Intra Main10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -14.82% | -16.49% | -27.44% | 1202.2% | 577.9% |
| Class A2 | -21.47% | -24.85% | -29.07% | 1119.5% | 624.0% |
| Class B | -15.06% | -23.15% | -21.18% | 1086.0% | 627.5% |
| Class C | -15.19% | -12.08% | -13.23% | 1026.3% | 583.6% |
| Class E | -19.58% | -23.35% | -21.51% | 992.5% | 615.0% |
| Overall | -16.87% | -19.90% | -21.83% | 1080.0% | 606.4% |
| Class D | -12.92% | -8.80% | -9.64% | 1013.4% | 663.9% |
| Class F | -30.84% | -34.56% | -34.60% | 688.3% | 658.9% |
| Class TGM | -43.72% | -49.31% | -48.60% | 513.1% | 658.7% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Random Access Main 10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -27.52% | -25.12% | -37.22% | 1205.3% | 1195.4% |
| Class A2 | -30.81% | -34.98% | -40.50% | 1103.1% | 1346.4% |
| Class B | -25.42% | -34.33% | -31.10% | 999.4% | 1197.0% |
| Class C | -27.12% | -24.29% | -25.03% | 1064.9% | 1294.1% |
| Class E |  |  |  |  |  |
| Overall | -27.37% | -29.94% | -32.58% | 1076.3% | 1250.9% |
| Class D | -27.81% | -24.52% | -25.81% | 1003.1% | 1417.7% |
| Class F | -33.60% | -36.80% | -37.37% | 851.2% | 853.5% |
| Class TGM | -43.07% | -48.90% | -48.87% | 693.7% | 676.2% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Low Delay B Main 10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -22.61% | -40.61% | -35.58% | 976.7% | 1030.5% |
| Class C | -25.00% | -28.31% | -30.38% | 937.3% | 1074.8% |
| Class E | -22.74% | -29.72% | -28.28% | 965.0% | 712.7% |
| Overall | -23.44% | -33.79% | -32.02% | 960.5% | 953.0% |
| Class D | -26.46% | -29.97% | -31.37% | 938.9% | 1175.1% |
| Class F | -31.37% | -41.12% | -41.47% | 859.7% | 808.4% |
| Class TGM | -41.36% | -51.49% | -51.48% | 691.5% | 643.3% |

The rate reduction for natural sequences over VTM in RA configuration for {Y, U, V} increased from ECM-17.0’s {-27.27%, -29.46%, -32.22%} to ECM-18.0’s {-27.37%, -29.94%, -32.58%}. For SCC sequences (class TGM) the rate reduction for RA configuration increased from ECM-16.1’s {-42.78%, -48.57%, -48.43%} to ECM-17.0’s { -43.07%, -48.90%, -48.87%}.

**Contributions**

In addition to 24 EE2 contributions, 42 (comparing to 41 last meeting) EE2-related and AHG12-related contributions were received. The EE2-related and AHG12-related contributions can be subdivided as follows:

***Intra (16)***

JVET-AN0110, "Non-EE2: Enhancement of Non-CCP Reordering List", Z. Liu, L. Zhang, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AN0123, "Non-EE2: Improvement on chroma MPM", Z. Li, W. Niu, X. Zeng, M. Jia, Y. Wang, C. Huang (ZTE)

JVET-AN0126, "Non-EE2: MPDIP clipping", K.-Y. Kim, J.-H. Son, J.-Y. Kim, J.-S. Kwak (WILUS)

JVET-AN0131, "Non-EE2: On interpolation filter for SGPM J. Lee, G. Moon, K. Kim, J.-G. Kim (KAU), J. Lee, S.-C. Lim (ETRI)

JVET-AN0132, "Non-EE2: Enhancement of MDIP mode selection", K. Kim, G. Moon, J. Lee, J.-G. Kim (KAU), J. Lee, S.-C. Lim (ETRI)

JVET-AN0152, "Non-EE2: Multiple Candidate Selection for MDIP", L. Wang, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang, W. Song (Hisense)

JVET-AN0154, "Non-EE2: Position-dependent Weighted Prediction Extension", Y. Wang, X. Zeng, Z. Li, M. Jia, C. Huang (ZTE)

JVET-AN0170, "Non-EE2: Additional OBIC candidates in MPM list", Y. Kim, S. Lee, S. Noh, H. Choi (HNU), W. Lim, S.-C. Lim (ETRI)

JVET-AN0192, "Non-EE2: Modification of reconstructed area for EIP", W. Niu, S. Xie, Z. Li, M. Jia, Y. Bai, C. Huang (ZTE)

JVET-AN0194, "Non-EE2: Extension on TMRL mode", Y. Liu, Y. Huo, Z. Zhang (Transsion)

JVET-AN0219, "AHG12 IntraTMP with DMVR", K. Naser, P. Bordes, F. Le Léannec, A. Robert (InterDigital)

JVET-AN0221, "AHG12: Reference sample generation for intra prediction", T. N. Canh, P. Yin, S. McCarthy (Dolby)

JVET-AN0234, "Non-EE2: On filtering condition for angular modes", Z. Zhu, Y. Yin, H. Xu, S. Wan (NWPU), S. Xie, X. Zeng, C. Huang (ZTE)

JVET-AN0286, "Non-EE2: TMRL Angle Offset Refinement", Gagan Rath, Karam Naser, Fabrice Le Leannec, Thierry Dumas (InterDigital)

JVET-AN0287, "Non-EE2: Combined Angular- and Gradient-PDPC", Gosala Kulupana, Saverio Blasi, Nicolas Neumann, Jani Lainema (Nokia)

JVET-AN0299, "Non-EE2: Improvement for candidates on MPM", W. Niu, Z. Li, S. Xie, M. Jia, Y. Bai, C. Huang (ZTE)

***Inter (7)***

JVET-AN0111, "Non-EE2: additional candidates for regular inter AMVP candidate list", C. Wang, Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AN0155, "Non-EE2: On improving adaptive GPM blending", Z. Zhang, Y. Huo, Y. Liu (Transsion)

JVET-AN0191, "Non-EE2: Binarization Improvement of GPM", X. Wang, J. Chen, C. Zhu, L. Luo, H. Guo (UESTC), Y. Huo, Y. Liu, Z. Zhang (Transsion)

JVET-AN0200, "Non-EE2: On improving CIIP Fusion", Y. Wang, X. Zeng, M. Jia, Z. Li, C. Huang (ZTE)

JVET-AN0218, "Non-EE2: Extension of Sub-Block Merge Mode Availability Conditions", Y. Liu, Y. Huo, Z. Zhang (Transsion)

JVET-AN0266, "Pairwise Merge Candidates with Motion Vector Scaling", S. Hong, L. Wang, K. Panusopone, D. Rusanovskyy (Nokia)

JVET-AN0228, "Independent CTUs for TM-padding", N. Neumann (Nokia)

***Cross Component Prediction (1)***

JVET-AN0270, "Non-EE2: CCCM with clipping", L.-C. Xu, C.-F. Liao, Y.-K. Lu, F. Liang (SYSU)

***In Loop Filters (7)***

JVET-AN0086, "AHG12: Bug Fix for ALF Coefficient Calculation", R. Xu, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang, W. Song (Hisense)

JVET-AN0113, "Non-EE2: Additional candidates for merge mode in ALF-CCCM", H. Zhang, N. Song, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AN0114, "Non-EE2: Local boosting CCP for ALF-CCCM", H. Huang, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AN0130, "Non-EE2: Improvement on Frame-level Inheritance Mode in ALF-CCCM", M. Jia, Y. Bai, X. Zeng, Z. Li, C. Huang (ZTE)

JVET-AN0163, "AHG12: On improving the bi-filtering modes in TALF", P. Astola, D. Buğdayci Sansli, J. Lainema (Nokia)

JVET-AN0164, "Non-EE2: ALF coefficient coding group extension", I. Jumakulyyev, D. Buğdayci Sansli, J. Lainema (Nokia)

JVET-AN0269, "AHG12: BIF with before DBF samples", K. Takada, S. Deshpande (Sharp)

***Coefficients Quantization and Coding (6)***

JVET-AN0087, "AHG12: Budget Control for Transform Skip Residual Coding", R. Xu, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang, W. Song (Hisense)

JVET-AN0088, "AHG12: Context Modeling for sig\_coeff\_flag in TSRC", R. Xu, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang, W. Song (Hisense)

JVET-AN0109, "EE2-4.1-related: On Linked Sign Prediction", Y. Zhang, L. Xu, Y. Yu, J. Gan, H. Yu, D. Wang (OPPO)

JVET-AN0112, "Non-EE2: Coding of a coefficient level in TSRC", Y. Yu, L. Xu, J. Gan, H. Yu, D. Wang (OPPO)

JVET-AN0125, "Non-EE2: On CABAC bin budget constraint", K.-Y. Kim, J.-H. Son, J.-Y. Kim, J.-S. Kwak (WILUS)

JVET-AN0175, "EE2-related: Unbiased Simple Quantizer (Related to EE2-4.2i)", M. Balcilar, M. Blestel, P. Andrivon (Ofinno)

***Entropy Coding (1)***

JVET-AN0214, "AhG12: CABAC contexts retraining", F. Galpin (InterDigital)

***Transform (2)***

JVET-AN0169, "Non-EE2: On inter multiple transform set selection and advanced SBT", J. Huo, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang, W. Song (Hisense)

JVET-AN0179, "EE2-2.1-related: Multiple Transform Set Selection for TMRL blend", W. Feng, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang, W. Song (Hisense)

***Partitioning (1)***

JVET-AN0211, "AhG12: Second reference frame for temporal partitioning prediction", G. Laroche, P. Onno, B. Galmiche (Canon)

***Other (1)***

JVET-AN0089, "AHG12/AHG18: On GDR test condition for video compression beyond VVC", T. Chujoh, Y. Kidani, K. Kawamura (KDDI)

Recommendations

The AHG recommends:

* To review all the related contributions.

[JVET-AN0013](https://jvet-experts.org/doc_end_user/current_document.php?id=16266) JVET AHG report: Film grain technologies (AHG13) [W. Husak, P. de Lagrange (co-chairs), A. Duenas, X. Meng, M. Radosavljević, A. Segall, G. Teniou, A. Tourapis (vice-chairs)]

1. **Discussion**

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 Technical Report (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 modeling methods

The following topics are worthy of discussion for the second edition:

* Conformance – this is interesting due to Film Grain modeling being associated with SEI messages
* Film Grain Analysis methods– preprocessing analysis (parameter estimation)

The following are additional topics that could also be considered and discussed at likely lower priority:

* EG/RP documents providing guidance or usage recommendations for film grain technologies– The group is still considering what could be useful information for the industry and the scope of such documents
* Future parameters and signaling – not a v2 topic

1. **Related contributions**

Five contributions related to AHG13 were identified as of 06/26/2025.

* One contribution was the AHG report:
  + JVET-AN0013 JVET AHG report: Film grain technologies (AHG13)
* Four other contributions were uploaded at the time of the report drafting:
  + JVET-AN0069 AHG9/AHG13: Updates for the film grain regions SEI message
  + JVET-AN0146 AHG9: On the film grain regions characteristics SEI message in TuC of VSEI
  + JVET-AN0229 AHG9: On the film grain characteristics SEI message in VSEI v4
  + JVET-AN0237 AHG13: Film grain analysis improvement

***Contributions***

There were four contributions registered other than the AHG report. All four were uploaded as of 10/02/25.

**JVET-AN0069 AHG9/AHG13: Updates for the film grain regions SEI message**

This contribution proposes updates for the film grain regions (FGR) SEI message (included in the technologies under consideration for future extensions of VSEI).

The Film Grain Regions Characteristics (FGR) SEI message supports three FG synthesis modes: per picture, per picture modulated by an alpha map, per region. In the region mode, the film grain model and film grain parameters may be changed per region. Snapshots of the region-based and alpha-map modes are provided below for illustration.

The current film grain regions (FGR) SEI message syntax can be split into different parts, corresponding to information on:

* The resolution at which the grain should be applied
* The FG mode, defined by
  + the number of signaled FG models (1 or 2)
  + the spatial mode (picture-level, region-level, picture-level with alpha-belnding) used for the FG synthesis
* Colour description information
* FG parameters
* Regions parameters.

**JVET-AN0146 AHG9: On the film grain regions characteristics SEI message in TuC of VSEI**

This contribution proposes the following changes for the film grain regions characteristics (FGR) SEI message:

1. Remove the ChromaFormatIdc condition in the interface text.
2. Add two constraints for fgr\_matrix\_coeffs.
3. Change the semantics of fgr\_comp\_model\_present\_flag[ m ][ c ] when it is equal to 0 to reflect the actual process.
4. Add a sensibility constraint for fgr\_intensity\_interval\_upper\_bound[ m ][ c ][ i ] and fgr\_intensity\_interval\_lower\_bound[ m ][ c ][ i ].
5. Add inference for fgr\_comp\_model\_value[ m ][ c ][ i ][ 0 ] when it is not present.

**JVET- AN0229 AHG9: On the film grain characteristics SEI message in VSEI v4**

This contribution proposes the following changes for the film grain characteristics (FGC) SEI message:

1. Move the payload extension inside the if( ) loop for fg\_characteristics\_cancel\_flag.
2. Remove the ChromaFormatIdc condition in the VSEI interface text
3. Add two notes on the presence of fg\_matrix\_coeffs
4. Change the semantics of fg\_comp\_model\_present\_flag[ c ] when it is equal to 0 to reflect the actual process.
5. Add a sensibility constraint for fg\_intensity\_interval\_upper\_bound[ c ][ i ] and fg\_intensity\_interval\_lower\_bound[ c ][ i ].
6. Add inference for fg\_comp\_model\_value[ c ][ i ][ 0 ] when it is not present.
7. Various editorial changes.

**JVET-AN0237 AHG13: Film grain analysis improvement**

This work presents several enhancements to the film grain analysis process. They include:

* Improved cut-off frequency estimation where cut-off frequencies are now estimated by accumulating data over frames.
* Implementing software to limit the number of different cut-off frequencies (different cut-off pairs) within the frame

Experiments were carried out on different film grain sequences, and the visual evaluation demonstrated that the estimated film grain parameters result in a higher fidelity representation of the film grain compared to the source.

1. **Recommendations**

The AHG recommends:

* Continue editing the second edition for the TR;
* the related input contributions (non-AHG9) to be reviewed;
* any liaisons to be reviewed;
* to continue conformance discussion;
* to consider any newly proposed SEI message extensions;
* to discuss the possibility of creating as appropriate documents providing Engineering Guideline (EG) or recommended practices (RP) relating to film grain technologies and their applications; and
* to continue the study of film grain technologies in JVET.

Potential new version JVET-AN2020 based on JVET-AN0237.

[JVET-AN0014](https://jvet-experts.org/doc_end_user/current_document.php?id=16025) 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)]

***Location***

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

NNVC software is based on latest VTM VTM-23.11 at the time of software integration.

Legacy version (up to NNVC-13.0) can be found in branch VTM-11.0\_nnvc and contains history of development of tools integrated in NNVC-14.0.

NNVC-14.0 anchor at https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/nnvc-ctc is used for NNVC performance evaluation.

***Software changes***

**Current NNVC**

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

|  |  |
| --- | --- |
| **MR** | **Comments** |
|  | new official branch NNVC (default branch) |
|  | VTM-11.0\_nnvc dis deprecated: no merge is possible |
| 332 | **JVET-AM0135** VLOP4 integration |
| 321 | adaptive nnlf training scripts have been merged |
| 329 | cherry picking VTM 23.10 |
| 337 | **JVET-AM0170** sadl v14 update |
| 347 | sadl v14.1 (fix + converter update) |
| 325 | nnpf models |
| 338 | NNSR porting |
| 334 | cherry picking VTM 23.11 |
| 340 | **JVET-AM0050** merging of branch hybrid\_codec\_e2e\_dev |
| 345/349/354 | set nnsr/rpr policy for official results |
| 346 | fix RPR memory leak |
| 342 | inter tools **JVET-AM0175** training |
| 343 | inter tools **JVET-AM0175** models |
| 341 | inter tools **JVET-AM0175** nnvc code |
| 356/358/357 | clean up DRF inference code |
| 351 | fix single layer default mode for hybrid |
| 344/350 | add scale information in log for rpr/nnsr mode |
| 352 | fix vtm mode build |
| 360 | nnpf nnvc sei code |
| 352 | fix build macro off |
| 362 | fix hybrid e2e chunk |
| 365 | mv zero for hybrid mode |

Additionally, several fixes were done on VTM default mode, allowing a running time closer to vanilla VTM, several fixes in hybrid mode, etc.

In SADL v14, the following changes were integrated:

|  |  |  |  |
| --- | --- | --- | --- |
| **SADLa** | | | |
| **Status** | **MR** | **Comments** |
| DONE | 153 | **JVET-AM0178** new layer pad |
| DONE | 154 | **JVET-AM0178** speed-up conv2d 2x2 |
| DONE | 155 | **JVET-AM0136** speed up lop6 |
| DONE | 156 | fix macro |
| DONE | 158 | fix build no saturation |
| DONE | 160 | fix speed up lop6 |
| DONE | 161 | add option to converter for DRF |
| DONE | 162 | fix build clang |

Additionally, several bug fixes were integrated, notably on the float inference regression in v14.

A 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> )

A new branch “NNVC\_cfe” used to generate results of CfE has been created. It contains the following non-normative changes:

* Choose NNLF activation per hierarchical depth (see JVET-AN0215)
* Set RPR policy to VTM mode
* Allows configuration file-based TDO parameters

During integration of new VTM and CfE tests, several issues were found and need to be addressed:

* Interaction of RPR and DRF
* Possible issues using HOP5 with high QP
* Possible interaction of NNSR and FGS
* NNSR policy for LDB not well handled
* NNSR/RPR policy to clean up

***Software overview***

Between the 2 meetings, a joint effort was made to support new features such as hybrid end-to-end coding and also to rebase the NNVC software on the newest VTM 23.11. The result is now the official NNVC software.

All NN tools of NNVC-13 and adoptions have been ported:

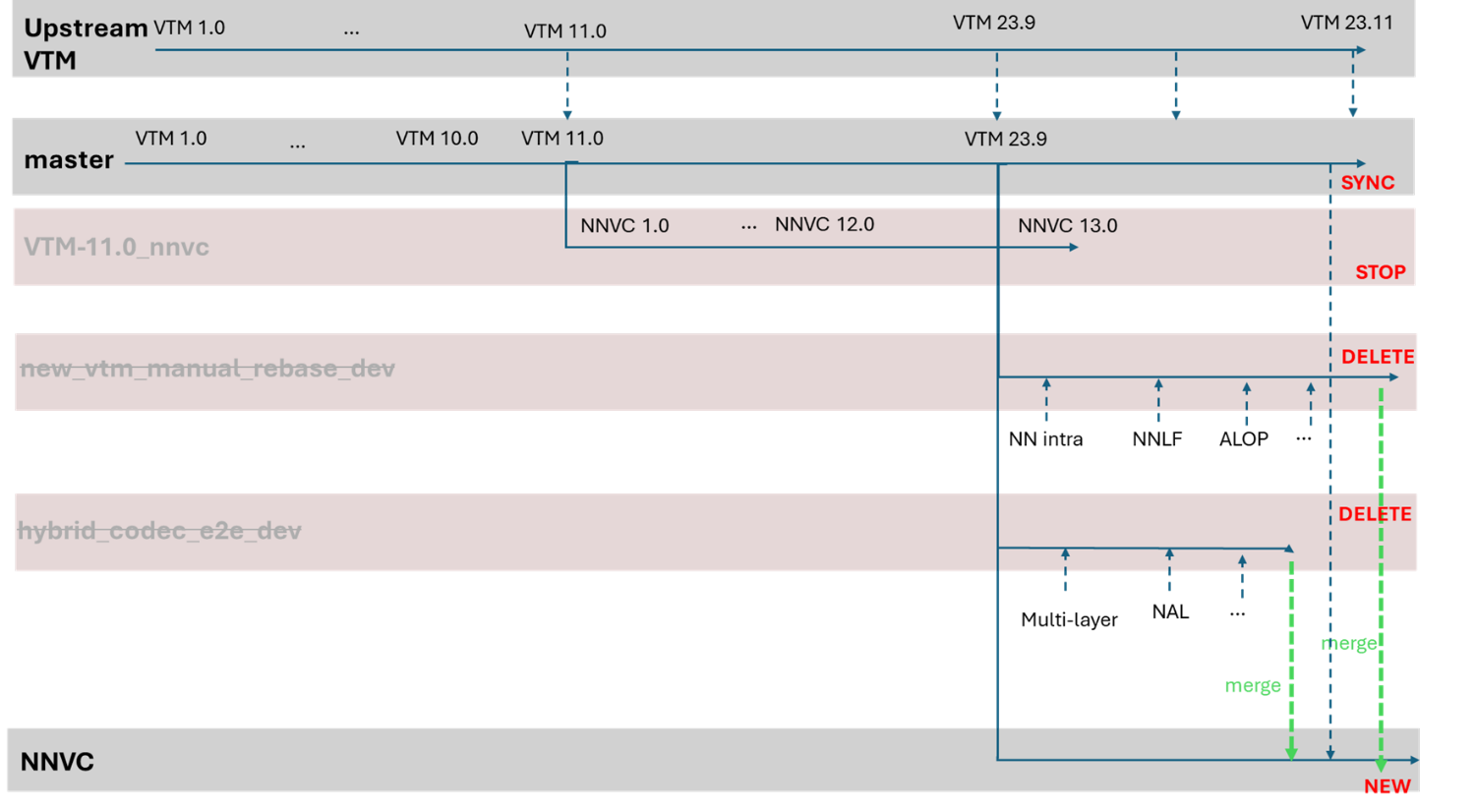
* NNLF: NN based Loop-Filter, support for latest VLOP, LOP and HOP, CALOP
* NNSR: NN based super-resolution
* NNIP: NN based Intra Prediction
* NNPF: NN based Post-Filter
* DRF: NN based Deep Reference Frame

A new framework for Hybrid end-to-end coding of intra slice has been integrated.

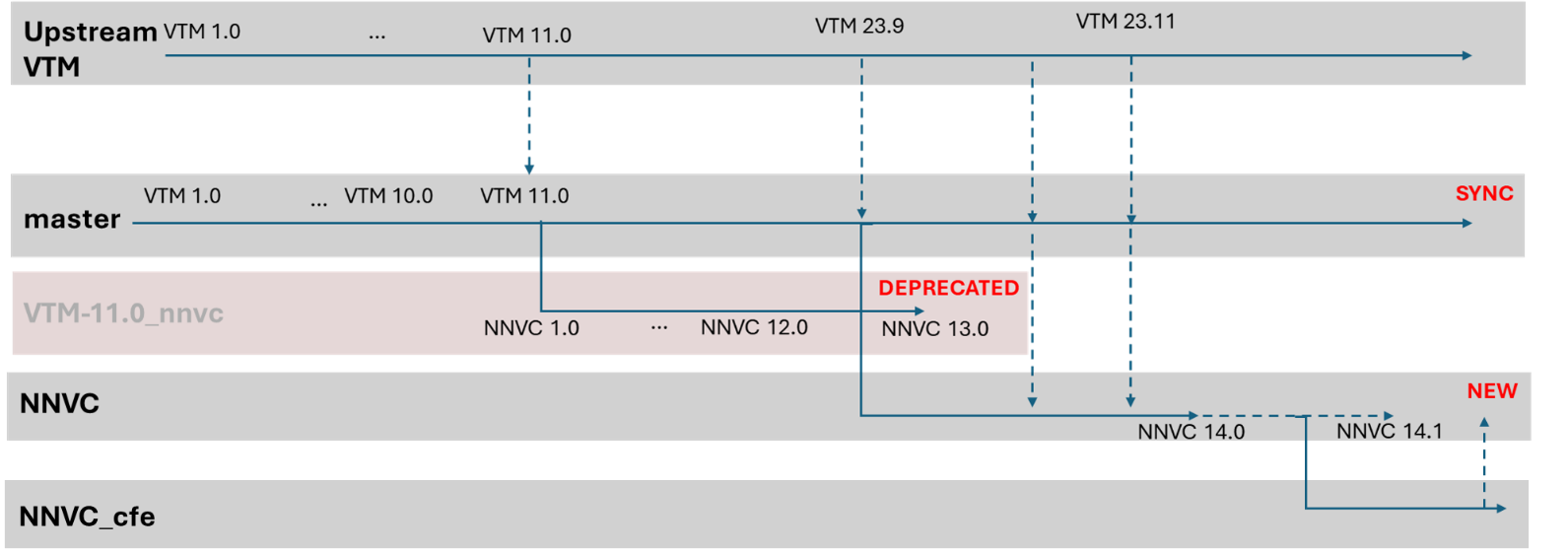
The master branch is kept synchronized with the upstream repository (VTM).

**Status of the repository**

The following diagram shows the status of the repository during the integration process.



The following diagram shows the current status of the repository.



***NNVC-14***

***Software version***

NNVC-14.1 was tagged 28th August, 2025

NNVC-14.0 was tagged July 28th, 2025 (contains VLOP4, DRF, hybrid e2e)

NNVC-13 was tagged April 28th, 2025 (contains LOP6)

NNVC-12 was tagged February 6th, 2025 (containing final LOP5 model)

NNVC-12rc1 was tagged February 5th, 2025 (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**

Overall, the new VTM-23.11 base allowed a speedup of about 30% of the encoding runtime for minor decrease in performance.

Moreover, the reduced runtime configurations allow to target an encoding runtime between 116% and 26% compared to VTM in RA configuration, for gains between {-8.01%, -14.92%, -13.53%} and {0.38%,-5.60%,-2.98%} for NNVC anchor.

Using more complex tools, i.e. HOP5 and DRF on top of NNVC-14 allows gains of {-15.60%,-20.55%,-20.70%} for an encoding complexity of 378% for RA configuration.

Note: see configurations section for naming convention.

***Comparison to VTM***

**NNVC-13.0 VTM vs NNVC-14.0 VTM**

Note: NNVC-14 is now based on VTM-23.11.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC 13 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -0.13% | 0.17% | 0.03% | -0.39% | 0.16% | -0.08% | 67% | 94% |
| Class A2 | 0.02% | 0.24% | 0.48% | -0.21% | 0.03% | 0.35% | 70% | 95% |
| Class B | -0.04% | 0.11% | 0.13% | -0.31% | 0.16% | 0.21% | 71% | 99% |
| Class C | -0.35% | 0.15% | 0.18% | -0.41% | 0.33% | 0.23% | 72% | 103% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -0.13% | 0.16% | 0.19% | -0.33% | 0.18% | 0.18% | 70% | 98% |
| Class D | -0.74% | -0.30% | -0.07% | -0.46% | 0.57% | 1.07% | 78% | 103% |
| Class F | 0.38% | 0.49% | 0.84% | 0.28% | 0.41% | 0.69% | 73% | 102% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC 13 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -0.03% | 0.29% | -0.28% | -0.41% | 0.30% | -0.66% | 70% | 92% |
| Class C | -0.12% | -0.01% | 0.33% | -0.31% | 0.00% | 1.62% | 74% | 95% |
| Class E | -0.46% | 0.22% | 0.59% | -0.93% | 0.59% | -0.21% | 70% | 97% |
| **Overall** | -0.17% | 0.18% | 0.14% | -0.51% | 0.27% | 0.21% | 71% | 94% |
| Class D | -0.23% | 0.11% | -0.53% | -0.47% | 0.10% | -0.55% | 79% | 96% |
| Class F | 0.34% | 0.50% | 0.40% | 0.02% | 0.90% | 0.21% | 71% | 94% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | |
|  | **BD-rate Over NNVC 13 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | 0.03% | 0.67% | 0.11% | -0.29% | 0.76% | -0.15% | 66% | 95% |
| Class C | -0.02% | 0.17% | 0.97% | -0.23% | 0.71% | 2.09% | 71% | 97% |
| Class E | -0.19% | 0.60% | 0.34% | -0.72% | 0.79% | -0.50% | 68% | 98% |
| **Overall** | -0.04% | 0.49% | 0.45% | -0.38% | 0.75% | 0.51% | 68% | 96% |
| Class D | -0.03% | 0.13% | -0.08% | -0.65% | 0.09% | -0.06% | 77% | 98% |
| Class F | 0.43% | 0.76% | 0.20% | 0.30% | 1.10% | 0.23% | 70% | 95% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC 13 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -0.62% | -0.66% | 0.42% | -0.59% | -0.41% | 0.78% | 79% | 97% |
| Class A2 | -0.60% | -0.50% | -0.50% | -0.58% | -0.42% | -0.40% | 83% | 97% |
| Class B | -0.69% | -0.41% | -0.35% | -0.85% | -0.19% | -0.20% | 84% | 100% |
| Class C | -0.43% | -0.63% | -0.53% | -0.83% | -0.26% | -0.26% | 88% | 102% |
| Class E | -0.36% | 0.12% | 0.38% | -0.60% | 0.27% | 0.30% | 83% | 100% |
| **Overall** | -0.55% | -0.43% | -0.17% | -0.72% | -0.20% | 0.00% | 84% | 99% |
| Class D | -0.40% | -0.47% | -0.17% | -0.98% | -0.41% | 0.35% | 90% | 107% |
| Class F | -0.12% | -0.69% | -1.05% | -0.08% | -0.39% | -0.25% | 85% | 101% |

Notes: results by InterDigital, crosschecked by xxx.

**NNVC-14.0 VTM vs NNVC-14.0 anchor**

**Anchor**: NNVC in VTM mode.

**Test**: NNLF LOP6 + NNIP.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -8.98% | -13.88% | -15.28% | -8.82% | -16.00% | -17.48% | 117% | 2264% |
| Class A2 | -8.31% | -14.98% | -9.57% | -8.42% | -15.43% | -9.57% | 116% | 2197% |
| Class B | -7.71% | -15.96% | -14.70% | -7.80% | -18.20% | -17.56% | 117% | 2965% |
| Class C | -7.43% | -14.34% | -13.72% | -7.62% | -14.96% | -15.20% | 114% | 3103% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -8.01% | -14.92% | -13.53% | -8.08% | -16.34% | -15.31% | 116% | 2678% |
| Class D | -7.94% | -13.68% | -12.50% | -6.81% | -15.31% | -13.82% | 108% | 3133% |
| Class F | -4.36% | -8.60% | -7.33% | -5.40% | -11.14% | -11.46% | 122% | 1541% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -5.90% | -10.86% | -10.00% | -6.14% | -10.75% | -12.09% | 109% | 2903% |
| Class C | -6.03% | -11.92% | -9.96% | -6.73% | -10.60% | -8.78% | 103% | 3206% |
| Class E | -6.48% | -4.86% | -8.42% | -7.68% | -4.57% | -6.24% | 115% | 2892% |
| **Overall** | -6.09% | -9.71% | -9.59% | -6.72% | -9.16% | -9.52% | 109% | 2998% |
| Class D | -6.80% | -10.02% | -6.71% | -6.35% | -6.01% | -3.24% | 101% | 3098% |
| Class F | -3.61% | -6.13% | -5.18% | -5.59% | -7.08% | -8.54% | 113% | 1761% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -6.47% | -13.30% | -12.04% | -6.51% | -14.04% | -14.97% | 115% | 2838% |
| Class C | -6.45% | -14.40% | -12.76% | -6.93% | -14.41% | -13.72% | 106% | 3111% |
| Class E | -7.40% | -6.56% | -8.74% | -8.54% | -7.28% | -8.30% | 122% | 3165% |
| **Overall** | -6.70% | -11.98% | -11.45% | -7.16% | -12.47% | -12.89% | 113% | 3007% |
| Class D | -7.32% | -11.59% | -9.54% | -6.39% | -8.50% | -8.43% | 101% | 3186% |
| Class F | -3.86% | -7.62% | -5.46% | -5.49% | -10.41% | -11.80% | 118% | 1774% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -9.32% | -15.82% | -17.29% | -9.08% | -19.30% | -19.74% | 165% | 2617% |
| Class A2 | -7.74% | -15.36% | -11.33% | -8.26% | -16.09% | -11.47% | 164% | 2210% |
| Class B | -7.67% | -15.11% | -15.80% | -7.80% | -17.73% | -18.38% | 163% | 2206% |
| Class C | -7.79% | -13.37% | -13.30% | -7.99% | -16.94% | -17.03% | 150% | 1750% |
| Class E | -11.32% | -16.94% | -18.34% | -11.54% | -17.52% | -19.77% | 159% | 2514% |
| **Overall** | -8.59% | -15.19% | -15.17% | -8.76% | -17.51% | -17.39% | 160% | 2204% |
| Class D | -7.68% | -11.58% | -12.23% | -7.11% | -16.07% | -16.69% | 144% | 1566% |
| Class F | -5.54% | -9.46% | -8.35% | -5.99% | -12.65% | -12.64% | 133% | 1871% |

Note: Results from Interdigital, crosschecked by xxx.

**NNVC-14 VTM mode vs NVC-14 reduced-runtime1**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **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 | -8.01% | -12.69% | -13.98% | -7.89% | -14.85% | -16.32% | 71% | 2297% |
| Class A2 | -7.01% | -13.32% | -7.91% | -7.18% | -13.79% | -7.95% | 72% | 2227% |
| Class B | -6.62% | -14.65% | -13.22% | -6.90% | -17.00% | -16.07% | 72% | 3041% |
| Class C | -6.04% | -12.58% | -11.80% | -6.43% | -13.38% | -13.46% | 67% | 3205% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -6.82% | -13.44% | -11.93% | -7.03% | -14.96% | -13.80% | 70% | 2739% |
| Class D | -6.85% | -12.12% | -11.08% | -5.92% | -14.05% | -12.89% | 70% | 3149% |
| Class F | -3.22% | -7.29% | -5.73% | -4.43% | -9.99% | -10.11% | 90% | 1610% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **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 | -9.32% | -15.82% | -17.30% | -9.08% | -19.30% | -19.75% | 157% | 2622% |
| Class A2 | -7.74% | -15.36% | -11.34% | -8.26% | -16.10% | -11.47% | 161% | 2204% |
| Class B | -7.67% | -15.11% | -15.80% | -7.80% | -17.73% | -18.38% | 159% | 2194% |
| Class C | -7.80% | -13.37% | -13.31% | -8.00% | -16.95% | -17.04% | 150% | 1763% |
| Class E | -11.32% | -16.94% | -18.34% | -11.54% | -17.52% | -19.77% | 155% | 2442% |
| **Overall** | -8.59% | -15.19% | -15.18% | -8.76% | -17.51% | -17.39% | 156% | 2193% |
| Class D | -7.68% | -11.58% | -12.23% | -7.11% | -16.07% | -16.69% | 144% | 1590% |
| Class F | -5.54% | -9.46% | -8.35% | -6.00% | -12.65% | -12.65% | 134% | 1909% |

**NNVC-14 VTM mode vs NVC-14 reduced-runtime2**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **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 | -5.29% | -11.22% | -11.25% | -4.91% | -13.32% | -13.61% | 46% | 2275% |
| Class A2 | -4.44% | -11.84% | -6.09% | -4.37% | -12.07% | -5.90% | 47% | 2206% |
| Class B | -4.17% | -13.58% | -12.22% | -4.35% | -15.75% | -14.83% | 46% | 3028% |
| Class C | -4.19% | -11.73% | -10.72% | -4.17% | -12.16% | -11.91% | 42% | 3189% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -4.45% | -12.27% | -10.40% | -4.42% | -13.57% | -12.02% | 45% | 2722% |
| Class D | -5.56% | -11.76% | -10.49% | -4.23% | -13.59% | -11.55% | 41% | 3127% |
| Class F | 0.49% | -5.53% | -4.14% | -0.73% | -8.25% | -8.16% | 57% | 1623% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **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 | -6.91% | -14.51% | -16.38% | -6.90% | -18.38% | -19.21% | 81% | 2551% |
| Class A2 | -5.45% | -14.66% | -10.56% | -6.17% | -15.42% | -10.83% | 75% | 2126% |
| Class B | -5.01% | -14.43% | -15.02% | -5.48% | -17.07% | -17.71% | 61% | 2114% |
| Class C | -4.95% | -11.19% | -11.91% | -5.20% | -15.48% | -16.32% | 56% | 1655% |
| Class E | -7.88% | -15.72% | -17.06% | -8.38% | -16.47% | -18.69% | 56% | 2355% |
| **Overall** | -5.87% | -13.98% | -14.15% | -6.25% | -16.56% | -16.67% | 64% | 2105% |
| Class D | -5.20% | -8.48% | -10.32% | -4.46% | -14.14% | -15.47% | 53% | 1508% |
| Class F | -1.14% | -8.29% | -7.10% | -1.78% | -11.56% | -11.28% | 54% | 1840% |

**NNVC-14 VTM mode vs NVC-14 reduced-runtime3**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **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 | 0.10% | -4.68% | -4.11% | 1.10% | -6.25% | -6.81% | 26% | 2425% |
| Class A2 | 2.67% | -3.82% | 3.10% | 3.69% | -4.01% | 3.55% | 27% | 2321% |
| Class B | 0.23% | -6.45% | -4.53% | 0.64% | -9.27% | -7.77% | 26% | 3084% |
| Class C | -0.93% | -6.57% | -4.75% | -0.77% | -7.46% | -5.96% | 23% | 3201% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | 0.38% | -5.60% | -2.98% | 0.97% | -7.13% | -4.83% | 26% | 2805% |
| Class D | -3.16% | -7.41% | -5.39% | -1.91% | -9.44% | -7.39% | 23% | 3122% |
| Class F | 4.15% | 0.28% | 2.45% | 2.81% | -3.24% | -3.03% | 36% | 1692% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **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 | -6.71% | -11.43% | -13.80% | -6.73% | -15.35% | -17.60% | 63% | 2542% |
| Class A2 | -5.18% | -11.29% | -7.75% | -6.03% | -12.49% | -8.11% | 52% | 2120% |
| Class B | -4.81% | -11.73% | -11.36% | -5.32% | -14.63% | -14.51% | 49% | 2109% |
| Class C | -4.72% | -7.90% | -7.69% | -5.04% | -12.93% | -12.87% | 41% | 1664% |
| Class E | -7.66% | -14.28% | -14.01% | -8.16% | -15.10% | -15.83% | 46% | 2361% |
| **Overall** | -5.64% | -11.18% | -10.79% | -6.08% | -14.10% | -13.81% | 49% | 2105% |
| Class D | -5.21% | -5.81% | -7.32% | -4.57% | -11.91% | -12.81% | 38% | 1507% |
| Class F | -2.23% | -6.12% | -4.09% | -3.17% | -10.53% | -9.57% | 39% | 1839% |

**NNVC-14.0 VTM mode vs NNVC-14.0 HOP.5**

**Anchor**: NNVC in VTM mode.

**Test**: NNLF HOP5 + NNIP.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -15.53% | -13.87% | -21.64% | -17.14% | -19.25% | -23.78% | 388% | 108236% |
| Class A2 | -15.05% | -20.80% | -26.89% | -14.34% | -20.07% | -23.88% | 352% | 95863% |
| Class B | -12.91% | -24.46% | -17.47% | -11.62% | -22.83% | -16.86% | 364% | 130086% |
| Class C | -13.69% | -17.83% | -17.25% | -12.17% | -14.96% | -14.32% | 274% | 130180% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -14.07% | -19.84% | -20.13% | -13.42% | -19.46% | -18.97% | 340% | 117985% |
| Class D | -14.51% | -18.02% | -17.88% | -10.74% | -13.01% | -12.24% | 252% | 132762% |
| Class F | -8.95% | -11.38% | -10.73% | -9.18% | -12.10% | -11.14% | 521% | 66119% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -9.69% | -12.14% | -6.10% | -8.85% | -9.20% | -3.21% | 352% | 123537% |
| Class C | -11.44% | -9.53% | -6.80% | -10.13% | -3.89% | -1.06% | 264% | 133154% |
| Class E | -10.17% | -11.01% | -6.26% | -9.51% | -11.40% | -5.28% | 742% | 113394% |
| **Overall** | -10.40% | -10.99% | -6.37% | -9.44% | -7.98% | -3.01% | 385% | 123979% |
| Class D | -12.63% | -7.30% | -0.62% | -9.94% | 1.90% | 13.67% | 242% | 128697% |
| Class F | -8.84% | -9.84% | -8.70% | -9.60% | -11.08% | -8.80% | 520% | 77947% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -10.89% | -15.13% | -8.90% | -9.89% | -12.30% | -5.92% | 469% | 122040% |
| Class C | -12.41% | -11.74% | -10.29% | -10.72% | -6.08% | -4.37% | 330% | 128334% |
| Class E | -11.18% | -11.14% | -5.88% | -10.52% | -11.92% | -4.51% | 1015% | 122535% |
| **Overall** | -11.47% | -13.00% | -8.61% | -10.32% | -10.13% | -5.05% | 506% | 124229% |
| Class D | -13.80% | -11.49% | -4.14% | -11.02% | -3.04% | 11.42% | 292% | 131792% |
| Class F | -9.63% | -11.73% | -10.41% | -10.37% | -13.35% | -11.39% | 638% | 77712% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -12.88% | -10.05% | -17.45% | -14.41% | -16.24% | -20.05% | 411% | 110327% |
| Class A2 | -12.95% | -17.02% | -20.64% | -13.73% | -18.12% | -17.78% | 284% | 86418% |
| Class B | -11.41% | -16.49% | -13.84% | -11.14% | -16.79% | -14.46% | 261% | 82910% |
| Class C | -12.56% | -13.64% | -15.46% | -11.89% | -13.61% | -15.18% | 199% | 58776% |
| Class E | -16.18% | -19.94% | -18.98% | -15.64% | -18.81% | -19.54% | 279% | 99486% |
| **Overall** | -12.96% | -15.45% | -16.79% | -13.04% | -16.55% | -16.95% | 272% | 83613% |
| Class D | -11.68% | -11.95% | -15.27% | -10.08% | -11.78% | -14.64% | 182% | 52002% |
| Class F | -9.64% | -11.73% | -9.09% | -9.32% | -11.98% | -10.21% | 184% | 73454% |

Note: Results from Interdigital, crosschecked by xxx.

**NNVC 14 VTM mode vs NNVC 14 HOP5+DRF**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **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 | -16.37% | -14.26% | -21.96% | -18.25% | -20.17% | -24.63% | 432% | 160427% |
| Class A2 | -16.62% | -21.67% | -27.30% | -16.52% | -21.69% | -25.14% | 390% | 142191% |
| Class B | -14.21% | -24.92% | -17.78% | -13.45% | -24.11% | -18.27% | 408% | 202265% |
| Class C | -15.99% | -18.97% | -18.47% | -15.66% | -17.68% | -17.22% | 304% | 202655% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -15.60% | -20.55% | -20.70% | -15.61% | -21.12% | -20.64% | 378% | 180055% |
| Class D | -16.43% | -17.66% | -17.55% | -13.77% | -15.35% | -14.83% | 281% | 192075% |
| Class F | -9.72% | -11.77% | -10.79% | -10.48% | -13.06% | -12.03% | 604% | 191335% |

**NNVC-14.0 VTM mode vs NNVC-14.0 VLOP**

**Anchor**: NNVC in VTM mode.

**Test**: NNLF VLOP4 + NNIP.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -7.86% | -7.33% | -6.00% | -9.05% | -8.85% | -7.10% | 114% | 1197% |
| Class A2 | -6.21% | -7.35% | -4.75% | -6.84% | -8.31% | -4.86% | 113% | 1099% |
| Class B | -5.68% | -8.06% | -6.66% | -6.45% | -9.46% | -8.32% | 114% | 1500% |
| Class C | -5.10% | -7.12% | -6.21% | -6.03% | -8.74% | -7.53% | 112% | 1608% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -6.07% | -7.52% | -6.03% | -6.94% | -8.91% | -7.17% | 113% | 1373% |
| Class D | -5.05% | -5.83% | -5.26% | -5.38% | -7.63% | -7.39% | 109% | 1563% |
| Class F | -3.03% | -3.82% | -3.89% | -4.05% | -5.53% | -5.67% | 117% | 839% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -3.97% | -7.94% | -2.95% | -5.03% | -11.17% | -9.68% | 106% | 1466% |
| Class C | -3.49% | -7.06% | -4.55% | -5.29% | -10.79% | -8.58% | 102% | 1594% |
| Class E | -4.35% | -5.72% | -2.68% | -6.50% | -8.27% | -4.74% | 107% | 1757% |
| **Overall** | -3.90% | -7.09% | -3.42% | -5.49% | -10.32% | -8.08% | 105% | 1578% |
| Class D | -3.95% | -4.79% | -1.90% | -5.26% | -10.71% | -7.71% | 101% | 1503% |
| Class F | -1.80% | -2.44% | -0.91% | -3.41% | -4.96% | -3.91% | 107% | 945% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -4.29% | -8.94% | -3.47% | -5.17% | -11.74% | -11.05% | 110% | 1421% |
| Class C | -3.90% | -7.79% | -4.94% | -5.38% | -11.77% | -8.36% | 104% | 1546% |
| Class E | -5.11% | -5.65% | -0.92% | -7.31% | -8.37% | -3.61% | 110% | 1880% |
| **Overall** | -4.37% | -7.73% | -3.32% | -5.77% | -10.91% | -8.29% | 108% | 1568% |
| Class D | -4.38% | -5.77% | -2.06% | -5.08% | -11.32% | -7.77% | 101% | 1565% |
| Class F | -2.08% | -2.52% | -1.21% | -3.73% | -6.40% | -6.86% | 110% | 910% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -8.16% | -9.18% | -8.86% | -8.68% | -11.78% | -9.92% | 161% | 1391% |
| Class A2 | -6.61% | -8.95% | -7.11% | -7.09% | -9.62% | -6.78% | 162% | 1246% |
| Class B | -6.39% | -8.65% | -8.77% | -6.66% | -10.33% | -10.01% | 161% | 1272% |
| Class C | -6.09% | -7.77% | -7.35% | -6.62% | -10.24% | -9.12% | 150% | 1085% |
| Class E | -9.32% | -10.60% | -11.23% | -9.87% | -10.83% | -10.86% | 157% | 1417% |
| **Overall** | -7.14% | -8.92% | -8.60% | -7.59% | -10.52% | -9.40% | 158% | 1265% |
| Class D | -5.97% | -6.23% | -6.79% | -5.91% | -9.04% | -9.13% | 144% | 990% |
| Class F | -4.26% | -5.00% | -4.83% | -4.76% | -6.27% | -6.63% | 133% | 1029% |

Note: Results from Interdigital, crosschecked by xxx.

**NNVC-14.0 VTM mode vs NNVC-14.0 CALOP**

**Anchor**: NNVC in VTM mode.

**Test**: NNLF CALOP4 + NNIP.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-v14-VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -10.05% | -12.79% | -18.48% | -12.08% | -14.43% | -18.25% | 273% | 2231% |
| Class A2 | -9.54% | -11.90% | -12.32% | -11.77% | -19.38% | -16.18% | 228% | 1981% |
| Class B | -8.56% | -20.62% | -19.18% | -6.08% | -21.47% | -20.10% | 237% | 2739% |
| Class C | -6.95% | -14.56% | -14.13% | -7.14% | -16.74% | -16.43% | 224% | 2927% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -8.63% | -15.69% | -16.32% | -8.70% | -18.38% | -17.97% | 239% | 2508% |
| Class D | -7.03% | -13.26% | -12.46% | -6.83% | -14.86% | -14.24% | 217% | 2260% |
| Class F | -3.85% | -8.68% | -7.87% | -4.73% | -10.87% | -11.50% | 252% | 1643% |

Note: Results from Nokia, crosschecked by xxx.

***Comparison to NNVC-14 anchor***

**NNVC-13 anchor vs NNVC-14.0 anchor**

**Anchor**: NNLF LOP6 + NNIP (NNVC 13)

**Test**: NNLF LOP6 + NNIP (NNVC 14)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC 13** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | 0.22% | 0.15% | 0.07% | 0.22% | -0.03% | -0.15% | 70% | 93% |
| Class A2 | 0.11% | 0.19% | 0.34% | -0.04% | 0.13% | 0.29% | 73% | 93% |
| Class B | 0.16% | 0.23% | 0.10% | 0.07% | 0.30% | 0.07% | 73% | 93% |
| Class C | -0.17% | 0.12% | 0.01% | 0.08% | 0.46% | -0.09% | 73% | 95% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | 0.07% | 0.18% | 0.12% | 0.08% | 0.24% | 0.03% | 72% | 94% |
| Class D | -0.50% | -0.41% | -0.20% | -0.15% | 0.53% | 0.59% | 78% | 95% |
| Class F | 0.44% | 0.53% | 0.58% | 0.31% | 0.76% | 0.29% | 74% | 94% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC 13** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | 0.10% | 0.10% | 0.31% | -0.04% | -0.22% | -0.16% | 72% | 93% |
| Class C | -0.05% | 0.03% | 0.53% | -0.04% | 0.05% | 1.07% | 74% | 95% |
| Class E | -0.08% | -0.07% | -0.09% | -0.23% | 0.16% | -0.46% | 73% | 92% |
| **Overall** | 0.00% | 0.04% | 0.29% | -0.09% | -0.04% | 0.17% | 73% | 93% |
| Class D | -0.06% | -0.26% | 0.24% | 0.09% | 1.21% | -0.67% | 80% | 96% |
| Class F | 0.42% | 0.66% | 0.76% | 0.21% | 1.19% | 0.93% | 74% | 94% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | |
|  | **BD-rate Over NNVC 13** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | 0.16% | 0.63% | 0.73% | 0.09% | 0.52% | 0.77% | 68% | 94% |
| Class C | 0.03% | 0.49% | 0.64% | -0.04% | 0.51% | 1.08% | 72% | 96% |
| Class E | -0.08% | 0.22% | 1.13% | -0.19% | 0.34% | 1.15% | 71% | 93% |
| **Overall** | 0.06% | 0.48% | 0.80% | -0.02% | 0.47% | 0.97% | 70% | 94% |
| Class D | 0.00% | 0.42% | 0.54% | 0.20% | 1.10% | 0.48% | 77% | 97% |
| Class F | 0.48% | 1.04% | 1.17% | 0.73% | 1.35% | 1.31% | 73% | 94% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC 13** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -0.03% | -0.29% | -0.08% | 0.00% | -0.28% | -0.10% | 82% | 94% |
| Class A2 | 0.01% | -0.01% | 0.14% | 0.02% | -0.11% | 0.09% | 85% | 95% |
| Class B | 0.02% | 0.06% | 0.16% | 0.03% | 0.13% | 0.08% | 86% | 96% |
| Class C | 0.12% | 0.13% | 0.23% | 0.20% | 0.25% | 0.34% | 88% | 96% |
| Class E | 0.18% | 0.23% | 0.04% | 0.24% | 0.12% | 0.00% | 84% | 95% |
| **Overall** | 0.06% | 0.03% | 0.11% | 0.10% | 0.05% | 0.10% | 86% | 96% |
| Class D | 0.20% | 0.25% | 0.29% | 0.30% | 0.25% | 0.90% | 90% | 97% |
| Class F | 0.17% | 0.23% | 0.12% | 0.22% | 0.42% | 0.52% | 85% | 96% |

Note: Results from InterDigital, crosschecked by xxx.

**NNVC-14 anchor vs NNVC-14.0 VLOP**

**Anchor**: NNLF LOP6 + NNIP

**Test**: NNLF VLOP4 + NNIP

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | 1.23% | 7.97% | 11.02% | -0.25% | 9.07% | 12.83% | 97% | 53% |
| Class A2 | 2.30% | 9.60% | 5.48% | 1.73% | 9.19% | 5.30% | 97% | 50% |
| Class B | 2.22% | 9.65% | 9.59% | 1.46% | 11.24% | 11.56% | 97% | 51% |
| Class C | 2.53% | 8.59% | 8.88% | 1.72% | 7.67% | 9.35% | 99% | 52% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | 2.12% | 9.02% | 8.86% | 1.24% | 9.45% | 9.97% | 98% | 51% |
| Class D | 3.16% | 9.18% | 8.52% | 1.54% | 9.39% | 7.81% | 100% | 50% |
| Class F | 1.43% | 5.50% | 3.92% | 1.44% | 6.79% | 6.97% | 96% | 54% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | 2.07% | 3.39% | 7.85% | 1.19% | -0.44% | 2.94% | 97% | 51% |
| Class C | 2.72% | 5.61% | 6.26% | 1.56% | -0.13% | 0.70% | 99% | 50% |
| Class E | 2.28% | -0.72% | 6.34% | 1.28% | -3.52% | 2.06% | 93% | 61% |
| **Overall** | 2.34% | 3.10% | 6.94% | 1.34% | -1.11% | 1.97% | 97% | 53% |
| Class D | 3.07% | 5.98% | 5.36% | 1.18% | -2.96% | -3.06% | 100% | 49% |
| Class F | 1.90% | 3.99% | 4.49% | 2.34% | 2.35% | 5.22% | 95% | 54% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | 2.35% | 5.17% | 9.71% | 1.45% | 2.73% | 4.84% | 96% | 50% |
| Class C | 2.74% | 7.74% | 9.16% | 1.68% | 3.14% | 6.41% | 98% | 50% |
| Class E | 2.47% | 1.06% | 8.61% | 1.34% | -1.00% | 5.26% | 91% | 59% |
| **Overall** | 2.51% | 5.00% | 9.26% | 1.50% | 1.93% | 5.47% | 95% | 52% |
| Class D | 3.17% | 6.96% | 8.41% | 1.41% | -0.90% | 2.03% | 99% | 49% |
| Class F | 1.88% | 5.62% | 4.55% | 1.89% | 4.74% | 5.67% | 94% | 51% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | 1.31% | 8.44% | 10.47% | 0.45% | 10.20% | 12.54% | 98% | 53% |
| Class A2 | 1.24% | 8.14% | 5.01% | 1.27% | 8.35% | 5.46% | 99% | 56% |
| Class B | 1.40% | 7.84% | 8.50% | 1.23% | 9.43% | 10.48% | 99% | 58% |
| Class C | 1.86% | 6.78% | 7.14% | 1.49% | 8.72% | 10.04% | 100% | 62% |
| Class E | 2.27% | 7.85% | 9.08% | 1.85% | 8.48% | 11.40% | 99% | 56% |
| **Overall** | 1.61% | 7.75% | 8.04% | 1.27% | 9.06% | 10.04% | 99% | 57% |
| Class D | 1.86% | 6.34% | 6.62% | 1.29% | 8.77% | 9.61% | 100% | 63% |
| Class F | 1.39% | 5.20% | 4.01% | 1.31% | 7.79% | 7.26% | 100% | 55% |

Note: Results from InterDigital, crosschecked by xxx.

**NNVC-14 anchor vs NNVC-14.0 HOP**

**Anchor**: NNLF LOP6 + NNIP

**Test**: NNLF HOP5 + NNIP

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -7.18% | -0.31% | -7.66% | -9.12% | -4.37% | -7.82% | 332% | 4780% |
| Class A2 | -7.34% | -6.68% | -19.04% | -6.42% | -5.28% | -15.93% | 303% | 4363% |
| Class B | -5.66% | -10.48% | -3.42% | -4.14% | -6.02% | 0.88% | 311% | 4387% |
| Class C | -6.77% | -4.05% | -4.08% | -4.91% | 0.06% | 1.20% | 241% | 4196% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -6.60% | -5.97% | -7.57% | -5.80% | -3.92% | -4.14% | 293% | 4405% |
| Class D | -7.16% | -5.11% | -6.32% | -4.20% | 2.93% | 1.80% | 232% | 4237% |
| Class F | -4.89% | -3.07% | -3.57% | -4.03% | -1.03% | 0.65% | 427% | 4291% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -4.04% | -1.41% | 4.14% | -2.90% | 1.73% | 9.75% | 323% | 4255% |
| Class C | -5.77% | 2.78% | 3.51% | -3.67% | 7.75% | 8.50% | 255% | 4153% |
| Class E | -3.94% | -6.23% | 2.22% | -1.92% | -7.04% | 1.16% | 646% | 3921% |
| **Overall** | -4.59% | -1.22% | 3.45% | -2.91% | 1.54% | 7.19% | 355% | 4136% |
| Class D | -6.26% | 2.61% | 6.79% | -3.83% | 8.87% | 18.16% | 241% | 4155% |
| Class F | -5.46% | -3.88% | -3.78% | -4.25% | -4.27% | -0.32% | 459% | 4426% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -4.74% | -2.05% | 3.31% | -3.62% | 1.92% | 10.14% | 409% | 4301% |
| Class C | -6.39% | 3.09% | 2.72% | -4.07% | 9.63% | 10.55% | 311% | 4125% |
| Class E | -4.08% | -4.73% | 3.16% | -2.13% | -4.98% | 4.32% | 835% | 3872% |
| **Overall** | -5.13% | -1.01% | 3.08% | -3.40% | 2.76% | 8.82% | 446% | 4131% |
| Class D | -7.00% | -0.02% | 5.80% | -4.94% | 6.37% | 21.29% | 288% | 4136% |
| Class F | -6.06% | -4.35% | -5.15% | -5.17% | -3.15% | 0.49% | 541% | 4380% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -3.90% | 6.91% | 0.02% | -5.82% | 4.15% | -0.24% | 250% | 4215% |
| Class A2 | -5.68% | -1.06% | -10.21% | -5.93% | -1.34% | -6.83% | 174% | 3910% |
| Class B | -4.11% | -1.36% | 2.50% | -3.62% | 1.33% | 5.06% | 160% | 3758% |
| Class C | -5.23% | -0.16% | -2.47% | -4.24% | 4.37% | 2.47% | 133% | 3358% |
| Class E | -5.52% | -3.58% | -0.70% | -4.57% | -1.47% | 0.38% | 176% | 3957% |
| **Overall** | -4.82% | -0.04% | -1.67% | -4.67% | 1.56% | 0.84% | 170% | 3793% |
| Class D | -4.36% | -0.34% | -3.72% | -3.22% | 5.48% | 2.14% | 127% | 3322% |
| Class F | -4.44% | -2.50% | -0.75% | -3.53% | 0.83% | 3.13% | 138% | 3926% |

Note: Results from InterDigital, crosschecked by xxx.

**NNVC-14.0 vs NNVC-14.0 RPR**

**Anchor**: NNLF LOP6 + NNIP

**Test**: NNLF LOP6 + NNIP + RPR multi-ratio

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -1.57% | 1.80% | 1.26% | -4.43% | -3.73% | -3.80% | 90% | 72% |
| Class A2 | -1.13% | 4.69% | 3.60% | -2.63% | -2.14% | -1.90% | 93% | 83% |
| Class B | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class C | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -0.54% | 1.30% | 0.97% | -1.41% | -1.17% | -1.14% | 96% | 90% |
| Class D | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class F | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -1.45% | 5.46% | 5.96% | -2.10% | -1.93% | -1.49% | 108% | 57% |
| Class A2 | -1.42% | 14.91% | 14.54% | -10.14% | -8.54% | -8.53% | 84% | 49% |
| Class B | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class C | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class E | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| **Overall** | -0.48% | 3.40% | 3.42% | -2.04% | -1.74% | -1.67% | 98% | 81% |
| Class D | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class F | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |

Note: Results from Interdigital, crosschecked by xxx.

**NNVC-14 RPR anchor vs NNVC-14.0 NNSR**

**Anchor**: NNLF LOP6 + NNIP + RPR multi-ratio

**Test**: NNLF LOP6 + NNIP + NNSR multi-ratio

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14 RPR** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -0.17% | 0.37% | 0.54% | 0.00% | 0.00% | 0.00% | 104% | 100% |
| Class A2 | -0.07% | -0.59% | -0.32% | 0.00% | 0.00% | 0.00% | 102% | 100% |
| Class B | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class C | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -0.05% | -0.04% | 0.04% | 0.00% | 0.00% | 0.00% | 101% | 100% |
| Class D | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class F | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14 RPR** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -0.33% | 0.92% | 0.06% | 0.00% | 0.00% | 0.00% | 104% | 100% |
| Class A2 | -1.92% | -2.89% | -2.67% | 0.00% | 0.00% | 0.00% | 103% | 100% |
| Class B | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class C | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class E | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| **Overall** | -0.38% | -0.33% | -0.43% | 0.00% | 0.00% | 0.00% | 101% | 100% |
| Class D | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class F | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100% | 100% |

Note: Results from InterDigital, crosschecked by xxx.

**NNVC-14 anchor vs NNVC-14.0 DRF**

**Anchor**: NNLF LOP6 + NNIP

**Test**: NNLF LOP6 + NNIP + DRF

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC 14** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -1.00% | -0.82% | -0.60% | -1.32% | -1.77% | -1.56% | 155% | 2275% |
| Class A2 | -1.98% | -1.14% | -1.05% | -2.63% | -2.29% | -2.09% | 145% | 2105% |
| Class B | -1.58% | -0.83% | -0.05% | -2.11% | -1.99% | -1.69% | 151% | 2409% |
| Class C | -2.96% | -1.87% | -1.71% | -4.09% | -3.62% | -3.68% | 133% | 2176% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -1.91% | -1.17% | -0.81% | -2.58% | -2.44% | -2.27% | 145% | 2256% |
| Class D | -3.01% | 0.25% | 0.51% | -3.57% | -2.79% | -3.12% | 130% | 2040% |
| Class F | -0.89% | -0.65% | -0.27% | -1.44% | -1.30% | -1.00% | 183% | 6383% |

Note: Results from InterDigital, crosschecked by xxx.

1. **Contributions**

We have 10 contributions for AhG14 and 1 telco report.

|  |  |  |
| --- | --- | --- |
| JVET-AN0014 | 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) |
| JVET-AN0042 | [AHG11] [AHG14] Teleconference on NNVC | E. Alshina, F. Galpin |
| JVET-AN0054 | AHG14: Extension of the QP range for TDO Lambda in NNVC S/W | H. Kwon, H. Ko (Hanyang Univ.), D. Kim, S.-C. Lim (ETRI) |
| JVET-AN0128 | AhG14: Improvement of SIMD implementation with expanded SIMD operators in SADL for LOP with Overlapped Feature Integration | J. Chi, A. Li, Y. Du, C. Zhu, L. Luo, H. Guo (UESTC), Y. Huo, Y. Liu, Z. Zhang (Transsion) |
| JVET-AN0196 | AHG14: Operator Improvements in the SADL library | W. Zhang, N. Fu, L. Qin, X. Chen, Z. Chen (Wuhan Univ.) |
| JVET-AN0197 | AHG14: The extension of SADL library | L. Qin, W. Zhang, N. Fu, Z. Chen (Wuhan Univ.) |
| JVET-AN0202 | [AHG11/AHG14] Comparison of Multi-Layer and Single-Layer Interfaces for Hybrid End-to-End Video Coding Frameworks | N. Zou, A. Hallapuro, F. Cricri, H. Zhang, A. B. Koyuncu, J. Ahonen, M. M. Hannuksela (Nokia) |
| JVET-AN0209 | AhG 11/AHG 14: Harmonization of Deep Reference Frame (DRF) with RPR in NNVC14.1 | N. Bhaskar, T. Solovyev, E. Alshina (Huawei) |
| JVET-AN0213 | AhG14: SADL update | F. Galpin (InterDigital) |
| JVET-AN0222 | [AHG14] New NN elements for SADL | A. Karabutov, E. Alshina (Huawei) |
| JVET-AN0225 | [AHG11][AHG14]: Further Improvements on Hybrid Multilayer Framework for End-to-End Learned Intra Frame | M. Aderdor, T. Solovyev, E. Alshina (Huawei) |
| [JVET-AN0216](https://www.jvet-experts.org/doc_end_user/current_document.php?id=16200) | [AHG11] Update on Multilayer framework for supporting a hybrid codec using End-to-End Learned Image Codec and Conventional Video Codec | [F. Urban, Y. Chen, F. Galpin, P. de Lagrange (InterDigital)](mailto:fabrice.urban@interdigital.com) |

1. **Configurations**

The following configurations are 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.6 | encoder\_xxx\_nnvc.cfg |
| NNVC. HOP | Intra Pred + HOP.5 | encoder\_xxx\_nnvc.cfg + nn-based/HOP5.cfg |
| NNVC. VLOP | Intra Pred + VLOP.4 | encoder\_xxx\_vtm.cfg + nn-based/vlop4.cfg |
| NNSR | Super-resolution | nn-based/nnsr.cfg + nn-based/nnsr\_classA\_multiratio.cfg |
| RPR | Anchor RPR | nn-based/rpr.cfg + nn-based/nnsr\_classA\_multiratio.cfg |
| NNPF | Adaptive post-filters | nn-based/nnpf/nnpf\_xxx.cfg |
| CALOP | Intra pred+adaptive LOP | encoder\_randomaccess\_nnvc.cfg+nn-based/intra.cfg+nn-based/calop.cfg |
| NNVC DRF | NNVC anchor + DRF | encoder\_xxx\_nnvc.cfg + drf.cfg |

1. **Recommendations**

The AHG recommends:

* Review all input contributions.
* Keep synchronized with VTM upstream
* Merge the NNVC\_cfe branch into NNVC branch
* Continue to develop NNVC software.
* Continue to develop hybrid end-to-end framework.
* 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.

It was commented that rather than integrating the complete cfe branch (related to submission JVET-AN0212) the normal process should be followed, i.e. making decision on the single elements (for which contributions exist), and potentially investigate in EE.

[JVET-AN0015](https://jvet-experts.org/doc_end_user/current_document.php?id=16267) JVET AHG report: Gaming content compression (AHG15) [S. Puri, J. Sauer (co-chairs), R. Chernyak, A. Duenas, L. Wang, V. Zakharchenko (vice chairs)]

1. **Software repositories**

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-11.0ecm17.0 vs ECM-17.0***

**SDR**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | |
|  | **Over Anchor** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class G1 | -11.9% | -24.8% | -19.6% | 1015% | 589% | #DIV/0! |
| Class G2 | -18.9% | -23.6% | -27.8% | 1201% | 765% | #DIV/0! |
| **Overall** | -15.0% | -24.3% | -23.2% | 1094% | 662% | #DIV/0! |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access Main 10** | | | | | |
|  | **Over Anchor** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class G1 | -27.9% | -46.1% | -37.2% | 778% | 1278% | #DIV/0! |
| Class G2 | -25.4% | -36.9% | -37.7% | 960% | 1409% | #DIV/0! |
| **Overall** | -26.8% | -42.0% | -37.4% | 854% | 1335% | #DIV/0! |

\* ECM decoder crashed for BaoleiYard in RA.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay B Main 10** | | | | | |
|  | **Over Anchor** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class G1 | -21.2% | -54.7% | -43.7% | 990% | 1501% | #DIV/0! |
| Class G2 | -18.8% | -50.5% | -49.4% | 942% | 1395% | #DIV/0! |
| **Overall** | -20.3% | -53.1% | -45.8% | 972% | 1460% | #DIV/0! |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay P Main 10** | | | | | |
|  | **Over Anchor** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class G1 | -19.6% | -60.3% | -51.0% | 819% | 1166% | #DIV/0! |
| Class G2 | -16.6% | -57.3% | -57.0% | 978% | 1417% | #DIV/0! |
| **Overall** | -18.5% | -59.2% | -53.2% | 875% | 1254% | #DIV/0! |

**HDR**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra** | | | | | | | | | |
|  | **Over VTM-11ecm18.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class G3 | -36.9% | -17.3% |  |  |  | -15.6% | -58.0% | -55.4% | 1088% | 655% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access** | | | | | | | | | |
|  | **Over VTM-11ecm18.0** | | | | | | | | | |
|  |  |  | **wPSNR** |  |  | **PSNR** |  |  |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class G3 | -53.7% | -32.9% |  |  |  | -33.9% | -71.8% | -70.6% | 872% | 1666% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Low Delay B** | | | | | | | | | |
|  | **Over VTM-11ecm18.0** | | | | | | | | | |
|  |  |  | **wPSNR** |  |  | **PSNR** |  |  |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class G3 | -50.6% | -27.8% |  |  |  | -26.0% | -75.6% | -72.9% | 883% | 1710% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **Low Delay P** | | | | | | | | | |
|  | **Over VTM-11ecm18.0** | | | | | | | | | |
|  |  |  | **wPSNR** |  |  | **PSNR** |  |  |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class G3 | -50.5% | -27.1% |  |  |  | -25.5% | -76.0% | -72.2% | 828% | 1366% |

Weighted PSNR metrics were not collected.

1. **Input contributions**

Four contributions listed below have been identified relating to the mandates of AHG15.

|  |  |  |
| --- | --- | --- |
| **Report** | | |
| [JVET-AN0053](https://jvet-experts.org/doc_end_user/current_document.php?id=16037) | AHG4/AHG15/AHG17: 4K gaming sequences featuring “Black Myth: Wukong” | [J. Sauer](mailto:johannes.sauer@huawei.com), [Y. Zhao](mailto:yin.zhao@huawei.com), Y. Sun, J. Zhou, E. Alshina (Huawei) |
| [JVET-AN0174](https://jvet-experts.org/doc_end_user/current_document.php?id=16158) | AHG15: Compression of gaming content using auxiliary data | [J. Sauer](mailto:johannes.sauer@huawei.com), Z. Li (Huawei) |
| [JVET-AN0263](https://jvet-experts.org/doc_end_user/current_document.php?id=16248) | AHG15: Transformer based depthmaps reconstruction for gaming content | [V. Zakharchenko (Nokia)](mailto:vlad.zakharchenko@nokia.com) |

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-AN0016](https://jvet-experts.org/doc_end_user/current_document.php?id=16268) JVET AHG report: Generative face video compression (AHG16) [Y. Ye (chair), H.-B. Teo, Z. Lyu, S. McCarthy, S. Wang (vice chairs)]

1. **Activities**

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>. No changes were made to the AHG16 software during this ad hoc period. Merge requests to add support for GFV and GFVE SEI messages to HEVC and AVC (as in JVET-AL0148) were submitted to HM and JM software before the 39th meeting, and are currently pending integration. At this meeting, one contribution on color calibration post-processing has been received.

Regarding coordination with AHG9 to develop the generative face video SEI messages, at this meeting, two contributions related to editorial improvements and bug fixes have been received.

1. **Related contributions**

The following input contribution to this meeting is related to the activities of AHG16:

* [JVET-AN0057](https://jvet-experts.org/doc_end_user/current_document.php?id=16041), AHG16: Colour calibration post-processing for generative face video coding [S. Yin, Z. Zhang, S. Wang (CityUHK), B. Chen, R.-L. Liao, J. Chen, Y. Ye (Alibaba)]

Additionally, the following input contribution is related to the high-level syntax aspects of the generative face video SEI messages:

* [JVET-AN0141](https://jvet-experts.org/doc_end_user/current_document.php?id=16125), AHG9: On the generative face video SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]
* [JVET-AN01](https://jvet-experts.org/doc_end_user/current_document.php?id=16140)56, AHG9: Text fixes and cleanup for GFV and GFE SEI messages [J. Chen, Y. Ye, B. Chen (Alibaba)]

1. **Recommendations**

The AHG recommends to:

* Review related contributions.

[JVET-AN0017](https://jvet-experts.org/doc_end_user/current_document.php?id=16269) JVET AHG report: Testing of video coding technology beyond CTC (AHG17) [J.-R. Ohm, M. Wien, F. Bossen (co-chairs), M. Abdoli, E. Alshina, V. Baroncini, J. Chen, R. Chernyak, Z. Deng, P. de Lagrange, L. Li, P. Nikitin, D. Rusanovskyy (vice chairs)]

1. **Activities**

The draft CfE document JVET-AM2026 was finalized and uploaded to the JVET document site. The test sequences for all categories defined in the CfE document were collected in a dedicated folder on the JVET content server.

Four online AHG calls were held on 2025-07-29, 2025-08-21, 2025-09-11, and 2025-09-29, respectively. The reports of these meetings are available in JVET-AN0041.

1. ***Preparation of bitstreams according to the CfE conditions***

The categories of the draft CfE include:

* **SDR RA UHD/4K**: Representing the use case of distribution of standard dynamic range UHD/4K video content e.g. in a streaming scenario, using a random-access configuration.
* **SDR RA HD**: Representing the use case of distribution of standard dynamic range HD video content e.g. in a streaming scenario, using a random-access configuration.
* **SDR LB HD**: Representing the use case of conversational and other low delay applications at HD resolution, correspondingly using a low-delay configuration.
* **HDR RA 4K**: Representing the use case of distribution of high dynamic range UHD/4K video content e.g. in a streaming scenario, using a random-access configuration.
* **HDR RA Cropped 8K**: Representing the use case of distribution of high dynamic range 8K video content e.g. in a streaming scenario, using a random-access configuration. In order to reduce the encoding workload for assessment of this category and allow investigation on 4K displays, cropped regions of 3840×2160 resolution are used.
* **Gaming LB HD**: Representing the use case of online gaming with a low-delay configuration.
* **UGC RA**: Representing the use case of user generated content at 1080×1920 or 1920x1080 resolution using a random-access configuration.

For all categories, test sequences and corresponding target rates are specified in JVET-AM2026. VTM anchor bitstreams as well as ECM bitstreams matching the target bitrates for study of improved compression performance were generated. Furthermore, for the study of reduced complexity encoding, bitstreams for the following encoder configurations were generated:

* **VTM RT1:** VTM with reduced runtime setting at about 65% of the runtime of the default VTM configuration;
* **VTM RT2:** VTM with reduced runtime setting at about 50% of the runtime of the default VTM configuration;
* **VTM RT3:** VTM with reduced runtime setting at about 25% of the runtime of the default VTM configuration;
* **ECM 2x:** ECM with a reduced runtime setting at about a factor of 2 of the runtime of the default VTM configuration.
* **ECM 5x**: ECM with a reduced runtime setting at about a factor of 5 of the runtime of the default VTM configuration.

1. ***Planning for on-site viewing sessions***

For conduction of the viewing tests, the AHG recommended all proposals submitted for the compression efficiency test case (CP) to be evaluated. For the runtime test case (RT), a selected subset was recommended in the last AHG. With this selection, 686 test points (“processed video sequences”, PVS) are to be evaluated for the CP case and 1088 test points are to be evaluated for the RT case.

A test including 12 test sessions for CP and 21 test sessions for RT was designed. The sessions separate PVS in HDR PQ, HDR HLG, SDR UHD, and SDR HD 50/60fps for smooth playout purposes. The suggested allocation of the test efforts is as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CP** | **Start time** | **duration** | **est. End** |  |
| Sat | 09:00 | 137 | 11:17 | CP1 |
| Sat | 11:30 | 125 | 13:35 | CP2 |
| Sat | 14:00 | 133 | 16:13 | CP3 |
| Sat | 16:30 | 163 | 19:13 | CP4 |
| **RT** | **Start time** | **duration** | **est. End** |  |
| Sun | 09:00 | 129 | 11:09 | RT1 |
| Sun | 11:30 | 127 | 13:37 | RT2 |
| Sun | 14:00 | 125 | 16:05 | RT3 |
| Sun | 16:30 | 125 | 18:35 | RT4 |
| **RT** | **Start time** | **duration** | **est. End** |  |
| Mon | 09:00 | 129 | 11:09 | RT5 |
| Mon | 11:30 | 119 | 13:29 | RT6 |
| Mon | 13:30 | 145 | 15:55 | RT7 |

For each session, 24 volunteers are requested to participate. A email requesting for registration for the sessions will be sent out at the beginning of the JVET meeting.

1. **Related contributions**

|  |  |  |
| --- | --- | --- |
| [JVET-AN0041](https://jvet-experts.org/doc_end_user/current_document.php?id=16024) | AHG17: AhG meeting notes | [M. Wien](mailto:wien@lfb.rwth-aachen.de) |
| [JVET-AN0052](https://jvet-experts.org/doc_end_user/current_document.php?id=16036) | [AHG17] [ Performance of GOP based RPR under CfE test conditions | Y. Sun, Y. Zhao, J. Sauer, J. Pardo, P. Jia, T. Solovyev, [E. Alshina (Huawei)](mailto:elena.alshina@gmail.com) |
| [JVET-AN0053](https://jvet-experts.org/doc_end_user/current_document.php?id=16037) | AHG4/AHG15/AHG17: 4K gaming sequences featuring “Black Myth: Wukong” | [J. Sauer](mailto:johannes.sauer@huawei.com), [Y. Zhao](mailto:yin.zhao@huawei.com), Y. Sun, J. Zhou, E. Alshina (Huawei) |
| [JVET-AN0080](https://jvet-experts.org/doc_end_user/current_document.php?id=16064) | AHG18: CfE response in additional functionality on ultra-low latency and packet loss resilience | [S. Ikonin](mailto:sergey.ikonin@huawei.com), [V. Khamidullin](mailto:vyacheslav.khamidullin1@huawei.com), [I. Gribushin](mailto:gribushin.ivan@huawei.com), [M. Sychev](mailto:Sychev.Maxim@huawei.com), [K. Malyshev](mailto:malyshev.kirill@huawei-partners.com), [A. Dzugaev](mailto:dzugaev.akhsarbek@h-partners.com), [A. Bovsha](mailto:bovsha.albert@h-partners.com), [X. Ma](mailto:maxiang6@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AN0085](https://jvet-experts.org/doc_end_user/current_document.php?id=16069) | Response to the joint CfE on video compression with capability beyond VVC | [M. Abdoli](mailto:mabdoli@xiaomi.com), P. Nikitin, F. Plowman, A. Tissier, R. G. Youvalari, M.-L. Champel (Xiaomi), Y.-J. Chang, C.-C. Chen, M. Coban, K. Cui, P. Garus, N. Hu, M. Karczewicz, J.-L. Lin, P.-H. Lin, X. Meng, B. Ray, [V. Seregin](mailto:vseregin@qti.qualcomm.com), Y. Shao, G. Verba, H. Wang, E. Ye, R. Yu, Y. Zhang, Z. Zhang, W. Zhu (Qualcomm), [F. Le Léannec](mailto:fabrice.leleannec@interdigital.com), K. Naser (InterDigital), [F. Wang (OPPO)](mailto:wangfan6@oppo.com), [Y. Kidani](mailto:yo-kidani@kddi.com), H. Kato, T. Chujoh, K. Kawamura (KDDI), [Z. Deng](mailto:zhipin.deng@bytedance.com), K. Zhang, L. Zhang (Bytedance), [A. Filippov](mailto:alexey.filippov@tcl.com), J. Konieczny, V. Rufitskiy, H. Qin, T. Dong, Z. Xu, K. Ding, C. Hollmann, I. Zupancic, D. Li (TCL), [X. Xiu](mailto:xiaoyuxiu@kwai.com), X. Wang (Kwai) |
| [JVET-AN0157](https://jvet-experts.org/doc_end_user/current_document.php?id=16141) | AHG17: Valgrind complexity analysis on CfE encoder run time targets | [S. Hong](mailto:hong.sujun@mail.sharp), [Y. Tokumo](mailto:tokumo.yasuaki@mail.sharp), [T. Ikai (Sharp)](mailto:ikai.tomohiro@mail.sharp) |
| [JVET-AN0177](https://jvet-experts.org/doc_end_user/current_document.php?id=16161) | AHG4/AHG17: Response to the call for new HDR materials for future video coding development | [J. Wang](mailto:blindwang@zju.edu.cn), [J. Zhang](mailto:jiaqi.zhang@zju.edu.cn), [L. Yu (ZJU)](mailto:yul@zju.edu.cn) |
| [JVET-AN0189](https://jvet-experts.org/doc_end_user/current_document.php?id=16173) | AHG17/AHG10: On perceptual coding for next-generation video coding standard | [Y. Zhao](mailto:yin.zhao@huawei.com), A. Karabutov, T. Guo, P. Jia, [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AN0190](https://jvet-experts.org/doc_end_user/current_document.php?id=16174) | AHG17/AHG10: On test model simulating hardware encoder | [Y. Zhao](mailto:yin.zhao@huawei.com), J. Mao, R. Zhao, X. Ma, T. Solovyev, [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AN0198](https://jvet-experts.org/doc_end_user/current_document.php?id=16182) | [AHG17] Wuhan University’s Response in Joint Call for Evidence on Video Compression with Capability beyond VVC | [W. Zhang](mailto:wenzhuo@whu.edu.cn), [L. Qin](mailto:qinluyi@whu.edu.cn), [X. Chen](mailto:xinxinchen@whu.edu.cn), [N. Fu](mailto:nianxiangfu@whu.edu.cn), [H. Qu](mailto:haodong@whu.edu.cn), [W. Ma](mailto:mwzgorgeous@whu.edu.cn), [J. Zhang](mailto:sissie_zhang@whu.edu.cn), [Z. Chen (Wuhan Univ.)](mailto:zzchen@whu.edu.cn) |
| [JVET-AN0212](https://jvet-experts.org/doc_end_user/current_document.php?id=16196) | AHG17: Description of NNVC-based CfE response | [D. Kim](mailto:kimddng@etri.re.kr), [S.-C. Lim (ETRI)](mailto:sclim@etri.re.kr), [T. Solovyev](mailto:solovyev.timofey@huawei.com), [J. Sauer](mailto:johannes.sauer@huawei.com), [J. Pardo](mailto:johan.esprit.pardo1@huawei.com), [P. Jia](mailto:panqi.jia@huawei.com), [A. Karabutov](mailto:karabutov.alexander@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com), [H. Kwon](mailto:hspeedkwon@hanyang.ac.kr), [H. Ko (HYU)](mailto:hyunsuk@hanyang.ac.kr), [F. Galpin](mailto:franck.galpin@interdigital.com), [T. Dumas](mailto:thierry.dumas@interdigital.com), [E. François (InterDigital)](mailto:edouard.francois@interdigital.com), [Y. Li](mailto:yli30@qti.qualcomm.com), [M. Karczewicz (Qualcomm)](mailto:martak@qti.qualcomm.com), [Z. Xiang](mailto:alanzxiang@global.tencent.com), [R. Chernyak](mailto:chernyak@global.tencent.com), [S. Liu (Tencent)](mailto:shanl@global.tencent.com) |
| [JVET-AN0243](https://jvet-experts.org/doc_end_user/current_document.php?id=16227) | Crosscheck of JVET-AN0052 (AHG17: Performance of GOP based RPR under CfE test conditions) | [Z. Xiang (Tencent)](mailto:alanzxiang@global.tencent.com) |
| [JVET-AN0267](https://jvet-experts.org/doc_end_user/current_document.php?id=16250) | Ericsson, Fraunhofer HHI and Nokia responses to Joint CfE on Video Compression with Capability beyond VVC | W. Ahmad, K. Andersson, M. Damghanian, V. Gritsenko, L. Litwic, D. Liu, M. Pettersson, V. Shchukin, R. Sjöberg, N. Stegmaier, [J. Ström](mailto:jacob.strom@ericsson.com), N. Svensson, P. Wennersten (Ericsson), C. Bartnik, J. Brandenburg, [B. Bross](mailto:benjamin.bross@hhi.fraunhofer.de), V. George, J. Güther, G. Hege, A. Henkel, T. Hinz, G. Lazarov, C. Lehmann, W. Lim, Y. Liu, S. de Luxán Hernández, D. Marpe, V. Menon, T. Nguyen, J. Pfaff, S. Puttkammer, T. Schierl, H. Schwarz, B. Stallenberger, C. Stoffers, K. Sühring, A. Wieckowski, T. Wiegand, M. Winken (Fraunhofer HHI), P. Astola, S. Blasi, D. Buğdayci Sansli, C. Feldmann, D. Fortin, [J. Funnell](mailto:john.funnell@nokia.com), S. Hong, I. Jumakulyyev, J. Lainema, N. Neumann, J. Ridge, D. Rusanovskyy, S. Schwarz (Nokia) |
| [JVET-AN0272](https://jvet-experts.org/doc_end_user/current_document.php?id=16276) | AHG17: ECM comparison points for CfE | K. Andersson, E. François, S. Hong, Y. Kidani, F. Le Léannec, X. Li, R.-L. Liao, Z. Lyu, F. Pu, V. Seregin, H.-B. Teo, A. Tissier, G. Verba, F. Wang, J.-R. Ohm, M. Wien, F. Bossen, M. Abdoli, E. Alshina, V. Baroncini, J. Chen, R. Chernyak, Z. Deng, P. de Lagrange, L. Li, P. Nikitin, D. Rusanovskyy |
| [JVET-AN0301](https://jvet-experts.org/doc_end_user/current_document.php?id=16305) | AhG17 Sharing experience of conducting JPEG AI Call for Proposals | [E. Alshina (Huawei)](mailto:elena.alshina@huawei.de) |
| [JVET-AN0303](https://jvet-experts.org/doc_end_user/current_document.php?id=16307) | External memory bandwidth evaluation for CfE response JVET-AN0267 | [C. Feldmann (Nokia)](mailto:Christian.feldmann@nokia.com) |
| [JVET-AN0318](https://jvet-experts.org/doc_end_user/current_document.php?id=16322) | AHG17 – Review of CfE responses | [K. Naser](mailto:karam.naser@interdigital.com), F. Le Léannec, F. Galpin, E. François (InterDigital) |
| [JVET-AN0330](https://jvet-experts.org/doc_end_user/current_document.php?id=16334) | Proposed modification of CfE test conditions | [E. Alshina](mailto:elena.alshina@huawei.com) |

It is noted that multiple documents have partial allocation to AHG17 and other AHGs. This includes JVET-AN0053, JVET-AN0157, JVET-AN0177, JVET-AN0189, JVET-AN0190.

1. **Expression of thanks**

All volunteers for the efforts of bitstream generation and reporting of metrics are thanked. Frank Bossen is thanked for crosschecking bitstreams and CSV files. Mathias Wien is thanked for preparing the viewing tests.

1. **Recommendations**

The AHG recommends:

* To conduct subjective tests assessing the proposed rate points and coding conditions in the draft CfE.
* To study the results of the visual tests and conclude on the findings.
* To review the remaining input contributions related to AHG17 during the meeting.

It was suggested to add a viewing session related to the CfE contribution on ULD/ER functionality (last session Monday).

First presentation of results planned for Tuesday (late, e.g. 1900).

[JVET-AN0018](https://jvet-experts.org/doc_end_user/current_document.php?id=16270) 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)]

1. **Activities**

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

***Teleconference***

The teleconference was held on August 21st with 27 participants attending.

The following topics were discussed:

* JVET-AN0046: On test conditions for ultra-low latency and packet loss resilience with full QP range
  + Network bandwidth point selection automation script
  + LDP/LDB simulations in full QP range
  + Spatial Scalability
* AHG18 software, MRs status
  + MR2: Full VTM
  + MR3: GDR fix
* JVET-AN0045: Codec software for ultra-low latency and packet loss resilience (related to JVET-AM0218)
  + Software overview
  + Transmission priority model

The meeting minutes are available in [JVET-AN0049](https://jvet-experts.org/doc_end_user/documents/40_Geneva/wg11/JVET-AN0049-v1.zip).

***Simulation software***

Adoption of last JVET meeting (JVET-AM0203, full VTM support) merged to ‘*ull-master*’ branch: <https://vcgit.hhi.fraunhofer.de/jvet-ahg-ull/VVCSoftware_VTM/-/tree/ull-master>. JVET-AM0195 (GDR) is cross-check pending.

1. **Related contributions**

A total of 12 contributions are identified relating to the mandates of AHG18. They are listed below. Some contributions also relate to the work of AHG12.

|  |  |  |
| --- | --- | --- |
| **Report** | | |
| [JVET-AN0018](https://jvet-experts.org/doc_end_user/current_document.php?id=16270) | 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-AN0049](https://jvet-experts.org/doc_end_user/documents/40_Geneva/wg11/JVET-AN0049-v1.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 proposals** | | |
| [JVET-AN0046](https://jvet-experts.org/doc_end_user/current_document.php?id=16030) | AHG18: On test conditions for ultra-low latency and packet loss resilience with full QP range | [S. Ikonin](mailto:sergey.ikonin@huawei.com), [I. Gribushin](mailto:gribushin.ivan@huawei.com), [V. Khamidullin](mailto:vyacheslav.khamidullin1@huawei.com), [B. Shevchenko](mailto:shevchenko.boris@h-partners.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AN0079](https://jvet-experts.org/doc_end_user/current_document.php?id=16063) | AHG18: Proposed methodology and test conditions for ultra-low latency and packet loss resilience performance evaluation | [S. Ikonin](mailto:sergey.ikonin@huawei.com), [I. Gribushin](mailto:gribushin.ivan@huawei.com), [X. Ma](mailto:maxiang6@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com), [S. Deshpande (Sharp)](mailto:sdeshpande@sharplabs.com) |
| [JVET-AN0089](https://jvet-experts.org/doc_end_user/current_document.php?id=16073) | AHG12/AHG18: On GDR test condition for video compression beyond VVC | [T. Chujoh](mailto:xtk-chuujou@kddi.com), [Y. Kidani](mailto:yo-kidani@kddi.com), [K. Kawamura (KDDI)](mailto:ki-kawamura@kddi.com) |
| **Other proposals** | | |
| [JVET-AN0045](https://jvet-experts.org/doc_end_user/current_document.php?id=16029) | AHG18: Codec software for ultra-low latency and packet loss resilience | [S. Ikonin](mailto:sergey.ikonin@huawei.com), [V. Khamidullin](mailto:vyacheslav.khamidullin1@huawei.com), [K. Malyshev](mailto:malyshev.kirill@huawei-partners.com), [I. Gribushin](mailto:gribushin.ivan@huawei.com), [X. Ma](mailto:maxiang6@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AN0080](https://jvet-experts.org/doc_end_user/current_document.php?id=16064) | AHG18: CfE response in additional functionality on ultra-low latency and packet loss resilience | [S. Ikonin](mailto:sergey.ikonin@huawei.com), [V. Khamidullin](mailto:vyacheslav.khamidullin1@huawei.com), [I. Gribushin](mailto:gribushin.ivan@huawei.com), [M. Sychev](mailto:Sychev.Maxim@huawei.com), [K. Malyshev](mailto:malyshev.kirill@huawei-partners.com), [A. Dzugaev](mailto:dzugaev.akhsarbek@h-partners.com), [A. Bovsha](mailto:bovsha.albert@h-partners.com), [X. Ma](mailto:maxiang6@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AN0081](https://jvet-experts.org/doc_end_user/current_document.php?id=16065) | AHG18: Software fixes for robust decoding in unicast scenario | [K. Malyshev](mailto:malyshev.kirill@huawei-partners.com), [V. Khamidullin](mailto:vyacheslav.khamidullin1@huawei.com), [M. Sychev](mailto:sychev.maxim@huawei.com), [S. Ikonin](mailto:sergey.ikonin@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AN0204](https://jvet-experts.org/doc_end_user/current_document.php?id=16188) | AHG18: Request on inclusion ultra-low latency and packet loss resilience category into CfP | [S. Ikonin](mailto:sergey.ikonin@huawei.com), [X. Ma](mailto:maxiang6@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com), [S. Wenger (Tencent)](mailto:swenger@global.tencent.com) |
| **Crosscheck** | | |
| [JVET-AN0082](https://jvet-experts.org/doc_end_user/current_document.php?id=16066) | AhG18: Crosscheck report for JVET-AM0195 | [V. Zakharchenko (Nokia)](mailto:vlad.zakharchenko@nokia.com) |
| **Informational** | | |
| [JVET-AN0050](https://jvet-experts.org/doc_end_user/current_document.php?id=16034) | AHG18 : An Introduction to 5G Latency/Throughput Measurement and Real-Time Monitoring for ULL Application Scenarios | B. Jeon (TTA), S. M. Kim (LGUplus) |
| [JVET-AN0254](https://jvet-experts.org/doc_end_user/current_document.php?id=16238) | AHG18: Packet marking mechanism for unicast scenario with channel feedback | [V. Zakharchenko (Nokia)](mailto:vlad.zakharchenko@nokia.com) |

1. **Recommendations**

The AHG recommends:

* Review all input contributions.
* Discuss test conditions and evaluation methodology, taking into account CfE evaluation results.
* 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.

# Project development (44)

## AHG1: Deployment and advertisement of standards (1)

Contributions in this area were discussed during 1910–1920 on Saturday 4 Oct. 2025 (chaired by JRO).

[JVET-AN0021](https://jvet-experts.org/doc_end_user/current_document.php?id=16242) Deployment status of the VVC standard [G. J. Sullivan]

This contribution contains a survey of deployed products and services, publicly available software source code, related tools, and formal specifications supporting the VVC standard (Rec. ITU-T H.266 | ISO/IEC 23090-3).

Revision marking is included to show changes relative to JVET-AL0021-v1 of April 2025.

1. **NHK** released software providing multilayer support on top of Fraunhofer HHI’s VVenC v1.6.1 encoder to GitHub in July 2023 [48]. An alpha-channel-enabled GStreamer package based on this encoder was later released by Fluendo (see item 13).
2. **Fluendo** received an award grant in July 2024 from the SPIRIT EU project for its **STREAM** (Scalable Telepresence with Real-time EnhAnced Multimedia) project for collaborative telepresence [56]. The project provides support in the **GStreamer** system for alpha channel usage with VVC, based on the NHK multilayer extension (see item 10) of the Fraunhofer HHI VVenC software, and was released to Github [57].
3. **Amlogic** released an **S905X5** Armv9 processor SoC with dual-stream 4K 10 bit @60 fps VVC capability in September 2023. **SEI Robotics** included the Amlogic processor in its **AI-SR** Android TV box at that time [100]. **Ugoos** used it for its **AM9** Android TV box in July 2025 [101][102].
4. **SBTVD Forum** in **Brazil**, following its phase 2 testing conducted during July–December 2021, announced in January 2022 the decision for VVC to be used for the main video stream for the upcoming next-generation **TV 3.0** broadcasting standard in Brazil, both for over-the-air and over-the-Internet transmission [135]. Experimental broadcasting began in Rio de Janeiro and São Paulo in 2025, and President of Brazil Luiz Inácio signed a presidential decree on 27 August 2025 establishing Brazil’s **DTV+** service (previously known as TV 3.0) based on ATSC 3.0 with VVC (further discussed below in item 48) as Brazil’s next-generation broadcast standard [136].

## AHG2: Text development and errata reporting (1)

Contributions in this area were discussed during 1920–1930 on Saturday 4 Oct. 2025 (chaired by JRO).

See also sections 6.1 and 6.2.1.

[JVET-AN0258](https://jvet-experts.org/doc_end_user/current_document.php?id=16243) Reference Guide to the Structural Concepts in the Versatile Video Coding (VVC) Standard [G. J. Sullivan (Dolby Labs)]

As JVET contemplates the creation of a new generation of video coding standard with capabilities beyond VVC, it is appropriate to make sure the high-level design and capabilities of VVC itself are well understood and appreciated.

This document contains an outline, primarily in a tabular format, of the structure of the Versatile Video Coding (VVC) standard (ITU-T H.266 and ISO/IEC 23090-3). It is primarily drafted to provide a reference guide to basic descriptions of the structural elements of the standard without requiring the reader to read through a substantial amount of less structured explanatory prose, as would ordinarily be found in a journal paper on the subject (such as the *IEEE Trans. CSVT* high-level syntax paper of October 2021), and without being burdened with all the extra information that would be found in the standard itself. Some historical background information is also provided about the features.

The author drafted this document as an informal guide for colleagues and eventual publication in some form, and it might still eventually become a conference or journal paper, although its format is a bit unusual for such a publication. It is provided here as tutorial information and could also evolve into some group publication such as an updated white paper or technical report, or an informative annex for the standard.

As an editorial convention within this document, since VVC is the focus of this document and is the most recent ITU-T/ISO/IEC video coding standard, it is referred to in the present tense, while other standards are referred to in the past tense as historical background. In cases where this document says a particular feature was introduced or first used in a particular standard, that means only that this feature was not in previous ITU-T and ISO/IEC standards, not that there was no knowledge of the technique in the community before that time.

It was commented that the paper could be referenced in the VVC white paper, and potentially some of the paragraphs might be used there.

## AHG3: Software development (1)

Contributions in this area were discussed during 1935–2000 on Saturday 4 Oct. 2025 (chaired by JRO).

[JVET-AN0292](https://jvet-experts.org/doc_end_user/current_document.php?id=16296) Multiview HEVC Reference SW implementation status [S. Choi, S. Paluri, D. Podborski, A. M. Tourapis (Apple)] [late]

This contribution discusses the current development status of a reference SW implementation for the currently defined multiview profiles of the HEVC standard. It is reported that the HM reference SW was extended to include support for all multiview profiles, including multiview monochrome profiles, in both the encoder and the decoder. The main limitation of the implementation is that currently the SW cannot be configured to support layers of different chroma format, bitdepth, or resolution capabilities. Other functionalities, such as motion compensated temporal filtering and film grain analysis and insertion may also be of limited use when multiview functionalities are desired. Such support is expected to be added in subsequent versions. It is proposed that the provided code is integrated with the official HM reference SW.

It was requested that the software should be provided in gitlab, and in a style that allows to identify the changes relative to the current HM.

Generally, the integration of existing and new multiview profiles in HM (transferring the old ones from HTM) is an excellent step forward.

It was also requested to start generating bitstreams for the remaining multiview profiles in JVET-AM1008, and provide a list of bitstreams until the next meeting. Also for the cases where different chroma format, bitdepth, resolution, or profile IDC is needed in the different layers, these might be generated separately, and also be helpful in the software development fully supporting such cases.

## AHG3: Test conditions and metrics (2)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0341](https://jvet-experts.org/doc_end_user/current_document.php?id=16345) Influence of color transformation on codec performance [M. Domanski, A. Grzelka, O. Stankiewicz (Poznan Univ. Tech.)] [late]

[JVET-AN0348](https://jvet-experts.org/doc_end_user/current_document.php?id=16352) AHG10: On reporting metrics for RPR [K. Andersson (Ericsson)] [late]

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

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0048](https://jvet-experts.org/doc_end_user/current_document.php?id=16032) AHG4: teleconference on VVC multilayer testing [P. de Lagrange (InterDigital)]

[JVET-AN0298](https://jvet-experts.org/doc_end_user/current_document.php?id=16302) AHG4: proposed updates for VVC multi-layer verification test plan [P. de Lagrange (InterDigital)] [late] [miss]

## AHG4: Test and training material (2)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0053](https://jvet-experts.org/doc_end_user/current_document.php?id=16037) AHG4/AHG15/AHG17: 4K gaming sequences featuring “Black Myth: Wukong” [J. Sauer, Y. Zhao, Y. Sun, J. Zhou, E. Alshina (Huawei)]

[JVET-AN0177](https://jvet-experts.org/doc_end_user/current_document.php?id=16161) AHG4/AHG17: Response to the call for new HDR materials for future video coding development [J. Wang, J. Zhang, L. Yu (ZJU)]

## AHG5: Conformance test development (0)

This section is kept as a template for future use.

## AHG7: ECM tool assessment (6)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0043](https://jvet-experts.org/doc_end_user/current_document.php?id=16027) AHG7: Preliminary tool analysis with the criteria in JVET-AM0042 [X. Li (Google)]

[JVET-AN0044](https://jvet-experts.org/doc_end_user/current_document.php?id=16028) Report of AHG7 conference call on Complexity Analysis [X. Li]

[JVET-AN0119](https://jvet-experts.org/doc_end_user/current_document.php?id=16103) AHG7: Analysis on group-off tests using Valgrind [R. Ishimoto, F. Zheming, T. Ikai (Sharp)]

[JVET-AN0203](https://jvet-experts.org/doc_end_user/current_document.php?id=16187) AHG7: On RGPM moved into group-2 [P. Bordes, K. Reuzé, E. François, K. Naser, F. Le Léannec (InterDigital)]

[JVET-AN0223](https://jvet-experts.org/doc_end_user/current_document.php?id=16207) AHG7: On bin to bit ratio in ECM [T. N. Canh, P. Yin, S. McCarthy (Dolby), J. N. Shingala (Ittiam)] [late]

[JVET-AN0253](https://jvet-experts.org/doc_end_user/current_document.php?id=16237) AHG7: On Memory Bandwidth Measurement [X. Li (Google), Y. Kim (Samsung), J. Pardo (Huawei), R. Ishimoto (Sharp), L.-F. Chen (Tencent)]

[JVET-AN0317](https://jvet-experts.org/doc_end_user/current_document.php?id=16321) AHG7: Preliminary tool analysis with the criteria in JVET-AM0042 – Update on IntraTMP [K. Naser, T. Dumas, M. Radosavljevic (InterDigital)] [late]

## AHG8: Optimization of encoders and receiving systems for machine analysis of coded video content (0)

This section is kept as a template for future use.

## AHG10: Encoding algorithm optimization (0+2)

This section is kept as a template for future use.

[JVET-AN0189](https://jvet-experts.org/doc_end_user/current_document.php?id=16173) AHG17/AHG10: On perceptual coding for next-generation video coding standard [Y. Zhao, A. Karabutov, T. Guo, P. Jia, E. Alshina (Huawei)]

See section 4.16.1

[JVET-AN0190](https://jvet-experts.org/doc_end_user/current_document.php?id=16174) AHG17/AHG10: On test model simulating hardware encoder [Y. Zhao, J. Mao, R. Zhao, X. Ma, T. Solovyev, E. Alshina (Huawei)]

See section 4.16.1

[JVET-AN0298](https://jvet-experts.org/doc_end_user/current_document.php?id=16302) AHG4: proposed updates for VVC multi-layer verification test plan [P. de Lagrange (InterDigital)] [late] [miss]

See section 4.4

## AHG13: Film grain synthesis (1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0237](https://jvet-experts.org/doc_end_user/current_document.php?id=16221) AHG13: Film grain analysis improvement [M. Radosavljević, F. Lefebvre, P. de Lagrange, Z. Ameur (InterDigital)]

## Implementation studies (0)

This section is kept as a template for future use.

## Profile/tier/level specification (1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0293](https://jvet-experts.org/doc_end_user/current_document.php?id=16297) Multiview 4:4:4 profiles for HEVC [S. Choi, S. Paluri, D. Podborski, E. Asbun, A. M. Tourapis (Apple)] [late]

## AHG15: Gaming content compression (2+1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0053](https://jvet-experts.org/doc_end_user/current_document.php?id=16037) AHG4/AHG15/AHG17: 4K gaming sequences featuring “Black Myth: Wukong” [J. Sauer, Y. Zhao, Y. Sun, J. Zhou, E. Alshina (Huawei)]

See section 4.6

[JVET-AN0174](https://jvet-experts.org/doc_end_user/current_document.php?id=16158) AHG15: Compression of gaming content using auxiliary data [J. Sauer, Z. Li (Huawei)]

[JVET-AN0263](https://jvet-experts.org/doc_end_user/current_document.php?id=16248) AHG15: Transformer based depthmaps reconstruction for gaming content [V. Zakharchenko (Nokia)]

## AHG16: Generative face video (1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

See also section 6.2.14.

[JVET-AN0057](https://jvet-experts.org/doc_end_user/current_document.php?id=16041) AHG16: Colour calibration post-processing for generative face video coding [S. Yin, Z. Zhang, S. Wang (CityUHK), B. Chen, R.-L. Liao, J. Chen, Y. Ye (Alibaba)]

## AHG17: CfE on video coding technology beyond VVC (17)

### General (5+2)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0041](https://jvet-experts.org/doc_end_user/current_document.php?id=16024) AHG17: AhG meeting notes [M. Wien]

[JVET-AN0052](https://jvet-experts.org/doc_end_user/current_document.php?id=16036) [AHG17] [ Performance of GOP based RPR under CfE test conditions [Y. Sun, Y. Zhao, J. Sauer, J. Pardo, P. Jia, T. Solovyev, E. Alshina (Huawei)]

[JVET-AN0055](https://jvet-experts.org/doc_end_user/current_document.php?id=16039) Crosscheck of JVET-AN0052 on Performance of GOP based RPR under CfE test conditions [X. Li (Google)] [late] [miss]

[JVET-AN0243](https://jvet-experts.org/doc_end_user/current_document.php?id=16227) Crosscheck of JVET-AN0052 (AHG17: Performance of GOP based RPR under CfE test conditions) [Z. Xiang (Tencent)]

[JVET-AN0294](https://jvet-experts.org/doc_end_user/current_document.php?id=16298) Crosscheck of JVET-AN0052 (Performance of GOP based RPR under CfE test conditions) [L. Li, J. Park, K. Choi] [late] [miss]

[JVET-AN0053](https://jvet-experts.org/doc_end_user/current_document.php?id=16037) AHG4/AHG15/AHG17: 4K gaming sequences featuring “Black Myth: Wukong” [J. Sauer, Y. Zhao, Y. Sun, J. Zhou, E. Alshina (Huawei)]

See section 4.6

[JVET-AN0157](https://jvet-experts.org/doc_end_user/current_document.php?id=16141) AHG17: Valgrind complexity analysis on CfE encoder run time targets [S. Hong, Y. Tokumo, T. Ikai (Sharp)]

[JVET-AN0177](https://jvet-experts.org/doc_end_user/current_document.php?id=16161) AHG4/AHG17: Response to the call for new HDR materials for future video coding development [J. Wang, J. Zhang, L. Yu (ZJU)]

See section 4.6

[JVET-AN0189](https://jvet-experts.org/doc_end_user/current_document.php?id=16173) AHG17/AHG10: On perceptual coding for next-generation video coding standard [Y. Zhao, A. Karabutov, T. Guo, P. Jia, E. Alshina (Huawei)]

[JVET-AN0190](https://jvet-experts.org/doc_end_user/current_document.php?id=16174) AHG17/AHG10: On test model simulating hardware encoder [Y. Zhao, J. Mao, R. Zhao, X. Ma, T. Solovyev, E. Alshina (Huawei)]

[JVET-AN0330](https://jvet-experts.org/doc_end_user/current_document.php?id=16334) Proposed modification of CfE test conditions E. [Alshina (Huawei)] [late]

### CfE submissions and evaluation (8)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0080](https://jvet-experts.org/doc_end_user/current_document.php?id=16064) AHG18: CfE response in additional functionality on ultra-low latency and packet loss resilience [S. Ikonin, V. Khamidullin, I. Gribushin, M. Sychev, K. Malyshev, A. Dzugaev, A. Bovsha, X. Ma, E. Alshina (Huawei)]

[JVET-AN0085](https://jvet-experts.org/doc_end_user/current_document.php?id=16069) Response to the joint CfE on video compression with capability beyond VVC [M. Abdoli, P. Nikitin, F. Plowman, A. Tissier, R. G. Youvalari, M.-L. Champel (Xiaomi), Y.-J. Chang, C.-C. Chen, M. Coban, K. Cui, P. Garus, N. Hu, M. Karczewicz, J.-L. Lin, P.-H. Lin, X. Meng, B. Ray, V. Seregin, Y. Shao, G. Verba, H. Wang, E. Ye, R. Yu, Y. Zhang, Z. Zhang, W. Zhu (Qualcomm), F. Le Léannec, K. Naser (InterDigital), F. Wang (OPPO), Y. Kidani, H. Kato, T. Chujoh, K. Kawamura (KDDI), Z. Deng, K. Zhang, L. Zhang (Bytedance), A. Filippov, J. Konieczny, V. Rufitskiy, H. Qin, T. Dong, Z. Xu, K. Ding, C. Hollmann, I. Zupancic, D. Li (TCL), X. Xiu, X. Wang (Kwai)]

[JVET-AN0198](https://jvet-experts.org/doc_end_user/current_document.php?id=16182) [AHG17] Wuhan University’s Response in Joint Call for Evidence on Video Compression with Capability beyond VVC [W. Zhang, L. Qin, X. Chen, N. Fu, H. Qu, W. Ma, J. Zhang, Z. Chen (Wuhan Univ.)]

[JVET-AN0212](https://jvet-experts.org/doc_end_user/current_document.php?id=16196) AHG17: Description of NNVC-based CfE response [D. Kim, S.-C. Lim (ETRI), T. Solovyev, J. Sauer, J. Pardo, P. Jia, A. Karabutov, E. Alshina (Huawei), H. Kwon, H. Ko (HYU), F. Galpin, T. Dumas, E. François (InterDigital), Y. Li, M. Karczewicz (Qualcomm), Z. Xiang, R. Chernyak, S. Liu (Tencent)]

[JVET-AN0267](https://jvet-experts.org/doc_end_user/current_document.php?id=16250) Ericsson, Fraunhofer HHI and Nokia responses to Joint CfE on Video Compression with Capability beyond VVC [W. Ahmad, K. Andersson, M. Damghanian, V. Gritsenko, L. Litwic, D. Liu, M. Pettersson, V. Shchukin, R. Sjöberg, N. Stegmaier, J. Ström, N. Svensson, P. Wennersten (Ericsson), C. Bartnik, J. Brandenburg, B. Bross, V. George, J. Güther, G. Hege, A. Henkel, T. Hinz, G. Lazarov, C. Lehmann, W. Lim, Y. Liu, S. de Luxán Hernández, D. Marpe, V. Menon, T. Nguyen, J. Pfaff, S. Puttkammer, T. Schierl, H. Schwarz, B. Stallenberger, C. Stoffers, K. Sühring, A. Wieckowski, T. Wiegand, M. Winken (Fraunhofer HHI), P. Astola, S. Blasi, D. Buğdayci Sansli, C. Feldmann, D. Fortin, J. Funnell, S. Hong, I. Jumakulyyev, J. Lainema, N. Neumann, J. Ridge, D. Rusanovskyy, S. Schwarz (Nokia)]

[JVET-AN0272](https://jvet-experts.org/doc_end_user/current_document.php?id=16276) AHG17: ECM comparison points for CfE [K. Andersson, E. François, S. Hong, Y. Kidani, F. Le Léannec, X. Li, R.-L. Liao, Z. Lyu, F. Pu, V. Seregin, H.-B. Teo, A. Tissier, G. Verba, F. Wang, J.-R. Ohm, M. Wien, F. Bossen, M. Abdoli, E. Alshina, V. Baroncini, J. Chen, R. Chernyak, Z. Deng, P. de Lagrange, L. Li, P. Nikitin, D. Rusanovskyy] [late]

[JVET-AN0303](https://jvet-experts.org/doc_end_user/current_document.php?id=16307) External memory bandwidth evaluation for CfE response JVET-AN0267 [C. Feldmann (Nokia)] [late]

[JVET-AN0318](https://jvet-experts.org/doc_end_user/current_document.php?id=16322) AHG17 – Review of CfE responses [K. Naser, F. Le Léannec, F. Galpin, E. François (InterDigital)] [late]

### Considerations towards CfP (4)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0056](https://jvet-experts.org/doc_end_user/current_document.php?id=16040) On Next Generation Video Codec Call for Proposal Timing [S. Wenger (Tencent)]

[JVET-AN0204](https://jvet-experts.org/doc_end_user/current_document.php?id=16188) AHG18: Request on inclusion ultra-low latency and packet loss resilience category into CfP [S. Ikonin, X. Ma, E. Alshina (Huawei), S. Wenger (Tencent)]

[JVET-AN0249](https://jvet-experts.org/doc_end_user/current_document.php?id=16233) Suggestions for a potential upcoming CfP [J. Samuelsson-Allendes, S. Deshpande (Sharp)]

[JVET-AN0301](https://jvet-experts.org/doc_end_user/current_document.php?id=16305) AhG17 Sharing experience of conducting JPEG AI Call for Proposals [E. Alshina (Huawei)] [late]

## AHG18 Ultra-low latency and packet loss resilience (8+2)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0045](https://jvet-experts.org/doc_end_user/current_document.php?id=16029) AHG18: Codec software for ultra-low latency and packet loss resilience [S. Ikonin, V. Khamidullin, K. Malyshev, I. Gribushin, X. Ma, E. Alshina (Huawei)]

[JVET-AN0082](https://jvet-experts.org/doc_end_user/current_document.php?id=16066) AhG18: Crosscheck report for JVET-AM0195 [V. Zakharchenko (Nokia)]

[JVET-AN0339](https://jvet-experts.org/doc_end_user/current_document.php?id=16343) Crosscheck of JVET-AM0195 (AHG18: Gradual Decoding Refresh under ultra-low latency test scenario) [E. Mora (VITEC)] [late]

[JVET-AN0046](https://jvet-experts.org/doc_end_user/current_document.php?id=16030) AHG18: On test conditions for ultra-low latency and packet loss resilience with full QP range [S. Ikonin, I. Gribushin, V. Khamidullin, B. Shevchenko, E. Alshina (Huawei)]

[JVET-AN0049](https://jvet-experts.org/doc_end_user/current_document.php?id=16033) 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-AN0050](https://jvet-experts.org/doc_end_user/current_document.php?id=16034) AHG18: An Introduction to 5G Latency/Throughput Measurement and Real-Time Monitoring for ULL Application Scenarios [B. Jeon (TTA), S. M. Kim (LGUplus)]

[JVET-AN0079](https://jvet-experts.org/doc_end_user/current_document.php?id=16063) AHG18: Proposed methodology and test conditions for ultra-low latency and packet loss resilience performance evaluation [S. Ikonin, I. Gribushin, X. Ma, E. Alshina (Huawei), S. Deshpande (Sharp]

[JVET-AN0080](https://jvet-experts.org/doc_end_user/current_document.php?id=16064) AHG18: CfE response in additional functionality on ultra-low latency and packet loss resilience [S. Ikonin, V. Khamidullin, I. Gribushin, M. Sychev, K. Malyshev, A. Dzugaev, A. Bovsha, X. Ma, E. Alshina (Huawei)]

See section 4.16.2

[JVET-AN0081](https://jvet-experts.org/doc_end_user/current_document.php?id=16065) AHG18: Software fixes for robust decoding in unicast scenario [K. Malyshev, V. Khamidullin, M. Sychev, S. Ikonin, E. Alshina (Huawei)]

[JVET-AN0089](https://jvet-experts.org/doc_end_user/current_document.php?id=16073) AHG12/AHG18: On GDR test condition for video compression beyond VVC [T. Chujoh, Y. Kidani, K. Kawamura (KDDI)]

[JVET-AN0204](https://jvet-experts.org/doc_end_user/current_document.php?id=16188) AHG18: Request on inclusion ultra-low latency and packet loss resilience category into CfP [S. Ikonin, X. Ma, E. Alshina (Huawei), S. Wenger (Tencent)]

See section 4.16.3

[JVET-AN0254](https://jvet-experts.org/doc_end_user/current_document.php?id=16238) AHG18: Packet marking mechanism for unicast scenario with channel feedback [V. Zakharchenko (Nokia)]

## CICP (1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0070](https://jvet-experts.org/doc_end_user/current_document.php?id=16054) CICP enum for generic subsampling and sample location [L. Barnes, D. Podborski, A. Tourapis (Apple)] [late]

# Low-level tool technology proposals (97)

## AHG11/AHG14: Neural network-based video coding (26)

### Summary and BoG reports

Contributions in this area were discussed during 0900–1050 on Saturday 4 Oct. 2025 (chaired by JRO).

[JVET-AN0023](https://jvet-experts.org/doc_end_user/current_document.php?id=16271) EE1: Summary report of exploration experiment on neural network-based video coding [E. Alshina, R. Chang, F. Galpin, Yue Li, Yun Li, M. Santamaria, T. Shao, J. Ström, Z. Xie (EE coordinators)]

Code base for the EE1 tests was NNVC14.0, anchor is default configuration of **NNVC-14.0** (NN-Intra and **LOP6** 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**, which consists of DIV2K, BVI-DVC, TVD. NN-based Inter tools were trained using Vimeo 90K triplet. 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 the complexity close to existing NNVC tool, 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.

According to the EE description 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 August 28 [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.

This round of EE1 tests includes:

*EE1-1: LOP in-loop filter*

*EE1-2: VLOP in-loop filter*

*EE1-3: NN-inter prediction*

*EE1-4: NN-based super-resolution*

Anchor for ALL tests is NNVC-14.0 with NN-Intra and LOP6 enabled (default configuration).

**EE1-1: LOP in-loop filter**

* EE1-1.1 – LOP with Overlapped Feature Integration  [JVET-AN0127](https://jvet-experts.org/doc_end_user/current_document.php?id=16111) ([UESTC,](mailto:hwguo@uestc.edu.cn) [Transsion)](mailto:zuhai.zhang@transsion.com) (crosscheck [JVET-AN0281](https://jvet-experts.org/doc_end_user/current_document.php?id=16285))

Key changes in head block of LOP filter are additional operations over Luma reconstruction and prediction input:

1. **Boundary Cropping**: Crop 1 pixel from the left/right columns and top/bottom rows of the original block, retaining the central (W-2)×(H-2) region.
2. **Mirror Symmetric Padding**: Restore the original block size by padding mirrored values from the cropped boundaries.
3. **2×2 DCT Transformation**: Apply 2x2 DCT-II to the padded block.

The changes introduced by proposed solution (on a right) relatively to LOP6 (on a left) are highlighted in the diagram below:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | *ecExtY*  [1,144,144] | |  | *PredExtY*  [1,144,144 ] |  | | … | | [DCT](#_DCT) | |  | [DCT](#_DCT) |  | |  | | [4,72,72 ] | |  | [4,72,72 ] |  | |  | | [CONCAT](#_concatenation_of_tensors)(d1, d2,d3, d4, d4, d5) | | | | |  d1+ d2+ d3+ d4+ d4+ d5 = d7,72,72  | | | | | [CONV](#_convolution_layer), 11, d7, d6 | | | | | [PReLU](#_Parametric_rectified_linear) | | | | | [dwCONV](#_depthwise_separable_convolution), 31, d6, d6, 2 | | | | |  d6,36,72  | | | | | [dwCONV](#_depthwise_separable_convolution), 13, d6, d6, 2 | | | | |  d6,36,36  | | | | | [CONV](#_convolution_layer), 11, d6, 2C | | | | | [PReLU](#_Parametric_rectified_linear) | | | | | 2C,36,36  | | | | | |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | *RecExtY*  [1,144,144] | | *RecExtY*  [1,144,144] | *PredExtY*  [1,144,144 ] | *PredExtY*  [1,144,144] | | … | | [DCT](#_DCT) | | Overlap DCT | [DCT](#_DCT) | Overlap DCT | |  | | [4,72,72 ] | | [4,72,72 ] | [4,72,72 ] | [4,72,72 ] | |  | | [CONV](#_convolution_layer) 3×3, 16, d1, 2↓, groups=2 | | | | | [CONCAT](#_concatenation_of_tensors)(d1, d2d3, d4, d4, d5) | | | | | [ d1+ d2+ d3+ d4+ d4+ d5,72,72 ] | | | | | [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 ] | | | | |

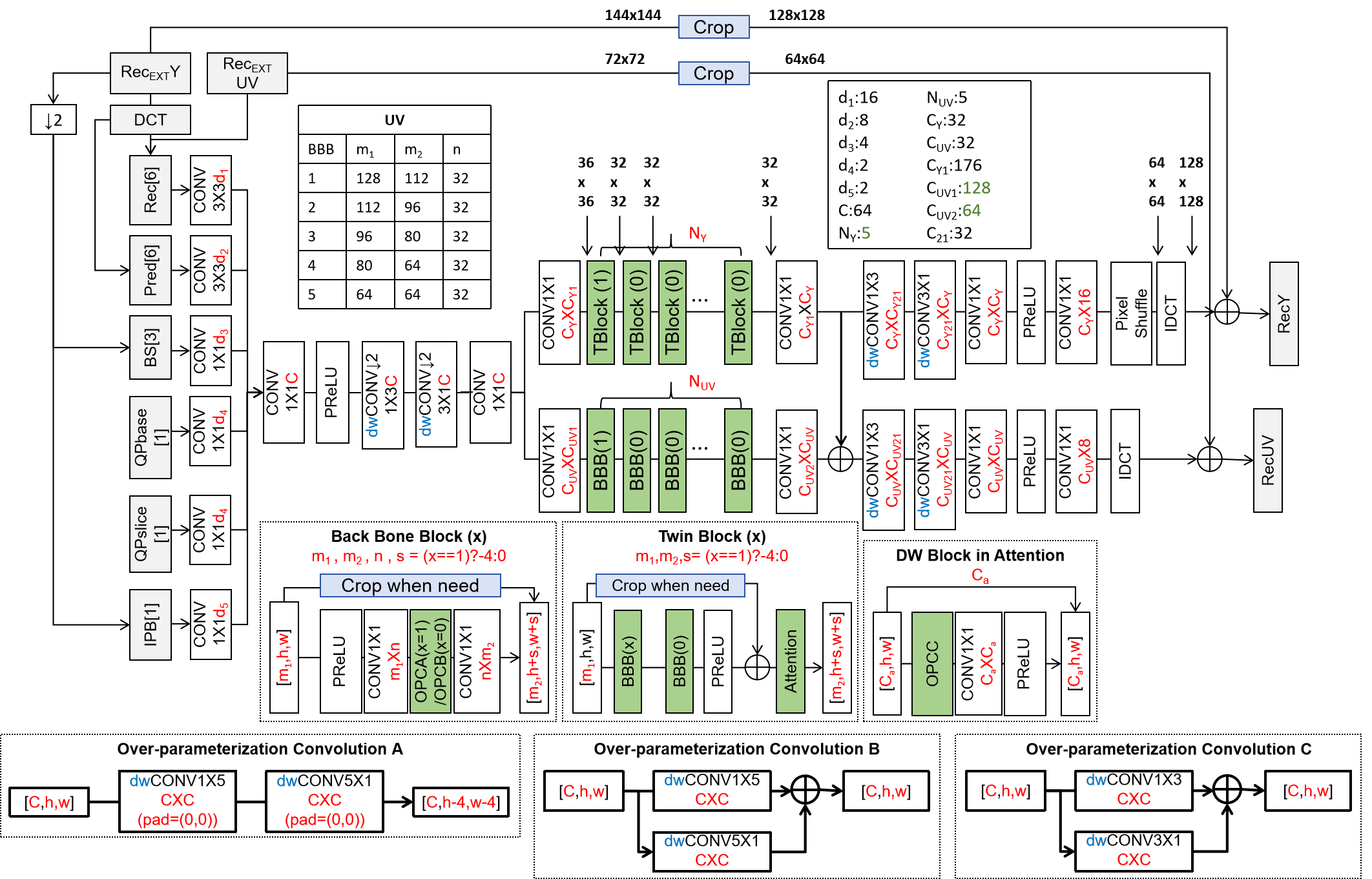
Ablation study:

* EE1-1.1.1: retraining LOP6 w/o change of architecture, use changed learning rate.
* EE1-1.1.2: only change architecture w/o overlapped feature.
* EE1-1.1.3.1: DCT II added to Sub-test 1.1.2 (full proposed package).
* EE1-1.1.3.2: DCT II added to Sub-test 1.1.2 (full proposed package), use changed learning rate.

Complexity measured in kMAC/pxl remains close to the LOP6 (16.57 kMAC/pxl), number of parameters are not reported, training time (only stage 3) is 7 days. PSNR drop for SlideShow is 0.4% (all-intra cfg test).

Encoder run time is unreliable, decoder run time claimed to be reliable, indicates reduction of decoding time (10%) due to SIMD acceleration for the group convolution (not yet available in SADL, but proposed in JVET-AN0128) and aligning channels number with multiple of 16. Cross-checker reported status of cross-check via e-mail:

* for inference:
  + successful inference xcheck of EE1-1.1.1, EE1-1.1.2, EE1-1.1.3.1 and EE1-1.1.3.2 under AI configuration, all results matched; and
  + all tests under RA configuration are still under-going and results are not available.
* for training:
  + as requested by proponents, only training of EE1-1.1.3.2 was cross-checked
    - successful training xcheck of EE1-1.1.3.2 under AI configuration, {Y: 0.01%, U: -0.16%, V: 0.12%} compared with JVET-AN0127.
    - RA configuration are still under-going, RA results are expected to be obtained within 5 days.
* EE1-1.2 –Backbone Block Enhancement of LOP In-Loop Filter with Over-Parameterized Training and Variable Channels  [JVET-AN0083](https://jvet-experts.org/doc_end_user/current_document.php?id=16067) ((training cross-check [JVET-AN0335](https://jvet-experts.org/doc_end_user/current_document.php?id=16339) )



Re-parametrization is only training modification. Three variants of over-parametrized modules were used during training, but in the inference, model returned to the original network structure. Training time increase 10h – 190 h.

Normative changes are in the chroma branch, to provide BBB(x) with richer input information, we increase the number of input channels of BBB(1) and gradually reduce the number of input channels of BBB(0) accordingly. The number of input channels of the five BBB(x)s in the chroma branch gradually decreases from 128 to 64.

SIMD acceleration for the depth-wise separable convolution at the boundary was provided. This acceleration is also applicable to the anchor. Run time reported relatively to accelerated NNVC-14.0.

Computational complexity reduced 16.60 -> 16.56 kMAC/pxl.

Training was successfully cross-checked (two runs of training ended up in very close performance).

*Table 1* ***EE1 LOP in-loop filter modifications (table needs update from v4 of JVET-AN0023)***

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | All intra cfg | | | | | Random Access | | | | |
| Y | U | V | EncT | DecT | Y | U | V | EncT | DecT |
| NNVC-LOP6 | 0.0% | 0.0% | 0.0% | 100% | 100% | 0.0% | 0.0% | 0.0% | 100% | 100% |
| EE1-1.1.1 | 0.0% | 0.1% | -0.0% |  | 100% | 0.1% | -0.2% | -0.4% |  | 100% |
| EE1-1.1.2 | -0.1% | -0.1% | -1.0% |  | 92% | -0.1% | -0.3% | -1.1% |  | 90% |
| EE1-1.1.3.1 | 0.0% | 0.1% | -0.0% |  | 91% | 0.1% | -0.2% | -0.4% |  | 89% |
| EE1-1.1.3.2 | -0.1% | -0.6% | -0.7% |  | 92% | -0.2% | -0.9% | -0.9% |  | 88% |
| EE1-1.2 | -0.1% | -0.6% | -0.1% | 99% | 102% | -0.1% | -0.7% | 0.2% | 100% | 103% |

It was commented that gain of both 1.1 and 1.2 is relatively low (within the 0.1% margin of training uncertainty). Basically, both could be combined, but then re-training in combination would be necessary.

For 1.1, training cross-check is not finalized yet. It shows an interesting decoding runtime reduction, which however is due to SIMD optimization in SADL which might likewise be applied to the anchor.

For 1.2, both inference and training cross-check are finalized. A concern was raised how much of the gain comes from over-parameterization using the new training strategy, and how much gain is due to the architectural change.

1.2 should be further investigated in EE on the aspect of benefit of the architectural change. It appears that the overparameterization could stabilize the training of LOP6 also without architectural change (which was not tested so far).

It was commented that the reported gain of both 1.1 and 1.2 appears too small to justify architectural changes. Proponents might consider if a combination could be beneficial to be investigated in EE.

1.1.1 is retraining of LOP6 without architectural change.

Revisit on variant 1.1.3.2 after completion of training cross-check and potential confirmation of the slightly higher gain (to be compared against 1.1.1 which does not apply an architectural change).

**EE1-2: VLOP in-loop filter**

* EE1-2.2 – Decomposed Content-Adaptive VLOP[JVET-AN0153](https://jvet-experts.org/doc_end_user/current_document.php?id=16137) (registered but not uploaded cross-check[JVET-AN0282](https://jvet-experts.org/doc_end_user/current_document.php?id=16286))

***图形用户界面, 应用程序, Teams

AI 生成的内容可能不正确。***

The comparison for this test is caVLOP4 (content-adaptive VLOP4).

Claimed performance benefits over caVLOP4 are as follows.

*Table 2* ***EE1 cVLOP in-loop filter modifications***

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Random Access | | | | | kMAC/pxl | | | Num Param, M | | |
| Y | U | V | EncT | DecT | Total | Filter | Intra | Total | Filter | Intra |
| NNVC-caVLOP4 | 0.0% | 0.0% | 0.0% | 100% | 100% | 9.9 | 5.2 | 4.8 | 1.4 | 0.074 | 1.3 |
| EE1-2.2 | -0.2% | -0.2% | -0.4% | 100% | 100% | 9.9 | 5.2 | 4.8 | 1.4 | 0.074 | 1.3 |

*Table 3* ***Performance of ‘VLOP’ family in-loop filters in NNVC vs VTM (NNVC all tools off)***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Random Access | | | | |
| Y | U | V | EncT | DecT |
| NNVC-VLOP4 | -6.1% | -7.5% | -6.0% | 113% | 1373% |
| NNVC-caVLOP4 | -8.6% | -15.7% | -16.3% | 239% | 2508% |

Comments from cross-checker: inference cross-check matched, training is still ongoing.

Gain for the content-adaptive VLOP4 appears interesting. However, the relatively large increase in decoding time is of concern, which appears larger than with the current CA-VLOP1 implementation. This may be an implementation issue, or may be caused by the decomposition approach. One reason may be that the model needs to be re-compiled and re-loaded each time it is changed.

Revisit after completion of cross-check. Proponents are asked to investigate why the decoding runtime is more significantly increased than for the existing CA-VLOP1 implementation.

**EE1-3: NN-inter prediction**

Anchor for tests in this category is NNVC-14.0 with NN-Intra and LOP6 enabled (default configuration).

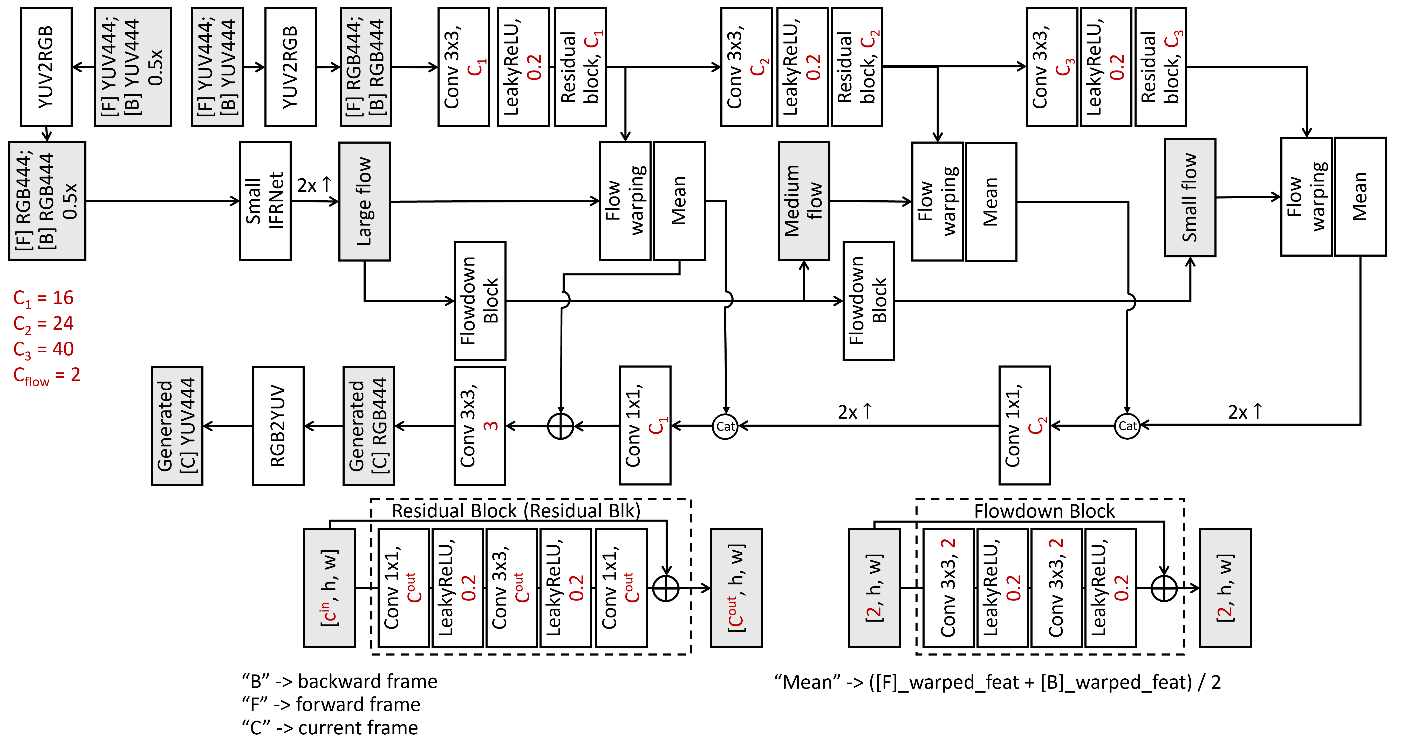
Deep Reference Frame (DRF) was adopted to NNVC at JVET 39th meeting. It is disabled by default.

Results for DRF in NNVC are provided as reference. As was agreed during NNVC teleconference adopted version of DRF is not enabled in LDB cfg (model was not trained for those purposes).

* EE1-3.1 – Deep Reference Frame Generation for Inter Prediction Enhancement with Structural Re-parameterization[JVET-AN0193](https://jvet-experts.org/doc_end_user/current_document.php?id=16177) **(*training*** and inference ***cross-check*** [JVET-AN0304](https://jvet-experts.org/doc_end_user/current_document.php?id=16308))

Significant reduction of model size and number of multiplications by using light version of DRF and structural re-parameterization. Training uses sophisticated loss: CharbonnierLoss + TernaryLoss. Training set is Vimeo-90K triplet. Training takes approx. 80 hours.

Cross-checker performed re-training, after re-training deviation from proponent’s results in average is {0.15%, -0.53%,0.64%} BD-rate for {Y, U, V} components, but bigger difference (0.3%) is observed for classes A2 , 0.14% for A1 and B, for other classes within usual margin.



* EE1-3.2 – RA/LDB Reference Frame Synthesis for VVC Inter Coding  [JVET-AN0084](https://jvet-experts.org/doc_end_user/current_document.php?id=16068) (cross-check [JVET-AN0306](https://jvet-experts.org/doc_end_user/current_document.php?id=16310) ongoing)

Training set is Vimeo-90K triplet, Loss is L1. Training uses video data compressed with QPs 7,12,17,22,27,32,37,42). Training takes approx. 120 hours. Decoding is still in progress (partial data available).

Cross-check status has been reported by cross-checker via e-mail:

* 1. Inference crosscheck failed for LDB (decoder crash)
  2. Inference crosscheck for RA was not bit exact (they have floating point operations in their inference code), there are also a crash in Class A
  3. Training crosscheck for RA model was done – Chroma results varied by 1.21%. Luma was okay.
  4. Inference crosscheck of float models did not show the same results. Maybe the models they provided were wrong.
* EE1-3.5 – Retrained DRF in NNVC14.0 [JVET-AN0195](https://jvet-experts.org/doc_end_user/current_document.php?id=16179) (***training*** and inference cross-check [JVET-AN0305](https://jvet-experts.org/doc_end_user/current_document.php?id=16309))

During porting of adopted DRF version to NNVC, color conversion process was modified compared to original version, so inference was different from training. Retraining was needed to align training and inference. Training takes approx. 50 hours.

Cross-checker performed re-training, after re-training deviation from proponent’s results is negligible (below 0.1%).

*Table 4* ***EE1 DRF family of tools in NNVC***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Random Access | | | | | Low-delay-B | | | | | kMAC/pxl | | Num Param, M | |
| Y | U | V | EncT | DecT | Y | U | V | EncT | DecT | Total | NN-Inter | Total | NN-Inter |
| NNVC-LOP6 | 0.0% | 0.0% | 0.0% | 100% | 100% | 0.0% | 0.0% | 0.0% | 100% | 100% | 21 | 0 | 1.5 | 0 |
| NNVC-DRF | -1.9% | -1.2% | -0.8% | 145% | 2256% | NA | | | | | 525 | 504 | 5.3 | 3.8 |
| EE1-3.1 | -1.3% | -0.6% | -0.8% | 111% | 776% | NA | | | | | 70 | 69 | 4.4 | 2.9 |
| EE1-3.2 | -2.5% | -0.5% | -0.9% | 135% | - | -1.9% | 0.5% | 3.0% | 158% | - | 608 | 487 | 4.3 | 2.8 |
| EE1-3.5 | -2.2% | -1.5% | -2.2% | 149% | 2474% | NA | | | | | 525 | 504 | 5.3 | 3.8 |

EE1-3.1 would be interesting as additional operation point with lower complexity of DRF.

It was reported by proponents of EE1-3.1 that they are currently are trying to identify the problems leading to partial deviation in training crosscheck. Revisit if update of the contributions becomes available.

EE1-3.2 is immature (not to be continued in EE)

Decision: Adopt JVET-AN0195 EE1-3.5 (re-training the current DRF model)

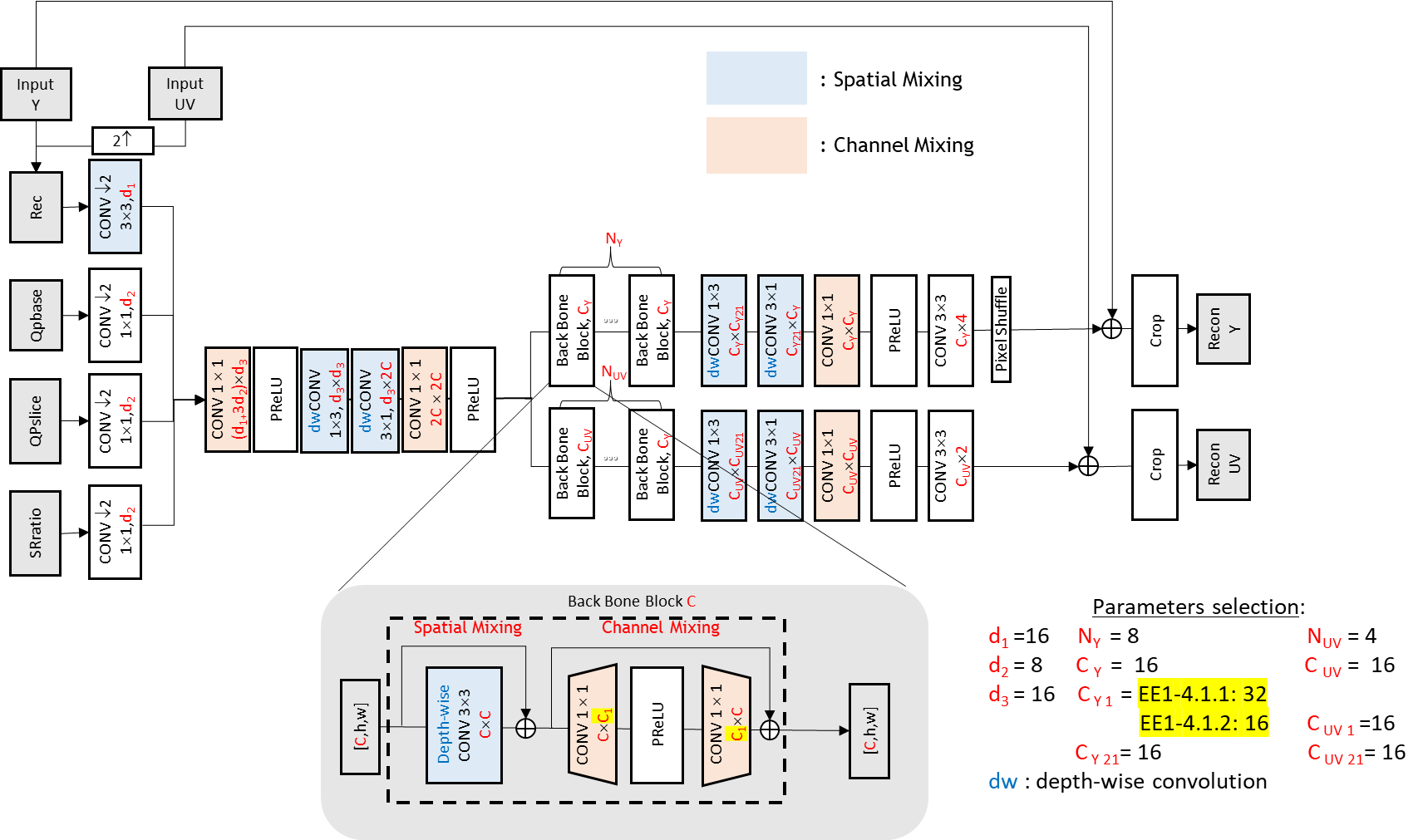
**EE1-4: NN-based super-resolution**

Per agreement during the second NNVC teleconference test conditions for NN-based super-resolution tests are aligned with RPR in NNVC:

NNSR testing conditions are:

* Multiple scaling ratios are used (x1.5 and x2)
* Reduced resolution is allowed for QP>=32 (base QP)
* Enabled only for 4K classes
* QP offset for chroma is the same for A1 and A2 (no per sequence adaptation).

EE1-4.1   NNSR with new backbone block based on Spatial-Channel Mixing (SCM) [JVET-AN0201](https://jvet-experts.org/doc_end_user/current_document.php?id=16185) (registered, but not yet available cross-check [JVET-AN0277](https://jvet-experts.org/doc_end_user/current_document.php?id=16281))

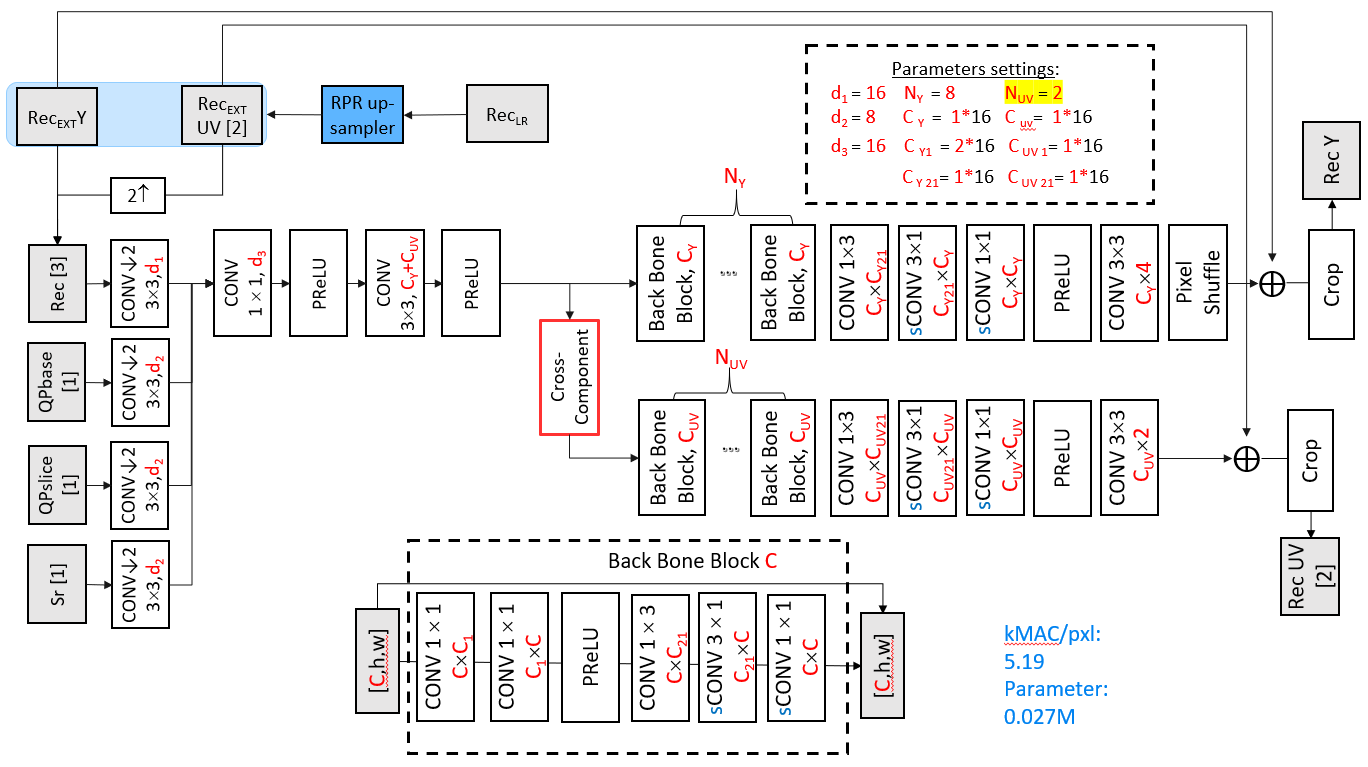


The key element is a new backbone block for NNSR that performs spatial mixing followed by channel mixing. No run time provided. Some (0.1…0.4%) BD-rate gain in Chroma compared to NNSR in NNVC-14.0.

Two variants are provided with C\_Y1=32 (kMAC/pxl 4.05, Nparam 17k) and C\_Y1=16 (kMAC/pxl 3 Nparam 12k).

* EE1-4.2 Cross-component enhanced NNSR [JVET-AN0238](https://jvet-experts.org/doc_end_user/current_document.php?id=16222) (cross-check [JVET-AN0256](https://jvet-experts.org/doc_end_user/current_document.php?id=16240))

Proposed changes enhance feature interaction between luma and chroma components. Some (0.1…0.4%) BD-rate gain in Chroma compared to NNSR in NNVC-14.0. Increase of kMAC/pxl compared to NNSR in NNVC-14.0



Anchor for tests in this category is NNVC-14.0 with NN-Intra and LOP6 enabled (default configuration).

Results (generated by AhG14) for RPR and NN-SR in NNVC are provided as reference.

Cross-check of inference – match, after re-training by cross-checked Chroma BD-rate drop 0.1..0.2%.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Random Access | | | | | All Intra | | | | | kMAC/pxl | | Num Param, M | |
| Y | U | V | EncT | DecT | Y | U | V | EncT | DecT | Total | NN-SR | Total | NN-SR |
| NNVC-LOP6 | 0.0% | 0.0% | 0.0% | 100% | 100% | 0.0% | 0.0% | 0.0% | 100% | 100% | 21 | 0 | 1.5 | 0 |
| NNVC-RPR | -0.5% | 1.3% | 1.0% | 96% | 90% | -0.5% | 3.4% | 3.4% | 98% | 81% | 21 | 0 | 1.5 | 0 |
| NNVC-NNSR | -0.6% | 1.3% | 1.0% | 97% | 90% | -0.8% | 3.1% | 3.0% | 100% | 81% | 26 | 4.7 | 1.7 | 0.02 |
| EE1-4.1.1 | -0.6% | 1.2% | 0.9% |  |  | -0.8% | 2.7% | 2.7% |  |  | 25 | 4.0 | 1.6 | 0.02 |
| EE1-4.1.2 | -0.6% | 1.2% | 0.9% |  |  | -0.8% | 2.7% | 2.7% |  |  | 24 | 3 | 1.6 | 0.01 |
| EE1-4.2 | -0.6% | 1.2% | 0.8% |  |  | -0.8% | 2.7% | 2.6% |  |  | 26 | 5.2 | 1.5 | 0.03 |

Run times are reported to be similar to current NNVC-NNSR.

EE1-4.1.2 could be interesting, having significant complexity reduction compared to current NNSR without impact on gain. Revisit after completion of cross-check JVET-AN0277.

EE1-4.2 is not attractive, no benefit in compression, slight complexity increase compared to current NNSR.

[JVET-AN0042](https://jvet-experts.org/doc_end_user/current_document.php?id=16026) [AHG11] [AHG14] Teleconference on NNVC [E. Alshina, F. Galpin]

### EE1 contributions: Neural network-based video coding (8)

There was no presentation or discussion about specific proposals in this category – contributions were discussed in the context of the EE summary report JVET-AN0023. For actions decided to be taken, see section 5.2.1, unless otherwise noted.

[JVET-AN0083](https://jvet-experts.org/doc_end_user/current_document.php?id=16067) EE1-1.2: Backbone Block Enhancement of LOP In-Loop Filter with Over-Parameterized Training and Variable Channels [J. Han, C. Jung, Q. Qin (Xidian Univ.)]

[JVET-AN0335](https://jvet-experts.org/doc_end_user/current_document.php?id=16339) Cross-check of JVET-AN0083 (EE1-1.2: backbone block enhancement of LOP in-loop filter with over-parameterized training and variable channels) [T. Dumas (InterDigital)] [late]

[JVET-AN0084](https://jvet-experts.org/doc_end_user/current_document.php?id=16068) EE1-3.2: RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding [Q. Qin, C. Jung (Xidian Univ.)]

[JVET-AN0306](https://jvet-experts.org/doc_end_user/current_document.php?id=16310) Crosscheck of JVET-AN0084 (EE1-3.2: RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding) [N. Bhaskar (Huawei)] [late]

[JVET-AN0127](https://jvet-experts.org/doc_end_user/current_document.php?id=16111) EE1-1.1: LOP with Overlapped Feature Integration [J. Chi, A. Li, Y. Du, C. Zhu, L. Luo, H. Guo (UESTC), Y. Huo, Y. Liu, Z. Zhang (Transsion)]

[JVET-AN0281](https://jvet-experts.org/doc_end_user/current_document.php?id=16285) Crosscheck of JVET-AN0127 (EE1-1.1: LOP with Overlapped Feature Integration) [Z. Xu (TCL)] [late] [miss]

[JVET-AN0153](https://jvet-experts.org/doc_end_user/current_document.php?id=16137) EE1-2.2: Decomposed Content-Adaptive VLOP4 [Z. Xu, J. Konieczny, A. Filippov, C. Hollmann, V. Rufitskiy, T. Dong, H. Qin (TCL)]

[JVET-AN0282](https://jvet-experts.org/doc_end_user/current_document.php?id=16286) Crosscheck of JVET-AN0153 (EE1-2.2: Decomposed Content-Adaptive VLOP4) [J. Chi, A. Li, Y. Du, C. Zhu, L. Luo, H. Guo (UESTC), Y. Huo, Y. Liu, Z. Zhang (Transsion)] [late] [miss]

[JVET-AN0193](https://jvet-experts.org/doc_end_user/current_document.php?id=16177) EE1-3.1: Deep Reference Frame Generation for Inter Prediction Enhancement with Structural Re-parameterization [W. Zhang, N. Fu, X. Chen, W. Ma, J. Zhang, Z. Chen (Wuhan Univ.)]

[JVET-AN0304](https://jvet-experts.org/doc_end_user/current_document.php?id=16308) Crosscheck of JVET-AN0193 (EE1-3.1: Deep Reference Frame Generation for Inter Prediction Enhancement with Structural Re-parameterization) [N. Bhaskar (Huawei)] [late]

[JVET-AN0195](https://jvet-experts.org/doc_end_user/current_document.php?id=16179) EE1-3.5: Retrained DRF in NNVC-14.0 [X. Chen, N. Fu, W. Zhang, W. Ma, J. Zhang, Z. Chen (Wuhan Univ.)]

[JVET-AN0305](https://jvet-experts.org/doc_end_user/current_document.php?id=16309) Crosscheck of JVET-AN0195 (EE1-3.5: Retrained DRF in NNVC-14.0) [N. Bhaskar (Huawei)] [late]

[JVET-AN0201](https://jvet-experts.org/doc_end_user/current_document.php?id=16185) EE1-4.1: NNSR with new backbone block based on Spatial-Channel Mixing (SCM) [H. Cho, S. Bahk, H. Y. Kim (KHU), D. Kim, S.-C. Lim (ETRI)]

[JVET-AN0277](https://jvet-experts.org/doc_end_user/current_document.php?id=16281) Crosscheck of JVET-AN0201 (EE1-4.1: NNSR with new backbone block based on Spatial-Channel Mixing (SCM)) [T. Yang, W.-X. He, Y.-Q. Zhu, X.-T. Xie, J.-S. Gong, Q.-M. Wang, Q. Liu (HUST), Z.-Y. Lv (vivo)] [late]

[JVET-AN0238](https://jvet-experts.org/doc_end_user/current_document.php?id=16222) EE1-4.2: Cross-component enhanced NNSR [T. Yang, W.-X. He, Y.-Q. Zhu, X.-T. Xie, J.-S. Gong, Q.-M. Wang, Q. Liu (HUST), Z.-Y. Lv (vivo)]

[JVET-AN0256](https://jvet-experts.org/doc_end_user/current_document.php?id=16240) Crosscheck of JVET-AM0238 (EE1-4.1: Cross-component enhanced NNSR) [H. Cho, S. Bahk, T. Lee, H. Y. Kim (KHU), D. Kim, S.-C. Lim (ETRI)] [late] [miss]

### EE1 related and beyond-EE contributions: Neural network-based video coding (11)

Contributions in this area were discussed during 1110–1245 and 1430–1800 on Saturday 4 Oct. 2025 (chaired by JRO).

[JVET-AN0054](https://jvet-experts.org/doc_end_user/current_document.php?id=16038) AHG14: Extension of the QP range for TDO Lambda in NNVC S/W [H. Kwon, H. Ko (Hanyang Univ.), D. Kim, S.-C. Lim (ETRI)]

This contribution proposes an NNVC S/W modification of the time-distortion optimization (TDO) Lambda configuration to support a wider range of QP values, which can be used for Call for Evidence (CfE) condition, where relatively higher QP ranges are needed. The TDO in the NNVC S/W skips the neural network-based loop filtering if the number of boundary strength (BS) partitions is less than a BS partition threshold. However, the BS partition threshold can have different optimal values for each slice. Thus, the threshold is determined by calculating the trade-off between distortion and the number of filtered blocks. To determine the optimal threshold value at the encoder, the proper Lambda value corresponding to the slice QP should be used. However, in the NNVC-14.1 S/W, the same Lambda is applied for QP values above 42, which restricts the use of QP-dependent optimized Lambda values, especially at high QP values. To address this issue, this contribution makes the QP range more flexible for TDO Lambda configuration in NNVC.

This makes the current non-normative TDO more flexible, by adding parameters that are currently hard coded in software to the parameter file. In CTC, nothing would change, as TDO is disabled.

Decision(SW): Adopt JVET-AN0054 (non-CTC). Also needs update of the description in JVET-AN2019.

[JVET-AN0172](https://jvet-experts.org/doc_end_user/current_document.php?id=16156) AHG11: Proposal of normative TDO method as an alternative option in NNVC [H. Kwon, H. Ko (Hanyang Univ.), D. Kim, S.-C. Lim (ETRI)]

This contribution proposes the adoption of a normative time-distortion optimization (TDO) method as an alternative option in the NNVC S/W, with the aim of minimizing the drop in coding performance. The TDO method skips NN-based filtering according to boundary strength (BS) partitions. The number of BS partitions is determined from the BS map, which is the input of the NN-based filter, and filtering is skipped if the number of BS partitions is lower than the BS partition threshold. Unlike the non-normative TDO method, the BS partition threshold is signalled in the slice header, which can reduce signaling overhead caused by block-level filtering on/off flags. The experimental results {Y, Cb, Cr | EncT, DecT} of the normative TDO method on top of NNVC-14.1, are reported as follows:

RA: {Y: 0.05% Cb: -0.10% Cr: -0.09% | EncT: 101% DecT: 78%},

LDB: {Y: -0.13% Cb: -1.19% Cr: -0.75% | EncT: 100% DecT: 70%}

It was commented that by disabling the option of block-level on/off control (and replacing it by a threshold based on BS) might have an impact that an encoder could no longer control potential visual artifacts locally.

It was asked how the threshold is determined? Similar as in non-normative method.

Investigate in EE, but report also results for VLOP and HOP.

[JVET-AN0209](https://jvet-experts.org/doc_end_user/current_document.php?id=16193) AhG 11/AHG 14: Harmonization of Deep Reference Frame (DRF) with RPR in NNVC14.1 [N. Bhaskar, T. Solovyev, E. Alshina (Huawei)]

In NNVC14.1, it was observed that when the tools Deep Reference Frame (DRF) and RPR were enabled in combination, the encoder crashed for some of the test sequences. Several bugs in the DRFG software were detected and fixed. These bugs occurred in relation to the DRF frames when RPR is applied. The fixes are available as a merge request. This input contribution explains details of the modifications needed to enable simultaneous functionalities DRF and RPR in NNVC.

This contribution resolves the problem that DRF so far requires pictures of identical size to generate the new reference. RPR filters are used for re-sizing.

It is noted that this was not included in the CfE response JVET-AN0212, as it would be a normative change of the NNVC SW.

Decision: Adopt JVET-AN0209 (non-CTC). SW coordinators will investigate appropriateness of the change by the time of merge request.

[JVET-AN0215](https://jvet-experts.org/doc_end_user/current_document.php?id=16199) AhG11: Filter restriction depending on hierarchical depth [F. Galpin, E. François (InterDigital)]

In NNVC software, several neural-network based loop-filter (NNLF) are available, targeting different complexity and gains. Moreover, additional algorithms on encoder side are also available to control the complexity at decoder, namely TDO (Time Distortion Optimization) based on different criteria (distortion, boundary strength etc.) and targeting block level control. An additional criterion is proposed based the hierarchical depth of the frame to encode, targeting both encoder and decoder complexity. For NNVC 14 anchor (using LOP6 NNLF), it allows to vary encoder complexity from x1.1 to x1.2 while decoder complexity vary from x3 to x27 wrt VTM, while gains vary from {-4.6%,-11.3%,-9.5} to {-8%,-14.9%,-13.5%} for RA configuration. For LDB configuration encoder complexity varies from x1 to x1.1 and decoder x9 to x30 with gains varying from {-4.5%,-11.3%,-11%} to {-6.1%,-9.7%, -9.6%}. The method has been used in CfE responses using NNVC in order to control the encoder and decoder complexity tradeoffs.

The decision of using the filter is basically dependent on the position in a GOP, using the depth parameter of VTM.

Decision(SW): Adopt JVET-AN0215 (non-CTC). Also needs description in JVET-AN2019.

[JVET-AN0202](https://jvet-experts.org/doc_end_user/current_document.php?id=16186) [AHG11/AHG14] Comparison of Multi-Layer and Single-Layer Interfaces for Hybrid End-to-End Video Coding Frameworks [N. Zou, A. Hallapuro, F. Cricri, H. Zhang, A. B. Koyuncu, J. Ahonen, M. M. Hannuksela (Nokia)]

This contribution compares two hybrid E2E video coding frameworks that integrate end-to-end learned intra-frame compression (LIC) methods with conventional compression techniques. Among the two hybrid frameworks, one adopts a single-layer interface, whereas the other employs a multi-layer interface. With these two hybrid frameworks, under the Random-Access configuration, the resulting BD-rates over NNVC-7.1 VTM (with NN tools off) anchor and NNVC-14 VTM (with NN tools off) anchor are respectively reported to be as follows:

The framework with single-layer interface compared to NNVC-7.1 VTM (with NN tools off):

Overall -0,45 % (Y), -3,11 % (Cb), -1,31 % (Cr)

The framework with multi-layer interface compared to NNVC-7.1 VTM (with NN tools off):

Overall 4,47 % (Y), 0,26 % (Cb), 1,79 % (Cr)

The framework with single-layer interface compared to NNVC-14 VTM (with NN tools off):

Overall 0,37 % (Y), -2,44 % (Cb), -0,62 % (Cr)

The framework with multi-layer interface compared to NNVC-14 VTM (with NN tools off):

Overall 5,33 % (Y), 0,96 % (Cb), 2,51 % (Cr)

It was commented that the difference is not only due to the overhead of the multi-layer stream, but likely also caused by different approach of RDO for the single-layer and multi-layer investigated in this contribution.

The multi-layer approach also allows a residual on the intra picture. A more fair comparison might be to configure the encoder such that the residual is skipped.

It was commented that there were bug fixes in referencing between base and enhancement layer between 14.0 and 14.1 (and some later fixes from JVET-AN0225, which may not have ben merged yet).

[JVET-AN0216](https://jvet-experts.org/doc_end_user/current_document.php?id=16200) [AHG11] Update on Multilayer framework for supporting a hybrid codec using End-to-End Learned Image Codec and Conventional Video Codec [F. Urban, Y. Chen, F. Galpin, P. de Lagrange (InterDigital)]

In this contribution, we present results using the framework integrated into the NNVC software to support an external base layer, proposed for hybrid codecs that combine End-to-End Learned (E2E) image compression methods with conventional compression methods such as VVC in JVET-AL0243. The framework is based on high level modifications of VVC to allow external picture coding in a base layer. The multi-layer capability of VVC can then be used transparently to allow the use of such pictures inside VVC, while allowing the encoder to do low-level RD choices in the enhancement layer. The main advantage of this approach is that it allows the use of an external picture without defining explicitly the external codec, while allowing the use of a standard VVC decoder on the enhancement layer. The framework is demonstrated with intra pictures encoded with VTM as external base layer using the NNVC software. The syntax overhead of the external base layer compared to single layer is minor.

The contribution investigates the amount of syntax overhead by testing single layer VVC versus multi-layer VVC with IDR pictures as base layer. The estimated rate increase appears to be less than 0.2%.

It is noted that there is a small difference in the reconstructed I pictures due to different usage of ALF in single and multi layer cases, which could effect some very small gains in some cases even if the rate is increased.

The overhead is typically larger for the smaller resolution classes. For class A1 the overhead is larger than A2, caused by the smaller intra period of campfire.

[JVET-AN0225](https://jvet-experts.org/doc_end_user/current_document.php?id=16209) [AHG11][AHG14]: Further Improvements on Hybrid Multilayer Framework for End-to-End Learned Intra Frame [M. Aderdor, T. Solovyev, E. Alshina (Huawei)]

This contribution reports the recent progress in the development of the hybrid codec exploration branch of NNVC, which allows usage of an end-to-end coded I-frame in order to improve compression performance. The first version of the multi-layer framework did not provide the expected compression benefits compared to the previous proposal of end-to-end coded I-frame [3], which uses a single layer in VTM. In this contribution, the difference is narrowed down only to high level syntax associated with multi-layer. This contribution describes the details of modifications and proposes harmonization between ‘multi-layer’ and ‘single layer’ frameworks. We further propose software changes to improve performance even further.

The presented bug fixes and proposals increase overall PSNR BD rate of multilayer hybrid VTM DCVC-FM vs. VTM 23.11 from:

AI: -4.75% (Y) -11.24% (U) -10.60% (V)

RA: 5.69% (Y) 1.00% (U) 3.25% (V)

to:

AI: -5.31% (Y) -11.58% (U) -10.80% (V)

RA: -2.23% (Y) -7.06% (U) -4.43% (V)

Some bug fixes were implemented in the context of this contribution on top of NNVC 14.1, caused by inconsistencies in RPL, and problems occurring when GOP size was not identical with intra period.

It was asked to include SW with the bug fixes in an update of the contribution.

Further changes proposed are enabling LMCS in E2E base layer (shifting some chroma gain to luma, which however may depend on the training of the E2E network), and enabling MCTF (which was not used before, but not disabled for technical reason). This provides a gain of approximately 2% (most comes from MCTF).

As an additional result, an average overhead of 0.4% is reported for the multi-layer approach in AI (on average over all classes, by tendency larger for smaller resolution).

Run time reported in the xls is unreliable.

The usage of LMCS is asserted to be useful for flexibility in experimentation with AI based codecs for intra pictures. Enabling MCTF is just an issue of config file.

Residual in enhancement layer was not skipped, but probably only used for high rate.

Decision(SW): Implement LMCS as a configurable option from JVET-AN0225 in the NNVC multi-layer interface with external base layer.

Complexity around 500 kMAC/pix.

[JVET-AN0224](https://jvet-experts.org/doc_end_user/current_document.php?id=16208) [AHG11] A Hybrid Framework Integrating End-to-End Learned Intra-Frame Codec with Conventional Codec [N. Zou, A. Hallapuro, F. Cricri, H. Zhang, A.B. Koyuncu, J. Ahonen, M. M. Hannuksela (Nokia)]

This contribution proposes a hybrid framework that integrates end-to-end learned intra-frame compression (LIC) methods with conventional compression techniques. The framework involves using LIC-coded intra frames and VTM-coded inter frames. Furthermore, for each intra frame, the encoder decides whether to code it with LIC or with VTM. Two sets of results are provided, depending on whether the LIC was optimized by means of perceptual finetuning (PFT). With this hybrid framework, under the Random-Access configuration, the resulting BD-rates over NNVC-7.1 VTM (with NN tools off) anchor are reported to be as follows:

The system optimized with MSE and rate losses (no perceptual finetuning):

Overall -0,92 % (Y), -3,94 % (Cb), -2,30 % (Cr)

Additionally, the Random-Access simulation results are evaluated with 8 perceptual metrics, the resulting perceptual BD-rates over NNVC-7.1 VTM (with NN tools off) anchor are reported to be as follows:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | AVG | msssim Torch | vif | fsim | nlpd | iw-ssim | vmaf | psnrHVS | lpips |
| W/O PFT | -6,04% | -6,99 % | -5,76 % | -6,08 % | -5,21 % | -6,74 % | -5,52 % | -4,16 % | -5,98 % |
| W/ PFT | -10,10 % | -13,29 % | -8,12 % | -8,72 % | -7,67 % | -11,93 % | -6,15 % | -4,88 % | -14,81 % |

The frame-level RDO is either using MSE (where it gives 0.9% luma gain compared to 0.4% without switching from JVET-AN0202). With perceptual metrics, the gain becomes 6%, but it is not known how much benefit the switching gives on perceptual metrics. PFT becomes worse for PSNR, but better for perceptual metrics (where the switching also includes MSSIM criteria).

For training, both MSE and MSSIM were used. 5 models for different QP were used, trained for the intra QP settings of RA.

Gain is zero for AI, as CTC uses different QPs

Exact numbers about usage of VVC vs E2E are not provided. Reportedly, highly depends on QP.

Complexity is around 1000 kMAC/pixel.

Overall discussion:

* The multi-layer framework that was included by last meeting had various problem in implementation that were solved at least partially.
* It is still assessed that the multi-layer interface still provides most flexibility to investigate with different E2E codecs, and use adaptation mechanisms globally and locally.
* The coding gain reported so far may not justify the impact on complexity. On key aspect might be the better optimization of adaptation, RDO, etc.
* More coordination appears necessary to further investigate and enhance the interface. A dedicated AHG11/14 telco (4 weeks after the meeting) could be useful.

[JVET-AN0255](https://jvet-experts.org/doc_end_user/current_document.php?id=16239) AHG11: VLOP3 with new backbone block based on Spatial-Channel Mixing (SCM) [H. Cho, S. Bahk, H. Y. Kim (KHU), D. Kim, S.-C. Lim (ETRI)]

This contribution proposes a new backbone block based on Spatial-Channel Mixing (SCM) for VLOP3. In the proposed method, the backbone block uses a depth-wise 3×3 convolution for spatial mixing and 1×1 pointwise convolutions that first expand and then reduce the channel dimension for channel mixing. These methods have been implemented based on VLOP3 of NNVC-14.1 using SADL float.

The BD-Rate results over VLOP3 of NNVC-14.1 for float are as follows:

* AI: {0.08% -0.89%, -1.10%}, DecT: 85%
* RA: {0.08%, -1.32%, -1.29%}, DecT: 77%
* LDB: {0.02%, -3.75%, -3.90%}, DecT: 78%

Complexity over the VLOP3 of NNVC-14.1 is as follows:

* Parameter Counts: 67.9k 🡪 68.2k (proposed)
* MAC per Pixel: 5.11k 🡪 5.04k (proposed)

It was asked why the decoding run time is significantly increased? Some operations are performed at lower resolution.

Training procedure is identical, floating point implementation is used, and compared to VLOP3 float..

Decoding runtime decrease is attractive.

It is believed by proponents that the benefit could still be realised with VLOP4

Investigate in EE. Integer implementation on top of VLOP4 should be tested.

[JVET-AN0319](https://jvet-experts.org/doc_end_user/current_document.php?id=16323) EE1-related: FlowWarp Operator for DRF Integer Inference Optimization [N. Fu, X. Chen, L. Qin, W. Zhang, Z. Chen (Wuhan Univ.)] [late]

This contribution introduces a FlowWarp operator, designed to mitigate the performance degradation observed in integer (int16) SADL inference of the NN inter tool Deep Reference Frame (DRF). Unlike the GridSample-based warp currently used in DRF, where pixel coordinates are first normalized to [−1,1] to construct a sampling grid and then de-normalized internally during sampling, FlowWarp operates directly in the pixel domain. By removing the normalization/de-normalization round-trip, it reduces extra arithmetic and tensor overhead and, under integer inference, avoids additional quantization and rounding errors, while preserving the intended warping behavior of the existing implementation.

Integrated the proposed FlowWarp operator into the JVET-AN0195 method (EE1-3.5: Retrained DRF in NNVC-14.0) with the JVET-AN0195 anchor and an int16 SADL implementation, the coding gains are as follows:

1. Class A1: 0.00% (Y), -0.04% (U), -0.01% (V) EncT: 98% DecT: 102%
2. Class A2: -0.05% (Y), 0.08% (U), 0.03% (V) EncT: 100% DecT: 106%
3. Class B: -0.08% (Y), 0.01% (U), 0.03% (V) EncT: 102% DecT: 102%
4. Class C: -0.17% (Y), 0.21% (U), 0.07% (V) EncT: 101% DecT: 101%
5. Overall: -0.08% (Y), 0.07% (U), 0.03% (V) EncT: 100% DecT: 102%
6. Class D: -0.70% (Y), 0.44% (U), 0.03% (V) EncT: 101% DecT: 101%
7. Class F: -0.05% (Y), -0.03% (U), 0.01% (V) EncT: 103% DecT: 104%

Integrated the proposed FlowWarp operator into the JVET-AN0193 method (EE1-3.1: Deep Reference Frame Generation for Inter Prediction Enhancement with Structural Re-parameterization) with the JVET-AN0193 anchor and an int16 SADL implementation, the coding gains are as follows:

1. Class A1: -0.02% (Y), 0.08% (U), -0.03% (V) EncT: 99% DecT: 97%
2. Class A2: -0.06% (Y), 0.07% (U), 0.04% (V) EncT: 95% DecT: 93%
3. Class B: -0.07% (Y), 0.03% (U), 0.07% (V) EncT: 112% DecT: 109%
4. Class C: -0.09% (Y), 0.10% (U), 0.00% (V) EncT: 112% DecT: 110%
5. Overall: -0.06% (Y), 0.07% (U), 0.02% (V) EncT: 106% DecT: 103%
6. Class D: -0.18% (Y), 0.24% (U), 0.28% (V) EncT: 105% DecT: 105%
7. Class F: -0.04% (Y), 0.06% (U), 0.09% (V) EncT: 107% DecT: 105%

This is only used in inference by changing normalization. Model parameters of EE1-3.5 are not changed.

It was commented that it is interesting to start integerization in Pytorch rather than doing it subsequently in SADL. However, it requires usage of an additional customization of Pytorch which might cause problems to users.

Investigate in EE, also investigate if further improvement is possible by retraining the model (where the integerization could already be applied in training)

[JVET-AN0340](https://jvet-experts.org/doc_end_user/current_document.php?id=16344) AHG11: Neural network in-loop filter usage based on activation map [M. Santamaria, D. Buğdayci Sansli, F. Cricri (Nokia)] [late]

This contribution presents a method to derive the block-level activation of the NNLF in NNVC. For each block to be filtered in an inter coded slice, an activation map is generated using boundary strength values of the block itself and activation information of its reference block(s). The activation map is generated at the decoder side reportedly reduces signaling of per-block activation information. For LOP6 the proposal is reported to achieve average BD-rates of {-0.02%, -0.10%, -0.07%} RA, {-0.25%, -1.34%, -1.37%} LDB, {-0.22%, -1.21%, -1.26%} LDP configurations, with decoding times of 96%, 91% and 90%, respectively. For VLOP4 the proposal is reported to achieve average BD-rates {-0.01%, 0.00%, -0.02%} RA, {-0.15%, -0.17%, -0.40%} LDB, {-0.06%, -0.18%, -0.57%} LDP with decoding times 97%, 90%, 90%, respectively. It is recommended to study this tool in the next EE1 round.

Conceptually, some similarity with JVET-AN0172, but using more criteria than BS. The usage of activation information requires additional memory

Investigate in EE. Also report about an encoder-only solution (without determining the activation map at the decoder). It might also be considered if a combination with JVET-AN0172 is possible.

### SADL and NNVC implementation, CTC (7)

Contributions in this area were discussed during 1805–1910 on Saturday 4 Oct. 2025 (chaired by JRO).

[JVET-AN0047](https://jvet-experts.org/doc_end_user/current_document.php?id=16031) EE1-related: Automated environment information collection [N. Le, M. Santamaria, H. Zhang, F. Cricri (Nokia)]

Currently, technical contributions on neural network technology for video coding provide limited information on the development and test environments, which may hinder reproduction and debugging processes by crosscheckers. To address this, we propose to employ a common Python script that automatically and accurately collects comprehensive details of these environments, and we provide an initial draft version of such a script, to be eventually further improved. Experts are invited to review the script and offer recommendations for enhancements.

It was asked what the benefit would be? Could this be used to identify reasons for divergence in crosscheck, for example? Yes, it might be useful to identify how different the environments are.

It was commented that also the ONNX version is relevant to be matching to generate the same model. It was reported that this was already included.

It was commented that some information collected by the script may be restricted due to privacy.

Decision(SW): It was agreed to include the script from JVET-AN0047 in the NNVC CTC repository as a tool that can be used (but not mandatory) to investigate potential problems in the computing environment.

[JVET-AN0128](https://jvet-experts.org/doc_end_user/current_document.php?id=16112) AhG14: Improvement of SIMD implementation with expanded SIMD operators in SADL for LOP with Overlapped Feature Integration [J. Chi, A. Li, Y. Du, C. Zhu, L. Luo, H. Guo (UESTC), Y. Huo, Y. Liu, Z. Zhang (Transsion)]

In this document, the results from the expanded SIMD acceleration implementation in the SADL library are presented. Specifically, this implementation adds SIMD support for the 3x3 group convolution operator with group count = 2 and input channel counts = 16/4—an operator used in the current JVET-AN0127 EE1-1.1 LOP with Attention models of NNVC. The simulation results demonstrate that the proposed expanded SIMD implementation improves decoding time without any loss in video quality. It is suggested to update the current SIMD implementation in SADL and integrate this new 3x3 group convolution SIMD operator.

Decision(SW): Adopt JVET-AN0128

[JVET-AN0196](https://jvet-experts.org/doc_end_user/current_document.php?id=16180) AHG14: Operator Improvements in the SADL library [W. Zhang, N. Fu, L. Qin, X. Chen, Z. Chen (Wuhan Univ.)]

This contribution presents the operator improvements in the Small AdHoc Deep Learning (SADL) library from Wuhan University. These improvements include layers: Resize, GridSample, Concat, Slice, Flatten, ReduceMean, Add, and Relu.

It was commented that the limitation to batch dimension 1 existing in many other SADL elements than the slice operator. It is not wrong changing this in slice, but might be useful for other operators as well (it is noted that for slice no warning message is output, as is the case for other operators).

Decision(SW): Adopt JVET-AN0196

[JVET-AN0197](https://jvet-experts.org/doc_end_user/current_document.php?id=16181) AHG14: The extension of SADL library [L. Qin, W. Zhang, N. Fu, Z. Chen (Wuhan Univ.)]

This contribution presents the extensions in the Small AdHoc Deep Learning (SADL) library from Wuhan University. These extensions include four new layers: Gather, GatherElements, Floor, and Sub.

It was asked which networks would need the newly proposed layers? Future versions of DRF may be using Gather and Floor.

Proponents are asked to further study and issue merge requests when the new layers are practically needed in the NNVC exploration. It may be too much burden to implement all possible Pytorch layers to SADL. The SW coordinator is asked to set priorities of merge requests.

[JVET-AN0213](https://jvet-experts.org/doc_end_user/current_document.php?id=16197) AhG14: SADL update [F. Galpin (InterDigital)]

1. **Changes details**

Changes are available in the repository at <https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/sadl>.

1. **New in version v14**

***Improvements***

* + MR154: SIMD speed-up for conv2D 2x2
  + MR155: speed up targeting LOP

***New***

* + MR153: new feature Pad

***Fixes***

* + MR156: fix issue for sparse pack for float
  + MR158: fix saturation off
  + MR161: converter special case for DRF
  + MR162: new compilers fixes

***Regression***

In float mode, LOP6 model has inference issue (see issue #62). The issue was solved in MR 180.

1. **New proposed in version v15**

Several MR in the queue:

* 8 new layers:
  + New Floor layer
  + New Gather layer
  + New GatherElements layer
  + New Sub layer
  + New Clip layer
  + New BitShift layer
  + New Depth2Space layer
  + New Abs layer
* Extension/speed-up:
  + SIMD Int32 ReLU
  + Extend concatenation
  + SIMD int32 add
  + Extend gridsample
  + Extend resize
  + Extension SIMD convolution 3x3 group=2 and depth=4/16 (for EE1 1.1)
* Fixes:
  + Flatten alignment with onnx
  + SIMD version of BiasAdd
  + Batch > 1
  + SIMD add scaling
  + ReduceMean

All changes that were implemented or planned were agreed.

Issuing bug reports in case of problems found is encouraged.

[JVET-AN0222](https://jvet-experts.org/doc_end_user/current_document.php?id=16206) [AHG14] New NN elements for SADL [A. Karabutov, E. Alshina (Huawei)]

This contribution presents the extensions in the Small AdHoc Deep Learning (SADL) library from Huawei Technologies with the following new elements:

1. BitShift,
2. Clip,
3. Depth2Space,
4. Abs.

The bitshift operation follows the method of ONNX and C++ (arithmetic shift).

Decision(SW): Adopt JVET-AN0222

[JVET-AN0257](https://jvet-experts.org/doc_end_user/current_document.php?id=16241) [AHG11] CPU and GPU time comparison for NNVC models [A. Karabutov, E.Alshina (Huawei), F. Galpin (InterDigital)] [late]

This contribution provides information about the execution time of neural networks across different devices. Two devices were tested: Huawei Mate50 Pro (CPU and NPU) and a high-end PC with an RTX 3090 GPU and CPU AMD Ryzen 9 5950X. LOP6 model from NNVC was used as the model under test. Several frameworks were used for the model inferencing: SADL, PyTorch and SNPE. The results showed that execution time on GPU can be faster than inference by SADL on CPU for the typical size of the processing block up to 15 times.

The current implementation of SADL allows you to control the operations executed by NN elements, but it is not optimized for running on GPUs, on which neural network solutions can demonstrate significant acceleration. To evaluate the complexity of algorithms on real devices, it is proposed to use the algorithm from JVET-AM0073 (including tables that allow the mapping).

Tile size and overlap can also be considered in the calculation, as well as bit depth of integer implementation.

It was commented that guaranteed real-time capability can likely not be deduced by this approach (or at least only for similar hardware architectures).

Further study on other elements of NNVC is recommended, e.g. to find coherence with kMAC/sample, CPU time, etc.

## AHG6/AHG12: Enhanced compression beyond VVC capability (70)

### Summary and BoG reports

Contributions in this area were discussed during 0905–1250 and during 1435–1535 on Sunday 5 Oct. 2025 (chaired by JRO).

[JVET-AN0024](https://jvet-experts.org/doc_end_user/current_document.php?id=16272) EE2: Summary report of exploration experiment on enhanced compression beyond VVC capability [V. Seregin, D. Buğdayci Sansli, J. Chen, R. Chernyak, K. Naser, J. Ström, F. Wang, M. Winken, X. Xiu, K. Zhang (EE coordinators)]

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Partitioning** | | | |
| 1.1a | Restrictions for TT splitting (normative way) with split\_cu\_flag context change | G.Wang (vivo) | Z.Deng(Bytedance)  Y.Liu(Transsion)  Z.Sun(OPPO) |
| 1.1b | Restrictions for TT splitting (non-normative way) | G.Wang (vivo) | Z.Deng(Bytedance)  Z.Sun(OPPO) |
| 1.1c | Temporal partitioning prediction optimization | G.Wang (vivo) | Z.Sun(OPPO) |
| 1.1d | Test 1.1a + Test 1.1c | G.Wang (vivo) | withdraw |
| 1.1e | Test 1.1b + Test 1.1c | G.Wang (vivo) | withdraw |
| 1.1f | Restrictions for TT splitting (normative way) | G.Wang (vivo) | Y.Liu(Transsion) |
| 1.1g | split\_cu\_flag context change | G.Wang (vivo) | Y.Liu(Transsion) |
| **2 Intra prediction** | | | |
| 2.1 | TMRL blend | S. Blasi  (Nokia) | V. Rufitskiy (TCL) |
| 2.3a | Switchable interpolation filter for TIMD side reference | T. Dong  (TCL) | S. Lee, Y. Kim, S. Noh, J. Bang, H. Choi (HNU) |
| 2.3b | Switchable interpolation filter for TIMD template. | T. Dong  (TCL) | M. Abdoli (Xiaomi) |
| 2.3c | Test 2.3a + Test 2.3b | T. Dong  (TCL) | S. Lee, Y. Kim, S. Noh, J. Bang, H. Choi (HNU) |
| 2.4 | Longer tap interpolation filtering | V. Rufitskiy  (TCL) | M. Abdoli (Xiaomi) |
| 2.5 | Combination of Test 2.1, Test 2.3b, and Test 2.4 | V. Rufitskiy  (TCL) | P. Andrivon (Ofinno) |
| 2.6a | Adaptive subsampling filter selection for CCLM/intra-CCCM/ALF-CCCM | Y. Kidani  (KDDI) | D. Bugdayci Sansli  (Nokia)  P.Bordes (InterDigital) |
| 2.6b | Adaptive subsampling filter selection for inter-CCCM | Y. Kidani  (KDDI) | D. Bugdayci Sansli  (Nokia) |
| 2.6c | Test 2.6a + Test 2.6b | Y. Kidani  (KDDI) | D. Bugdayci Sansli  (Nokia) |
| 2.7 | Reducing candidate modes in decoder derived CCP | S. Wan(NWPU)  S. Xie(ZTE) | P. Bordes (InterDigital) |
| 2.8 | Enhanced CCP Fusion mode | P. Bordes  (InterDigital) | Y.Kidani (KDDI)  N.Zouidi  (Ofinno) |
| **3** **Inter prediction** | | | |
| 3.1 | Generated merge candidates | D. Bugdayci Sansli  (Nokia) | K. Naser  (InterDigital)  R. G. Youvalari (Xiaomi) |
| 3.2a | Joint reordering of GPM with affine prediction | L. Zhang  (OPPO) | Y. Wang  (Bytedance) |
| 3.2b | Modifications to the affine merge list | L. Zhang  (OPPO) | Y. Wang  (Bytedance) |
| 3.2c | Test 3.2a + Test 3.2b | L. Zhang  (OPPO) | Y. Wang  (Bytedance) |
| 3.3 | Joint reordering of GPM with intra prediction | Z. Sun  (OPPO) | N.Zouidi  (Ofinno)  X.Li  (Alibaba) |
| 3.4a | Test 3.2a + Test 3.3 | Z. Sun  (OPPO) | X. Li  (Alibaba)  C. Ma  (Kwai) |
| 3.4b | Test 3.2a + Test 3.2b + Test 3.3 | Z. Sun  (OPPO) | X. Li  (Alibaba)  C. Ma  (Kwai) |
| **4** **Transform and coefficients coding** | | | |
| 4.1 | Linked sign prediction | Y. Zhang  (OPPO) | C. Hollmann (TCL) |
| 4.2a | Shifting quantization center for TSRC under non-CTC (RDOQ on) | Y. Yu  (OPPO)  M. Le Pendu (InterDigital) | P. Nikitin (Xiaomi)  M. Balcilar (Ofinno)  B. Ray (Qualcomm) |
| 4.2b | Shifting quantization center for RRC under non-CTC (DQ disabled, RDOQ on) | Y. Yu  (OPPO)  M. Le Pendu (InterDigital) | P. Nikitin (Xiaomi)  M. Balcilar (Ofinno)  B. Ray (Qualcomm) |
| 4.2c | Test 4.2a + Test 4.2b | Y. Yu  (OPPO)  M. Le Pendu (InterDigital) | P. Nikitin (Xiaomi)  M. Balcilar (Ofinno)  B. Ray (Qualcomm) |
| 4.2d | Shifting quantization center for TSRC under CTC | Y. Yu  (OPPO)  M. Le Pendu (InterDigital) | P. Nikitin (Xiaomi) |
| 4.2e | Shifting quantization center for RRC under CTC | Y. Yu  (OPPO)  M. Le Pendu (InterDigital) | P. Nikitin (Xiaomi) |
| 4.2f | Test 4.2d + Test 4.2e | Y. Yu  (OPPO)  M. Le Pendu (InterDigital) | P. Nikitin (Xiaomi) |
| 4.2g | Shifting quantization center for RRC under non-CTC (DQ disabled, RDOQ disabled) | M. Le Pendu (InterDigital)  Y. Yu  (OPPO) | M. Balcilar (Ofinno) |
| 4.2h | Shifting quantization center for TSRC under non-CTC (DQ disabled, RDOQ disabled) | M. Le Pendu (InterDigital)  Y. Yu  (OPPO) | M. Balcilar (Ofinno) |
| 4.2i | Test 4.2g + Test 3.2h | M. Le Pendu (InterDigital)  Y. Yu  (OPPO) | M. Balcilar (Ofinno) |
| 4.3a | Residual sign prediction restriction | C. Hollmann  (TCL) |  |
| 4.3b | RSP context modelling | C. Hollmann  (TCL) |  |
| 4.3c | Test 4.3a with retraining of existing contexts | C. Hollmann  (TCL) |  |
| 4.3d | Test 4.3a + Test 4.3b | C. Hollmann (TCL) |  |
| **5 In-loop filtering** | | | |
| 5.1a | Regularization of ALF-CCCM | Z. Xie  (OPPO) | M. Jia  (ZTE) |
| 5.1b | Regularization for ALF-CCCM enabled in I slice | Z. Xie  (OPPO) | M. Jia  (ZTE) |
| 5.2a | Non-downsampled ALF-CCCM | L. Xu  (OPPO) |  |
| 5.2b | Reuse of CU partition in ALF-CCCM | L. Xu  (OPPO) |  |
| 5.2c | Test 5.2a + Test 5.2b | L. Xu  (OPPO) |  |
| 5.3a | Remove single model of ALF-CCCM | N. Song  (OPPO) |  |
| 5.3b | Separate “bad window” condition for Cb and Cr components | N. Song  (OPPO) |  |
| 5.3c | Test 5.3a + Test 5.3b | N. Song  (OPPO) |  |
| 5.4 | Additional models for ALF-CCCM | F. Wang  (OPPO) |  |
| 5.5a | Test 5.1 + Test 5.2 | L. Xu  Z. Xie  (OPPO) | P.Astola (Nokia) |
| 5.5b | Test 5.1 + Test 5.2 + Test 5.4 | L. Xu  Z. Xie  F. Wang  (OPPO) | P.Astola (Nokia) |
| 5.5c | Test 5.1 + Test 5.2 + Test 5.3 + Test 5.4 | N. Song  L. Xu  Z. Xie  F. Wang  (OPPO) | P.Astola (Nokia) |
| 5.6 | Reuse of TALF control information | Y. Bai  (ZTE) | I.Jumakulyyev (Nokia)  Z.Xie (OPPO) |

***Partitioning***

**Test 1.1: On partitioning optimization ([JVET-AN0121](https://jvet-experts.org/doc_end_user/current_document.php?id=16105))**

In multi-type tree partitioning, different splitting patterns may result in the same coding block structure. As shown in Figure (a), a binary tree split in vertical direction followed by a ternary tree split in horizontal direction may have the same coding block structure as a ternary tree split in horizontal direction followed by a binary tree split in vertical direction. A similar case is shown in Figure (b).

A two lines with red x and a red x

AI-generated content may be incorrect.

In the tests, the duplicated partitioning splitting is disabled in a normative way and in encoder only. Additionally, context derivation for split\_cu\_flag was changed where instead of using width for the above neighbour block and height of the left neighbour block, the area of those blocks is utilized in comparing the current block area with the neighbour blocks area.

In the second part of the test, a prediction method for (No split) mode is introduced. For each CU, if the current depth is smaller than the temporal minimum QT depth minus 1, then (No split) is disallowed. Other split predictions are not changed. ECM has a similar prediction scheme for splitting modes (QT, BT, TT).

Test 1.1a: Restrictions for TT splitting (normative way) with split\_cu\_flag context change

Test 1.1b: Restrictions for TT splitting (non-normative way).

Test 1.1c: Temporal partitioning prediction optimization.

Test 1.1f: Restrictions for TT splitting (normative way).

Test 1.1g: split\_cu\_flag context change.



Results (also in runtime) for tests a and b confirmed by crosscheckers (at least partial results available), also confirm reduction in encoding time. Some crosscheckers expressed support for test 1.1a.

It was commented that 1.1g (which is a subset of 1.1a) has slightly better gain and also gives runtime reduction. It is a very small modification of the context definition, not adding context. It is also confirmed by crosschecker (crosscheck doc not registered yet) that also the encoding time is reduced. Revisit after availability of full crosscheck results.

***Intra prediction***

**Test 2.1: TMRL blend ([JVET-AN0171](https://jvet-experts.org/doc_end_user/current_document.php?id=16155))**

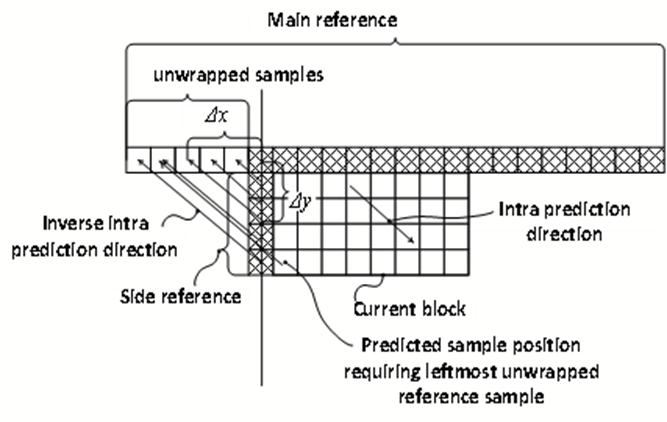
In the test, a new mode is introduced for blending TMRL predictors. In TMRL, a template search is performed to determine pairs of intra mode and MRL index. In this mode, a template search is performed to determine up to three pairs of intra mode and MRL index. Correspondingly up to three predictors are then blended together to compute a prediction for the current block. Up to two predictors are obtained using directional intra prediction modes. A third non-directional predictor can also be used, obtained using PLANAR or BV prediction.

To differentiate TMRL blend from conventional TMRL, a different template size and a different list of MRL indexes are used in TMRL blend than in conventional TMRL. The template size is adaptively set to 2 or 4 depending on the block size, similarly to the template size used in TIMD. Template costs are computed in such a way that template samples closer to the current block are weighted more than template samples located further away from the current block.

A flag is coded to indicate the mode.

**Test 2.3: Interpolation filter unification for unwrapping and TIMD template generation ([JVET-AN0120](https://jvet-experts.org/doc_end_user/current_document.php?id=16104))**

In Test 2.3a, a set of candidate interpolation filters (4-tap or 6-tap) is defined for generating side reference (shown in the next figure) samples along the prediction direction. The filter switch is done based on the block size.



In Test 2.3b, switchable interpolation filters (4-tap or 8-tap) are applied for template generation of TIMD. The filter switch is done based on the block size.

Test 2.3a: Switchable interpolation filter for TIMD side reference.

Test 2.3b: Switchable interpolation filter for TIMD template.

Test 2.3c: Test 2.3a + Test 2.3b.

**Test 2.4: Longer tap interpolation filtering ([JVET-AN0158](https://jvet-experts.org/doc_end_user/current_document.php?id=16142))**

For each predictor a component used in DIMD, an interpolation filter is selected, and the selection of an interpolation filter is performed based on the DIMD blending parameters specified for a block.

The length of the interpolation filters is selected according to the next table.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Weight | [1,7] | [8,24] | [25,31] | [32,48] | >48 |
| Filter length | 16 | 16 | 16 | 8 | 8 |

Similarly, when TIMD uses blending, an interpolation filter of 8-, 12-, or 16-taps is selected based on the number of modes used in the blending classified into the following categories:

* angular modes;
* DC mode;
* non-angular modes other than DC mode.

The filter length (number of taps) is determined from the number of modes in the categories as follows.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of angular modes | 2 | 1 | 1 | 1 |
| DC mode | any | 1 | 0 | any |
| Non-angular modes other than DC mode | any | 0 | 0 | more than 0 |
| Filter length | 12 | 16 | 8 | 12 |

When the main reference side has length of 8 or smaller then the number of taps of the selected interpolation filter is capped to not exceed 10-tap.

Test 2.4: Switchable interpolation filtering for DIMD and TIMD predictors.

**Test 2.5: Combination of TMRL, TIMD, and DIMD interpolation filtering ([JVET-AN0158](https://jvet-experts.org/doc_end_user/current_document.php?id=16142))**

In this combination test, TMRL blend is combined with TIMD interpolation filters such that Test 2.3b is used for filtering in the prediction derivation for TIMD template, while Test 2.4 filters are used in the TIMD and DIMD prediction derivation.

Test 2.5: Test 2.1 + Test 2.3b + Test 2.4.

**Test 2.6:  Adaptive subsampling filter selection for CCLM/CCCM ([JVET-AN0275](https://jvet-experts.org/doc_end_user/current_document.php?id=16279))**

Many 4:2:0 colour format videos are generated from 4:4:4 color format videos using different subsampling filters. For example, {1,1; 1,1} and {1, 2, 1; 1, 2 ,1} filters are used, which are known as MPEG1 and MPEG2 subsampling filters for 4:2:0 format, respectively. ECM uses only MPEG2 filter for CCLM and CCCM.

To align the subsampling filters between the generation process of 4:2:0 colour format videos and CCLM and CCCM processes, this test introduces an adaptive subsampling filter selection method for CCLM and CCCM. MPEG1 and MPEG2 subsampling filters are adaptively selected for the luma subsampling processes of CCLM and CCCM (including intra-CCCM and ALF-CCCM) by reusing the existing SPS flags in ECM, which specify the video colour format and spatial allocation of luma and chroma samples (i.e., sps\_chroma\_format\_idc, sps\_chroma\_horizontal\_collocated\_flag and sps\_chroma\_vertical\_collocated\_flag). The values of the existing SPS flags for every test sequence are automatically determined by the encoder-side method based on the analysis of a first picture characteristic.

Similarly, the adaptive filter selection method is also introduced into the filter derivation and application processes of inter-CCCM, where the prediction chroma sample value of inter-CCCM can be obtained using the following formula:

*predChromaVal = c0 L0+ c1L2 + c2L3 + c3L5 + c4 nonlinear((L0+L2+L3+L5+2) >> 2) + c5 B,*

in addition to the following existing inter-CCCM formula:

*predChromaVal = c0 L0+ c1L1 + c2L2 + c3L3 + c4L4 + c5L5 + c6 nonlinear((L0+L3+1) >> 1) + c7 B,*

where *nonlinear* is CCCM’s nonlinear operator and B is bias.

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Test 2.6a: Adaptive subsampling filter selection for CCLM/intra-CCCM/ALF-CCCM.

Test 2.6b: Adaptive subsampling filter selection for inter-CCCM.

Test 2.6c: Test 2.6a + Test 2.6b.

Test 2.6d: Test 2.6a for Gaming\_LD\_HD class with CTC QPs.

**Test 2.7: Reduced candidate modes in DDCCP ([JVET-AN0220](https://jvet-experts.org/doc_end_user/current_document.php?id=16204))**

In the test, cross-component models with local boost are removed from the DDCCP candidate list, the candidate list is changed from {CCLM, CCCM, CCCM with LB-CCP, MM-CCCM, MM-CCCM with LB-CCP, GL-CCCM} to {CCLM, CCCM, MM CCCM, GL-CCCM}.

The next table summarizes the reduction for the number of modes.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Number of non-fusion modes | Number of fusion modes | Total Number |
| ECM DDCCP | 6 | 15 | 21 |
| Test | 4 | 6 | 10 |
| Reduction | 2 | 9 | 11 |

Test 2.7: Reduced candidate modes in decoder derived CCP.

**Test 2.8: Enhanced CCP fusion mode ([JVET-AN0168](https://jvet-experts.org/doc_end_user/current_document.php?id=16152))**

In the test, for DDCCP or CCPM fusion modes, two CCP predictions using the regressing-based GPM (RGPM) method, which derives the blending weights from the template, are combined. The blending weights are derived jointly for the two chroma components using the same method as in RGPM and SGPM modes. The maximum number of fusion candidates is signalled in SPS (8 in AI and for inter slices, otherwise 12).

Test 2.8a: Enhanced CCP fusion mode.

Test 2.8b: Test 2.7 + Test 2.8a ([JVET-AN0173](https://jvet-experts.org/doc_end_user/current_document.php?id=16157)).



For 2.1, an expert comments that the gain is higher in class E than in other classes (lowest in class A). Also, some encoder optimization is performed that could also be applied in anchor. No additional TM is used, but additional processing similar to DIMD is necessary. Among 2.1…2.4, 2.1 has worst tradeoff.

It was commented by crosscheckers that gains of 2.3b and 2.4 are believed be additive, however no results are available on such a combination. Both are straightforward changes using longer interpolation filters. Standalone, 2.4 has a better tradeoff.

Decision: Adopt JVET-AN0158 test 2.4.

Revisit: Proponents of 2.3b are encouraged to report results on combination with 2.4.

Test 2.6 shows significant gain only for two sequences (one from class A, and one from class F), which is natural as the other sequences obviously used the chroma subsampling currently implemented.

It is straightforward to use the chroma subsampling (horizontal and/or vertical shift) information from SPS in CCCM/CCLM/ALF-CCCM (if available), as investigated in test 2.6a. An automatic detection algorithm is also provided.

In 2.6b, a different model is used for inter CCCM. However, inter CCCM does not use downsampling, and the new model does not show benefit

Results are confirmed by cross-check.

Decision: Adopt JVET-AN0090 test 2.6a, including the detection method (disabled by default). In CTC, the per-sequence config can be used to signal (update necessary for cat robot and slide show)

Revisit: It might be beneficial necessary to update the SDR CTC for those sequences in VTM (which has this option for CCLM but only for vertical shift). Also some of the sequences in CfE would have additional gain for ECM (see info in JVET-AN0090). Proponents are asked to provide updated configuration files in a new version of JVET-AN0090.

2.7 removes the two local boost modes showing reduction of encoding and decoding time with marginal loss in compression.

2.8a reduces the number of candidates from 12 to 8, which also gives similar reduction in encoding and decoding runtime.

2.8a has better tradeoff than 2.7, and also the combination 2.8b has worse tradeoff than 2.8a.

Decision: Adopt JVET-AN0168 test 2.8a.

***Inter prediction***

**Test 3.1: Generated merge candidates ([JVET-AM0059](https://jvet-experts.org/doc_end_user/current_document.php?id=15706))**

In this test, new merge candidates are generated from the existing ones in the list. After the initial merge list is constructed, new candidates are added to the list before the pair-wise average candidates are generated and ARMC is applied.

Candidate generation first creates two separate lists of uni-predictors from existing candidates. If a uni-prediction candidate is found, it is taken as it is and if a bi-prediction candidate is found, motion information from each prediction direction is taken to the related list.

The template cost of each candidate in the list is calculated, the lists are sorted in ascending cost order. From the lowest cost predictors, new uni and bi-predicted merge candidates are generated and added to the list before ARMC stage. The actual number of newly generated candidates depends on the found unique uni-predictors, where upper limit is set to the maximum number of merge candidates.

Test 3.1: Generated merge candidates.

**Test 3.2:  Joint reordering of GPM with affine prediction ([JVET-AN0091](https://jvet-experts.org/doc_end_user/current_document.php?id=16075))**

In ECM, when the jointly reordering GPM method is applied, a candidate list is constructed with each candidate containing one split mode and the MVs of the two GPM partitions. This candidate list is reordered using a template-based scheme. Only the selected candidate index, instead of the split mode and the motion information of the two partitions, needs to be signalled to the decoder to indicate the split mode and motion vector pair.

In Test 3.2a, a jointly reordering GPM with affine mode is introduced, where a candidate list is constructed with each candidate containing one split mode, two partition indices and two affine mode indicators (isAffine0, isAffine1), the usage of the mode is indicated by flag.

For each GPM partition, the partition index is used to get motion information from regular merge or affine merge lists, and the partition is predicted by affine or non-affine motion compensation. The candidate list is reordered using a template-based scheme, the selected candidate index is signalled to the decoder. Besides, the samples of the current template are mapped to the original domain during the construction of the jointly reordering GPM candidate list when the LMCS is enabled.

To reduce the complexity, the tested mode is only used when the block size is not equal to 128 or when there is at least one adjacent/non-adjacent coded block with affine prediction. When constructing the candidate list, the number of available affine merge candidates is reduced to 15, and the candidate list size is reduced to 10 when the current slice satisfied the LDB condition; otherwise, the candidate list size is set to be 16. No additional RDO is added on the encoder side.

In Test 3.2b, the construction of affine candidates is modified. For each control point, while checking the corresponding neighbouring positions, all the available motion information with a different reference picture is stored and then used to construct the possible affine candidates (temporally derived affine candidates for GPM). This process is carried out by traversing the possible CPMVs combinations. The neighbouring positions and CPMVs combination are the same as in ECM.

Test 3.2a: Joint reordering of GPM with affine prediction.

Test 3.2b: Affine merge list modifications.

Test 3.2c: Test 3.2a + Test 3.2b.

**Test 3.3: Joint reordering of GPM with intra prediction ([JVET-AN0092](https://jvet-experts.org/doc_end_user/current_document.php?id=16076))**

In the test, intra prediction modes are added as additional candidates into the joint reordering of split modes and partition indices, where the regular GPM modes together with intra prediction modes are reordered jointly, and there up to 6 intra-prediction candidate modes are added to the final list. A flag is introduced to indicate whether the scheme is applied.

The construction of intra prediction candidate modes is the same as in intra MPM list. To reduce the overall complexity for both encoding and decoding, the size of candidate list is set to 16 for slice not satisfying low delay condition; otherwise, the candidate list size is set to 10. The total RDO processes in ECM remain unchanged.

Test 3.3: Joint reordering of GPM with intra prediction.

**Test 3.4: Combination for GPM reordering tests ([JVET-AN0093](https://jvet-experts.org/doc_end_user/current_document.php?id=16077))**

Test 3.4a: Test 3.2a + Test 3.3.

Test 3.4b: Test 3.2a + Test 3.2b + Test 3.3.



Test 3.1: Results confirmed by cross-checkers, and technology supported by them. Tradeoff is within an acceptable margin.

Decision: Adopt JVET-AN0236 test 3.1

Results confirmed by cross-checkers, and support was expressed for the combination 3.4a which has the best overall tradeoff. It is noted that 3.2b which standalone provides more interesting gain for LB, loses this advantage when combined with 3.2a and 3.3 (in 3.4b).

Decision: Adopt JVET-AN0093 test 3.4a.

***Transform and coefficient coding***

**Test 4.1: Linked sign prediction ([JVET-AN0094](https://jvet-experts.org/doc_end_user/current_document.php?id=16078))**

In the test, a linked sign prediction method is introduced, where the residual contribution from non-sign predicted coefficients is added to the residual contribution of sign predicted coefficient when assessing boundary continuity, the method has three steps:

1. Non sign predicted coefficients linking process
2. Residual hypothesis of the linked coefficient group
3. Sign correction of non sign predicted coefficients.

In the non sign predicted coefficient linking process, those coefficients are classified into two groups: inside (type A) and outside (type B) of the sign predicted coefficient area, shown in the next figure.

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If neither type A nor type B coefficients exist, then the method is not used. If only type A or B coefficients exists, these non sign predicted coefficients are linked to the sign predicted coefficient with the smallest coefficient magnitude. Together, these coefficients constitute a linked coefficient group. The linked coefficients are used together to calculate two hypotheses for their combined contribution to the residual.

If both type A and B coefficients exist, type A coefficients are linked to the sign predicted coefficient with the second-smallest coefficient magnitude. Type B coefficients are linked to the sign predicted coefficient with the smallest coefficient magnitude. Each linked group will be used to calculate two hypotheses respectively for their combined contribution to the residual.

An example of linked coefficients grouping is shown in the next figure, where LSP denotes a selected sign predicted coefficient in the linked group.

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AI-generated content may be incorrect.

Similar to the current sign prediction method, each linked group is used to calculate two hypotheses (for positive and negative sign) of its contribution to the residual as follows:

or

where represents the combined residual contribution at the x-th and y-th position of the current block for one hypothesis of the linked group; represents the residual contribution at the x-th and y-th position of the current block from the sign predicted coefficient assuming it has a positive sign; represents the residual contribution at the x-th and y-th position of the current block from the i-th non sign predicted coefficient with signs applied as signalled by their corresponding bypass coded sign bits; and represents the number of non-SP coefficients in the LCG.

The signs for both type A and B coefficients remain bypass coded. However, when they are included into a linked group, the meaning of these signalled sign bits may be modified.

If the sign predicted coefficient associated with the group is correct, then the signs of its linked non sign predicted coefficients are the same as indicated by coded sign bits. Otherwise, the signs of its linked non sign predicted coefficients are interpreted as the reverse of what was signalled by their sign bits

Test 4.1: Linked sign prediction.

**Test 4.3: Residual sign prediction restriction ([JVET-AN0129](https://jvet-experts.org/doc_end_user/current_document.php?id=16113))**

In Test 4.3a, sign prediction is not applied to blocks that have only one non-zero coefficient in the sign prediction area.

Int Test 4.3b, the number of contexts used for the sign prediction flags is increased from 8 to 16 by adding a dependency on the transform type.

In Test 4.3c, a restriction from Test 4.3a has been applied and the initial values for the original context models have been retrained using the CabacTraining application. Initial values for other contexts have not been retrained.

Test 4.3a: Sign prediction restriction.

Test 4.3b: Increased contexts for sign prediction.

Test 4.3c: Test 4.3a with sign prediction context retraining.

Test 4.3d: Test 4.3a + Test 4.3b.

**Test 4.2: Shifting quantization center ([JVET-AN0095](https://jvet-experts.org/doc_end_user/current_document.php?id=16079), [JVET-AN0096](https://jvet-experts.org/doc_end_user/current_document.php?id=16080), [JVET-AN0097](https://jvet-experts.org/doc_end_user/current_document.php?id=16081))**

A fix for RDOQ implementation with LFNST and NSPT was submitted to ECM-18.0 in MR 960. In ECM, when RDOQ is used for a block with LFNST or NSPT, only up to 16 or 8 coefficients (depending on the block size) are encoded in RDOQ, instead of using the number of output coefficients of LFNST or NSPT for the current block.

In non-CTC configuration, when DQ and SignPred are disabled, the test results for the fix are as follows.

AI: Y -0.52% / U -0.21% / V -0.20%

RA: Y -0.35% / U -0.22% / V -0.14%

LDB: Y -0.25% / U 0.03% / V -0.09%

In the 4.2 tests, (\*) denotes the results when the fix is applied.

In ECM for RRC, the shifting amount in the dequantized coefficients is inversely proportional to the quantization indices of DQ as follows.

where is the dequantized coefficient, is the size of the lookup table, is the dequantized value of the -th of DQ,is the auxiliary quantization index calculated as

A lookup table of T is defined as follows.

In the test, the shift to dequantized values is applied when DQ is disabled (non-CTC configuration). The shift is applied as follows.

where is the dequantized coefficient, is the size of the lookup table, is the dequantized value of the quantization level , and is the auxiliary quantization level that is calculated as

Test 4.2a: Shifting of quantization center applied to TSRC ([JVET-AN0095](https://jvet-experts.org/doc_end_user/current_document.php?id=16079)).

Test 4.2b: Shifting of quantization center applied to RRC ([JVET-AN0095](https://jvet-experts.org/doc_end_user/current_document.php?id=16079)).

Test 4.2c: Test 4.2a + Test 4.2b ([JVET-AN0095](https://jvet-experts.org/doc_end_user/current_document.php?id=16079)).

Test 4.2g: Shifting of quantization center applied to RRC without RDOQ ([JVET-AN0097](https://jvet-experts.org/doc_end_user/current_document.php?id=16081)).

Test 4.2h: Shifting of quantization center applied to TSRC without RDOQ [JVET-AN0097](https://jvet-experts.org/doc_end_user/current_document.php?id=16081)).

Test 4.2i: Test 4.2h + Test 4.2h ([JVET-AN0097](https://jvet-experts.org/doc_end_user/current_document.php?id=16081)).

Test 4.2d: Shifting of quantization center applied to TSRC in CTC ([JVET-AN0096](https://jvet-experts.org/doc_end_user/current_document.php?id=16080))

A modification of the quantization center shift is tested with enabled DQ (used only in RRC in the CTC settings). Since the quantization level from Q0 or Q1 (instead of the DQ quantization index) is coded into a bitstream and the value of quantization level can be used to better reflect the rate, this test uses the quantization level from Q0 and Q1 instead of quantization indices of DQ to derive the shifting amount.

The same quantization level from quantizer Q0 and Q1 will generate a similar rate while the dequantization value of Q1 is smaller than that of Q0 for the same quantization level . Therefore, Q1 and Q0 are further modified to use different table sizes, a lookup table of size 32 and a lookup table of size 48 are used for Q0 and Q1, respectively.

where indicates the Q0 or Q1, is the dequantized coefficient, is the size of the lookup table, is the dequantized value of the quantization level from quantizer Qi, is the auxiliary quantization index calculated as

Furthermore, those tables can be interleaved to form one table as follows.

The dequantization value for quantization level k from Q0 or Q1 is calculated as follows.

where is the size of the lookup table, and is the auxiliary quantization index that is calculated as

Test 4.2e: Modified shifting of quantization center applied to RRC ([JVET-AN0096](https://jvet-experts.org/doc_end_user/current_document.php?id=16080))

Test 4.2f: Test 4.2d + Test 4.2e ([JVET-AN0096](https://jvet-experts.org/doc_end_user/current_document.php?id=16080))

In summary, there are the following aspects:

* RDOQ fix MR 960 (encoder only)
* Quantization center shift for TSRC with DQ enabled and disabled.
* Quantization center shift for RRC with DQ disabled.
* Modified quantization center shift for RRC with DQ enabled.



Test 4.1 does not have interesting tradeoff, encoding runtime increase too large.

Test 4.3a could be attractive in reducing the number of sign predictions, but this has some more significant loss in LB without large decrease in encoding/decoding time. It was reported by proponents that this is mainly caused by class E. Retraining reduces the chroma losses, but mainly by better gain in other classes.

Test 4.3b has good tradeoff for LB, but increasing the number of contexts does not improve in RA, and also in AI, gain is rather small. When combining tests a and b, RA even shows some loss

Overall, no relevant benefit in tests 4.1 and 4.3.

Test 4.2 investigates shifting of quantization center. This shows benefit using the shift for RRC (4.2b\*) but not for TSRC (4.2a\*) when DQ and sign prediction are disabled (non-CTC), and some further gain if RDOQ is also disabled (4.2g). Under CTC, application to TSRC gives some gain mainly for screen content (4.2d), and results in 4.2a\* and 4.2c\* also show that it has almost no impact in the non-CTC case when used for TSRC as well. Another variant is tested using a modified shifting for RRC which shows also some gain for non-screen content (4.2e). It is however not known how this modified shifting would work in the non-CTC case, and how this modified shifting would work for TSRC. Therefore, it is not to be considered at this moment, but further results may be provided in the future.

It was confirmed that sign bit hiding is enabled in all cases.

The normative change related to RRC would be to remove the constraint not using the quantization center when DQ is disabled (non-CTC case). This is asserted to be beneficial according to test 4.2b\*.

The normative change related to TSRC would be to enable the shift of quantization center (same as for RRC). This would also affect the CTC case (would be beneficial for screen content, test 4.2d).

In terms of normative changes, test 4.2c\* includes both aspects.

Decision: Adopt JVET-AN0095 test 4.2c\*. Also encoder modifications are necessary for CTC and non-CTC cases.

***In-loop filtering***

**Test 5.1: On regularization of ALF-CCCM ([JVET-AN0098](https://jvet-experts.org/doc_end_user/current_document.php?id=16082))**

A regularization method of EIP is applied to derive of ALF-CCCM coefficients, a regularization parameter is determined by the number of input samples. For the cases where the number of input samples is smaller than {16, 32, 64, 256, or 1024}, the regularization parameter is set to {192, 160, 128, 96, or 64}, respectively. Otherwise, the regularization parameter is always set to 32.

If there is a sample whose correction exceeds the threshold, the corresponding samples using the same ALF-CCCM model will not be filtered. In the test, the threshold is modified from 32 to 16 and 28 for the single-model filter and the multi-model filter, respectively.

The tested method is not applied to large blocks, which regression window is larger than 64x64, in ALF-CCCM.

Test 5.1a: Regularization of ALF-CCCM.

Test 5.1b: Regularization of ALF-CCCM enabled in I-slices.

**Test 5.2: On ALF-CCCM ([JVET-AN0099](https://jvet-experts.org/doc_end_user/current_document.php?id=16083))**

In ALF-CCCM method, the output samples of luma SAO are used as inputs to the CCCM filtering. To obtain a correction signal, the SAO chroma samples are subtracted from the CCCM output samples. The correction is weighted by 0.5 and added to the ALF chroma output to improve chroma reconstruction samples.

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. When applying multi-models, if any sample’s correction exceeds the threshold with either model, the corresponding samples using the same ALF-CCCM model will not be filtered.

Two aspects are introduced in this test:

1. Two new model types are introduced, which are non-downsampled models used in intra CCCM prediction and inter CCCM prediction. A slice level syntax element is signalled to indicate the application of non-downsampled models. A CTU level flag is further signalled to indicate whether the current CTU uses the downsampled ALF-CCCM. The filtering process of the two new model types is summarized in the following equations.

New model 0 (same to intra CCCM):

New model 1 (same to inter CCCM):

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1. The CU partition is introduced into ALF-CCCM. A slice level syntax element is signalled to indicate the application of CU partition. A CTU level flag is further signalled to indicate whether the current CTU is processed according to the CU partition instead of the existing 8 ALF-CCCM block sizes {4x4, 8x2, 2x8, 8x8, 16x16, 32x32, 64x64, 128x128}.

Test 5.2a: Non-downsampled ALF-CCCM.

Test 5.2b: CU partitioning in ALF-CCCM.

Test 5.2c: Test 5.2a + Test 5.2b.

**Test 5.3: Updated multi-models usage strategy for ALF-CCCM ([JVET-AN0101](https://jvet-experts.org/doc_end_user/current_document.php?id=16085))**

In ALF-CCCM, a single CCCM model is calculated for each block, and then samples within the block are filtered by using this model. If any sample in either the Cb or Cr component of the block has a correction exceeding a threshold, the block will use multi-models instead. When filtered by the multi-models, if there is a sample in either the Cb or Cr component whose correction exceeds the threshold, the corresponding samples that use the same model as this sample will not be filtered.

In Test 5.3a, single model is removed, and only multi-models are applied in a block.

In Test 5.3b, the correction threshold condition is treated separately for the Cb and Cr components. ECM disables the model for both components together.

Test 5.3a: Remove single model of ALF-CCCM.

Test 5.3b: Separate correction condition for Cb and Cr components.

Test 5.3c: Test 5.3a + Test 5.3b.

**Test 5.4: On ALF-CCCM model ([JVET-AN0103](https://jvet-experts.org/doc_end_user/current_document.php?id=16087))**

In the test, nonlinear terms with the chroma samples are added at additional positions for model 0, model 3, model 4 and model 5, as shown in yellow in the next table.

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Test 5.4: Additional models for ALF-CCCM.

**Test 5.5: Combination tests for ALF-CCCM ([JVET-AN0106](https://jvet-experts.org/doc_end_user/current_document.php?id=16090))**

Test 5.5a: Test 5.1a + Test 5.2c.

Test 5.5b: Test 5.1a + Test 5.2c + Test 5.4.

Test 5.5c: Test 5.1a + Test 5.2c + Test 5.3a +Test 5.4.

Test 5.5c\*: Test 5.5c with encoder optimization.

Test 5.5d: Test 5.1a + Test 5.2c + Test 5.3a.

**Test 5.6: Reuse of TALF control information ([JVET-AN0199](https://jvet-experts.org/doc_end_user/current_document.php?id=16183))**

In this test, slice and CTB-level TALF control information of the current picture is stored for a potential reuse in subsequent pictures. A flag is introduced to indicate whether the TALF control information of the current picture reuses that of the previously encoded picture.

At the encoder side, a similarity is evaluated by comparing the ALF CTB on/off status of the two pictures. The similarity score is defined as the percentage of CTBs with the same ALF on/off status relative to the total number of CTBs. If the similarity score falls below a threshold of 0.2, the TALF control information from the previous picture is not reused.

Test 5.5: Reuse of TALF control information.



Answers to questions:

* The regularization of 5.1a is used for both cases of single model and multi model.
* Decoding time is increased in 5.3a, as the option of single model is removed, and always two models need to be computed.

5.1…5.5 are related to different modifications in ALT-CCCM (and combinations thereof). 5.1.a and 5.3a each have a reasonable standalone tradeoff. However, a combination of 5.1a and 5.3a was not tested. 5.5d is a combination additionally including 5.2c (combination of 5.2a and 5.2b). Gains of all three together can at least for RA be considered as additive (as for RA 5.2c has almost no gain overall with loss in luma and small gain in chroma). Therefore, it might be concluded that the gain only comes from 5.1a and 5.3a, such that their gains would be additive in combination. Further, the runtime is also approximately the addition of the individual encoder runtimes of all three proposals (2% in total), whereas the addition of individual runtimes only from 5.1a and 5.3a would only be slightly more than 1%.

It was further remarked that the combination 5.2c has worse performance than 5.2a in RA, and for LB perhaps small gain, but a different balance balance between luma and chroma (which likely comes from 5.2b). Also the standalone tradeoff of either 5.2a or 5.2b is not reasonable in RA.

Decision: Adopt JVET-AN0098 Test 5.1a

Decision: Adopt JVET-AN0101 Test 5.3a

Test 5.6 does not provide gain in RA, and small loss in chroma. The runtime reduction is unreliable – according to proponents, there should be no change in runtime.

### EE2 contributions: Enhanced compression beyond VVC capability (24)

There was no presentation or discussion about specific proposals in this category – contributions were discussed in the context of the EE summary report JVET-AN0024. For actions decided to be taken, see section 5.2.1, unless otherwise noted.

[JVET-AN0090](https://jvet-experts.org/doc_end_user/current_document.php?id=16074) EE2-2.6: Adaptive subsampling filter selection for CCLM/CCCM [Y. Kidani, H. Kato, K. Kawamura (KDDI)]

[JVET-AN0251](https://jvet-experts.org/doc_end_user/current_document.php?id=16235) Crosscheck of JVET-AN0090 (EE2-2.6: Adaptive subsampling filter selection for CCLM/CCCM) [P. Bordes (InterDigital)] [late]

[JVET-AN0278](https://jvet-experts.org/doc_end_user/current_document.php?id=16282) Crosscheck report for JVET-AN0090 (EE2-2.6: Adaptive subsampling filter selection for CCLM/CCCM) [D. Buğdayci Sansli (Nokia)] [late]

[JVET-AN0091](https://jvet-experts.org/doc_end_user/current_document.php?id=16075) EE2-3.2: Joint reordering of GPM with affine prediction [L. Zhang, Y. Yu, Z. Sun, H. Yu, D. Wang (OPPO)]

[JVET-AN0315](https://jvet-experts.org/doc_end_user/current_document.php?id=16319) Crosscheck of JVET-AN0091 (EE2-3.2: Joint reordering of GPM with affine prediction) [Y. Wang (Bytedance)] [late] [miss]

[JVET-AN0092](https://jvet-experts.org/doc_end_user/current_document.php?id=16076) EE2-3.3: Joint reordering of GPM with intra prediction [Z. Sun, Y. Yu, L. Xu, H. Yu, D. Wang (OPPO)]

[JVET-AN0165](https://jvet-experts.org/doc_end_user/current_document.php?id=16149) Crosscheck of JVET-AN0092 (EE2-3.3: Joint reordering of GPM with intra prediction) [N. Zouidi (Ofinno)]

[JVET-AN0276](https://jvet-experts.org/doc_end_user/current_document.php?id=16280) Crosscheck of JVET-AN0092 (EE2-3.3: Joint reordering of GPM with intra prediction) [X. Li (Alibaba)] [late]

[JVET-AN0093](https://jvet-experts.org/doc_end_user/current_document.php?id=16077) EE2-3.4: Combination of EE2-3.2 and EE2-3.3 [L. Zhang, Z. Sun, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AN0323](https://jvet-experts.org/doc_end_user/current_document.php?id=16327) Crosscheck of JVET-AN0093 (EE2-3.4: Combination of EE2-3.2 and EE2-3.3) [X. Li (Alibaba)] [late]

[JVET-AN0332](https://jvet-experts.org/doc_end_user/current_document.php?id=16336) Crosscheck of JVET-AN0093 (EE2-3.4: Combination of EE2-3.2 and EE2-3.3) [C. Ma (Kwai)] [late] [miss]

[JVET-AN0094](https://jvet-experts.org/doc_end_user/current_document.php?id=16078) EE2-4.1: Linked Sign Prediction [Y. Zhang, L. Xu, Y. Yu, J. Gan, H. Yu, D. Wang (OPPO)]

[JVET-AN0312](https://jvet-experts.org/doc_end_user/current_document.php?id=16316) Crosscheck of JVET-AN0094 (EE2-4.1: Linked Sign Prediction) [C. Hollmann (TCL), L. Xu (SYSU)] [late]

[JVET-AN0095](https://jvet-experts.org/doc_end_user/current_document.php?id=16079) EE2-4.2a, b, c: Shifting Quantization Center for non-CTC [Y. Yu, H. Yu, J. Gan, L. Xu, H. Huang, F. Wang, Z. Xie, D. Wang (OPPO), M. Pendu, F. Le Léannec, K. Naser (InterDigital)]

[JVET-AN0239](https://jvet-experts.org/doc_end_user/current_document.php?id=16223) Crosscheck of JVET-AN0095 (EE2-4.2a, b, c: Shifting Quantization Center for non-CTC) [P. Nikitin (Xiaomi)] [late]

[JVET-AN0291](https://jvet-experts.org/doc_end_user/current_document.php?id=16295) Crosscheck of JVET-AN0095 (EE2-4.2a\*, b\*, c\*: Shifting Quantization Center for non-CTC) [M. Balcilar (Ofinno)] [late]

[JVET-AN0311](https://jvet-experts.org/doc_end_user/current_document.php?id=16315) Crosscheck of JVET-AN0095 (EE2-4.2a\*, b\*, c\*: Shifting Quantization Center for non-CTC) [B. Ray (Qualcomm)] [late]

[JVET-AN0096](https://jvet-experts.org/doc_end_user/current_document.php?id=16080) EE2-4.2d, e, f: Shifting Quantization Center for CTC [Y. Yu, H. Yu, J. Gan, L. Xu, H. Huang, F. Wang, Z. Xie, D. Wang (OPPO), M. Pendu, F. Le Léannec, K. Naser (InterDigital)]

[JVET-AN0240](https://jvet-experts.org/doc_end_user/current_document.php?id=16224) Crosscheck of JVET-AN0096 (EE2-4.2d, e, f: Shifting Quantization Center for CTC) [P. Nikitin (Xiaomi)] [late] [miss]

[JVET-AN0097](https://jvet-experts.org/doc_end_user/current_document.php?id=16081) EE2-4.2g, h, i: Shifting Quantization Center for non-CTC [M. Pendu, F. Le Léannec, K. Naser (InterDigital), Y. Yu, H. Yu, J. Gan, L. Xu, H. Huang, F. Wang, Z. Xie, D. Wang (OPPO)]

[JVET-AN0250](https://jvet-experts.org/doc_end_user/current_document.php?id=16234) Crosscheck of JVET-AN0097 (EE2-4.2g, h, i: Shifting Quantization Center for non-CTC) [M. Balcilar (Ofinno)] [late]

[JVET-AN0098](https://jvet-experts.org/doc_end_user/current_document.php?id=16082) EE2-5.1: On regularization of ALF-CCCM [Z. Xie, N. Song, L. Xu, F. Wang, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AN0295](https://jvet-experts.org/doc_end_user/current_document.php?id=16299) Crosscheck of JVET-AN0098 (EE2-5.1: On regularization of ALF-CCCM) [M. Jia (ZTE)] [late]

[JVET-AN0099](https://jvet-experts.org/doc_end_user/current_document.php?id=16083) EE2-5.2: On ALF-CCCM [L. Xu, N. Song, Z. Xie, F. Wang, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AN0327](https://jvet-experts.org/doc_end_user/current_document.php?id=16331) Crosscheck of JVET-AN0099 (EE2-5.2: On ALF-CCCM) [W. Yin (Bytedance)] [late] [miss]

[JVET-AN0101](https://jvet-experts.org/doc_end_user/current_document.php?id=16085) EE2-5.3: Updated multi-models usage strategy for ALF-CCCM [N. Song, L. Xu, Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AN0333](https://jvet-experts.org/doc_end_user/current_document.php?id=16337) Crosscheck of JVET-AN0101 (EE2-5.3: Updated multi-models usage strategy for ALF-CCCM) [C. Ma (Kwai)] [late] [miss]

[JVET-AN0103](https://jvet-experts.org/doc_end_user/current_document.php?id=16087) EE2-5.4: On ALF-CCCM Model [F. Wang, N. Song, Z. Xie, L. Xu, H. Huang, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AN0334](https://jvet-experts.org/doc_end_user/current_document.php?id=16338) Crosscheck of JVET-AN0103 (EE2-5.4: On ALF-CCCM Model) [C. Ma (Kwai)] [late] [miss]

[JVET-AN0106](https://jvet-experts.org/doc_end_user/current_document.php?id=16090) EE2-5.5: The combinations of EE2-5.1, EE2-5.2, EE2-5.3 and EE2-5.4 [N. Song, L. Xu, F. Wang, Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AN0322](https://jvet-experts.org/doc_end_user/current_document.php?id=16326) Crosscheck of JVET-AN106 (EE2-5.5: The combinations of EE2-5.1, EE2-5.2, EE2-5.3 and EE2-5.4) [P. Astola (Nokia)] [late]

[JVET-AN0120](https://jvet-experts.org/doc_end_user/current_document.php?id=16104) EE2-2.3: Interpolation filter unification for unwrapping and TIMD template generation [T. Dong, V. Rufitskiy, A. Filippov (TCL)]

[JVET-AN0288](https://jvet-experts.org/doc_end_user/current_document.php?id=16292) Crosscheck of JVET-AN0120 (EE2-2.3b: Interpolation filter unification for unwrapping and TIMD template generation) [M. Abdoli (Xiaomi)] [late]

[JVET-AN0296](https://jvet-experts.org/doc_end_user/current_document.php?id=16300) Crosscheck of JVET-AN0120 (EE2-2.3a/ab: Interpolation filter unification for unwrapping and TIMD template generation) [S. Lee, Y. Kim, S. Noh, J. Bang, H. Choi (HNU)] [late]

[JVET-AN0121](https://jvet-experts.org/doc_end_user/current_document.php?id=16105) EE2-1.1: On partitioning optimization [G. Wang, C. Zhou, Z. Lv (vivo)]

[JVET-AN0274](https://jvet-experts.org/doc_end_user/current_document.php?id=16278) Crosscheck of JVET-AN0121 (EE2-1.1: On partitioning optimization) [Z. Deng (Bytedance)] [late]

[JVET-AN0328](https://jvet-experts.org/doc_end_user/current_document.php?id=16332) Crosscheck of JVET-AN0121 (EE2-1.1a: On partitioning optimization) [Y. Liu, Y. Huo, Z. Zhang (Transsion)] [late]

[JVET-AN0344](https://jvet-experts.org/doc_end_user/current_document.php?id=16348) Crosscheck of JVET-AN0121 (EE2-1.1: On partitioning optimization) [Z. Sun (OPPO)] [late]

[JVET-AN0353](https://jvet-experts.org/doc_end_user/current_document.php?id=16357) Crosscheck of JVET-AN0121 (EE2-1.1f: On partitioning optimization) [Y. Liu, Y. Huo, Z. Zhang (Transsion)] [late]

[JVET-AN0129](https://jvet-experts.org/doc_end_user/current_document.php?id=16113) EE2-4.3: Residual Sign Prediction restriction [C. Hollmann, A. Filippov (TCL)]

[JVET-AN0338](https://jvet-experts.org/doc_end_user/current_document.php?id=16342) Crosscheck of JVET-AN0129 (EE2-4.3: Residual Sign Prediction restriction) [Y. Zhang (OPPO)] [late] [miss]

[JVET-AN0158](https://jvet-experts.org/doc_end_user/current_document.php?id=16142) EE2-2.4: Longer tap interpolation filtering [V. Rufitskiy, A. Filippov, T. Dong (TCL)]

[JVET-AN0289](https://jvet-experts.org/doc_end_user/current_document.php?id=16293) Crosscheck of JVET-AN0158 (EE2-2.4: Longer tap interpolation filtering) [M. Abdoli (Xiaomi)] [late]

[JVET-AN0168](https://jvet-experts.org/doc_end_user/current_document.php?id=16152) EE2-2.8a: Enhanced CCP Fusion mode [P. Bordes, F. Galpin, K. Naser, F. Le Léannec (InterDigital)]

[JVET-AN0171](https://jvet-experts.org/doc_end_user/current_document.php?id=16155) EE2-2.1: TMRL blend [S. Blasi, G. Kulupana, D. Buğdayci Sansli, J. Lainema (Nokia), K. Naser, G. Rath, F. Le Leannec, T. Dumas (InterDigital)]

[JVET-AN0302](https://jvet-experts.org/doc_end_user/current_document.php?id=16306) Crosscheck of JVET-AN0171 (EE2-2.1: TMRL blend) [V. Rufitskiy (TCL), Y. Lu (SYSU)] [late]

[JVET-AN0173](https://jvet-experts.org/doc_end_user/current_document.php?id=16157) EE2-2.8b: Combination of EE2-2.7 and EE2-2.8a [P. Bordes, F. Galpin, K. Naser, F. Le Léannec (InterDigital), S. Wan, Y. Yin, Z. Zhu (NWPU), S. Xie, X. Zeng, C. Huang (ZTE)]

[JVET-AN0166](https://jvet-experts.org/doc_end_user/current_document.php?id=16150) Crosscheck of JVET-AN0168 and JVET-AN0173 (EE2-2.8: Enhanced CCP Fusion mode) [N. Zouidi (Ofinno)]

[JVET-AN0329](https://jvet-experts.org/doc_end_user/current_document.php?id=16333) Crosscheck of JVET-AN0168 and JVET-AN0173 (EE2-2.8a, b: Enhanced CCP Fusion mode) [Y. Kidani (KDDI)] [late]

[JVET-AN0199](https://jvet-experts.org/doc_end_user/current_document.php?id=16183) EE2-5.6: Reuse of TALF control information [Y. Bai, M. Jia, W. Niu, S. Xie, C. Huang (ZTE)]

[JVET-AN0300](https://jvet-experts.org/doc_end_user/current_document.php?id=16304) Cross-check of JVET-AN0199 (EE2-5.6: Reuse of TALF control information) [I. Jumakulyyev (Nokia)] [late]

[JVET-AN0345](https://jvet-experts.org/doc_end_user/current_document.php?id=16349) Crosscheck of JVET-AN0199 (EE2-5.6: Reuse of TALF control information) [Z. Xie, L. Xu (OPPO)] [late] [miss]

[JVET-AN0220](https://jvet-experts.org/doc_end_user/current_document.php?id=16204) EE2-2.7: Reducing Candidate Modes in DDCCP [S. Wan, Y. Yin, Z. Zhu (NWPU), S. Xie, X. Zeng, C. Huang (ZTE)]

[JVET-AN0252](https://jvet-experts.org/doc_end_user/current_document.php?id=16236) Crosscheck of JVET-AN0220 (EE2-2.7: Reducing Candidate Modes in DDCCP) [P. Bordes (InterDigital)] [late]

[JVET-AN0236](https://jvet-experts.org/doc_end_user/current_document.php?id=16220) EE2-3.1: Generated Merge Candidates [D. Buğdayci Sansli, J. Lainema (Nokia)]

[JVET-AN0241](https://jvet-experts.org/doc_end_user/current_document.php?id=16225) Crosscheck of JVET-AN0236 (EE2-3.1: Generated Merge Candidates) [R. G. Youvalari (Xiaomi)] [late]

[JVET-AN0314](https://jvet-experts.org/doc_end_user/current_document.php?id=16318) crosscheck of JVET-AN0236 EE2-3.1: Generated Merge Candidates [K. Naser (InterDigital)] [late]

[JVET-AN0275](https://jvet-experts.org/doc_end_user/current_document.php?id=16279) EE2-2.5a: Combination of tests EE2-2.1, EE2-2.3b, and EE2-2.4 [V. Rufitskiy, T. Dong, A. Filippov (TCL), S. Blasi, G. Kulupana, D. Buğdayci Sansli, J. Lainema (Nokia), K. Naser, G. Rath, F. Le Leannec, T. Dumas (InterDigital)] [late]

[JVET-AN0308](https://jvet-experts.org/doc_end_user/current_document.php?id=16312) Crosscheck of JVET-AN0275 (EE2-2.5a: Combination of tests EE2-2.1, EE2-2.3b, and EE2-2.4) [P. Andrivon (Ofinno)] [late]

### EE2 related contributions (3)

Contributions in this area were discussed during 1535–1615 on Sunday 5 Oct. 2025 (chaired by JRO).

[JVET-AN0109](https://jvet-experts.org/doc_end_user/current_document.php?id=16093) EE2-4.1-related: On Linked Sign Prediction [Y. Zhang, L. Xu, Y. Yu, J. Gan, H. Yu, D. Wang (OPPO)]

This contribution proposes a new linked sign prediction method related to the EE2-4.1. In particular, restrictions to the linked sign prediction (LSP) algorithm are proposed, where only the SP coefficient with the lowest magnitude can be converted to LSP coefficient, and the LSP method will only be applied when the number of those non-SP coefficients inside the SP area (type A coefficients) is less than or equal to the number of predicted signs in the current block. The proposed method is implemented on top of ECM-18.0 and experimental results following the CTC are summarized as follows:

AI: -0.01 % (Y) 0.06% (U) 0.10% (V) 100.6% (EncT) 100.3% (DecT)

RA: -x.xx% (Y) x.xx% (U) x.xx% (V) xx% (EncT) xx% (DecT)

LD: -x.xx% (Y) x.xx% (U) x.xx% (V) xx% (EncT) xx% (DecT)

Overall, no better tradeoff compared to EE2-4.1.

[JVET-AN0307](https://jvet-experts.org/doc_end_user/current_document.php?id=16311) Crosscheck of JVET-AN0109 (EE2-4.1-related: On Linked Sign Prediction) [C. Hollmann (TCL)] [late]

[JVET-AN0175](https://jvet-experts.org/doc_end_user/current_document.php?id=16159) EE2-related: Unbiased Simple Quantizer (Related to EE2-4.2i) [M. Balcilar, M. Blestel, P. Andrivon (Ofinno)]

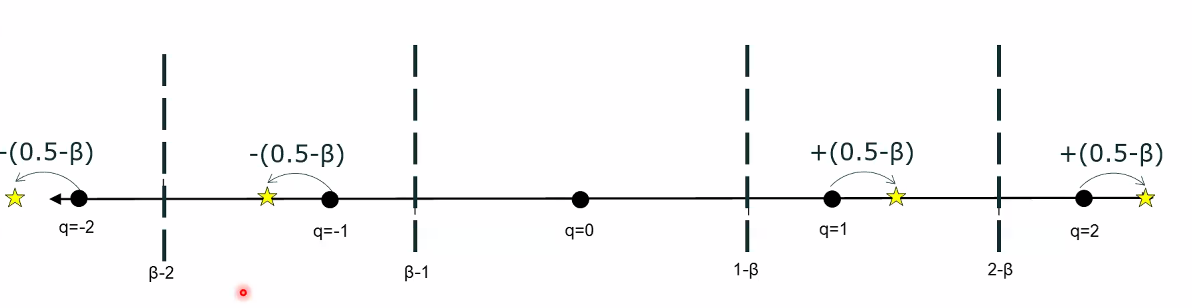
In JVET-AM0311, it was proposed to apply quantization center shifting when the encoder is supposed to use only Uniform Reconstruction Quantizer (URQ). This setting is non-CTC where the encoder should be configurated with both DQ and RDOQ disabled. In this contribution, it is claimed that URQ quantizer is biased and re-arranging dequantization points decreases the quantization error. Even though Test-4.2i decreases the error by shifting reconstruction points, this contribution shows that further improvement is possible. The experimental results over Test-4.2i are summarized as follows:

AI : -0.26% (Y) -0.51%(U) -0.71%(V) 100.0%(EncT) 100.4% (DecT)

RA : -1.29% (Y) -2.23 % (U) -2.29% (V) 100.4% (EncT) 100.7% (DecT)

LDB : -0.79%(Y) -0.18 % (U) -0.60% (V) 99.9% (EncT) 100.7% (DecT)

It is proposed to shift the dequantization points such that the distance between 0 and +/-1 is higher than for the higher points.



It was commented that the shift could also be applied at the encoder side.

It was asked if beta would be signalled? No, it is hard coded, same values as currently used for the different slice types.

It was pointed out that signalling beta in slice header might not be costly.

Investigate in EE along with JVET-AN0324.

[JVET-AN0316](https://jvet-experts.org/doc_end_user/current_document.php?id=16320) Crosscheck of JVET-AN0175 (EE2-related: Unbiased Simple Quantizer) [M. Le Pendu, F. Le Léannec (InterDigital)] [late]

[JVET-AN0324](https://jvet-experts.org/doc_end_user/current_document.php?id=16328) EE2-4.2i-related: Unbiased Simple Quantizer with Quantization Center Shifting [M. Le Pendu, F. Le Léannec (InterDigital)] [late]

In JVET-AN0097, the test EE2-4.2i proposed to apply quantization center shifting when the encoder only uses Uniform Reconstruction Quantizer (URQ). This setting is non-CTC where the encoder should be configured with both Dependent Quantization (DQ) and Rate Distortion Optimized Quantization (RDOQ) disabled. In JVET-AN0175 another adjustment method of the dequantization points was proposed to compensate for the bias of the URQ quantizer in the same non-CTC setting. In this contribution, it is claimed that the URQ quantizer bias can be similarly compensated using the quantization center shifting method with modified weight tables. The experimental results over EE2-4.2i are summarized as follows:

AI : -0.26% (Y) -0.55%(U) -0.67%(V) 99.8%(EncT) 100.3% (DecT)

RA : XX% (Y) XX %(U) XX% (V) XXX.X% (EncT) XXX.X% (DecT)

LDB: XX% (Y) XX %(U) XX% (V) XXX.X% (EncT) XXX.X% (DecT)

Similar concept as JVET-AN0175, but different way of implementation. Results are not identical (but gains are almost identical) due to different rounding.

Investigate in EE.

### ECM modifications and software improvements beyond EE2 (39)

#### Intra and CIIP (18)

Contributions in this area were discussed during 1615–1930 on Sunday 5 Oct. 2025 (chaired by JRO).

[JVET-AN0110](https://jvet-experts.org/doc_end_user/current_document.php?id=16094) Non-EE2: Enhancement of Non-CCP Reordering List [Z. Liu, L. Zhang, Y. Yu, H. Yu, D. Wang (OPPO)]

This contribution proposes to extend the non-CCP mode in Intra chroma coding by including additional chroma DIMD modes in the mode candidate list. On top of the ECM-18.0 software, simulation results {Y, U, V, EncT, DecT} for all the test sequences in the CTC are reported below:

AI: -0.02% 0.03% 0.02%, EncT 99.7%, DecT 100.1%

RA: x.xx% x.xx% x.xx%, EncT xx.x%, DecT, xx.x%

Not enough interest expressed due to small gain, and it is not a simplification, additional processing necessary.

[JVET-AN0336](https://jvet-experts.org/doc_end_user/current_document.php?id=16340) Cross-check of JVET-AN0110 (Non-EE2: Enhancement of Non-CCP Reordering List) [Z. Lyu (vivo)] [late]

[JVET-AN0123](https://jvet-experts.org/doc_end_user/current_document.php?id=16107) AHG12: Improvement on chroma MPM [Z. Li, W. Niu, X. Zeng, M. Jia, Y. Wang, C. Huang (ZTE)]

This proposal proposes to modify the chroma MPM list construction, specifically, to modify the MPM list construction for non-CCP mode. The simulation results on top of ECM-18.0 are summarized as follows:

AI : {-0.02%, -0.01%, 0.02%, 99.6%, 100.0%}

Not enough interest expressed due to small gain, and it is not a simplification, additional processing necessary.

[JVET-AN0346](https://jvet-experts.org/doc_end_user/current_document.php?id=16350) Crosscheck of JVET-AN0123 (Non-EE2: Improvement on chroma MPM) [Z. Xie, Z. Liu (OPPO)] [late] [miss]

[JVET-AN0126](https://jvet-experts.org/doc_end_user/current_document.php?id=16110) Non-EE2: MPDIP clipping [K.-Y. Kim, J.-H. Son, J.-Y. Kim, J.-S. Kwak (WILUS)]

This contribution proposes a modification to the MPDIP mode by clipping the predicted sample values to the range of the reference samples. This approach aligns with the existing behavior in the EIP mode. On top of ECM-18.0, the simulation results are reported as follows:

AI: {-0.01%, 0.02%, 0.09%, 99.8%, 100.1%}

RA: {\*-0.01%, \*0.05%, \*0.00%, XXX%, XXX%}   
(\*The overall result in RA was obtained by copying several anchor results.)

Not enough interest expressed due to small gain, and it is not a simplification, additional processing necessary to determine clipping values.

[JVET-AN0131](https://jvet-experts.org/doc_end_user/current_document.php?id=16115) Non-EE2: On interpolation filter for SGPM [J. Lee, G. Moon, K. Kim, J.-G. Kim (KAU), J. Lee, S.-C. Lim (ETRI)]

This contribution proposes a method to replace the interpolation filter for Spatial Geometric Partitioning Mode (SGPM). In ECM-18.0, SGPM forms candidates from combinations of the partition, block vectors, and angular modes. Each candidate produces the final predictor by blending two predicted blocks. However, when a smoothing filter is applied for prediction, the resulting prediction can become excessively smoothed. In the proposed method, the 8-tap cubic interpolation filter is used for the angular mode in SGPM. The proposed method was implemented on top of ECM-18.0 software, and the experimental results are summarized as follows:

* AI: -0.02 %, 0.04 %, 0.04 %, 100.2% (EncT), 100.1% (DecT)
* RA: x.x%, x.x%, x.x%, x% (EncT), x% (DecT)

Avoiding the switching between filters is assessed to be an advantage, and even comes with a small coding gain. By using always an 8-tap filter, encoding time should not be impacted, and decoding time might slightly increase.

Investigate in EE.

[JVET-AN0132](https://jvet-experts.org/doc_end_user/current_document.php?id=16116) Non-EE2: Enhancement of MDIP mode selection [K. Kim, G. Moon, J. Lee, J.-G. Kim (KAU), J. Lee, S.-C. Lim (ETRI)]

This contribution proposes a modification of the Most Dominant Intra Prediction (MDIP) process in ECM-18.0. In ECM-18.0, MDIP derives 8 directional intra-prediction modes from a histogram of gradients (HoG) of neighboring templates and selects the mode with the lowest template cost. However, this process does not evaluate non-directional candidates, and for modes predicted with Matrix-based Position-Dependent Intra Prediction (MPDIP), the template cost is still compared using the corresponding conventional angular prediction instead of MPDIP itself, which can limit accurate mode selection. To address these issues, the proposed method adds DC mode to the MDIP candidate list and applies MPDIP to template prediction in order to reorder the candidates. The proposed method was implemented on top of ECM-18.0 software, and the experimental results are summarized as follows:

* AI: -0.02%, 0.04%, 0.04%, 100.3% (EncT), 100.0% (DecT)
* RA: x.x%, x.x%, x.x%, x% (EncT), x% (DecT)

The number of candidates is increased by one by adding DC mode.

The usage of MPDIP prediction for template cost calculation likely increases processing complexity.

Preliminary results for RA show losses in some classes, and also for AI most gain comes from class E.

Not sufficient gain to justify investigation – further study recommended, e.g. why is loss occurring in RA?

[JVET-AN0152](https://jvet-experts.org/doc_end_user/current_document.php?id=16136) Non-EE2: Multiple Candidate Selection for MDIP [L. Wang, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang, W. Song (Hisense)]

In ECM, the MDIP mode is selected as the one with the lowest template cost among eight intra prediction modes derived from HoG, and its usage is indicated by a signaling flag. This contribution proposes a Second Most Dominant Intra Prediction mode, which selects an intra mode with the second lowest template cost from eight intra prediction modes. And a flag is used to indicate which mode is selected.

On top of ECM18.0, simulation results of the proposed method are reported as follows:

For AI configuration: -0.03%, 0.08%, 0.06%, with xx% EncT, xx% DecT.

For some classes, the encoder run time is increased. This may be due to the additional RD check necessary whether the new flag should use the best or the second best mode. The decoder run time should not be affected.

Investigate in EE. The encoder run time should be brought to reasonable tradeoff to justify against the small coding gain, the number of RD checks should not be increased.[JVET-AN0154](https://jvet-experts.org/doc_end_user/current_document.php?id=16138) Non-EE2: Position-dependent Weighted Prediction Extension [Y. Wang, X. Zeng, Z. Li, M. Jia, C. Huang (ZTE)]

This contribution proposes a position-dependent weighted prediction extension method. The method expends adjustment range and makes weight adjustment more relevant to position. The proposed method was implemented on top of ECM-18.0 software. The simulation results are summarized as follows,

AI: -0.02%/0.00%/0.04% Y/U/V, 99.9%/99.6% EncT/DecT.

Most gain coming from class E, also D/F/TGM have higher gain than the larger classes.

The gain is not high. Results confirmed and proposal supported by cross-checker.

Investigate in EE. It should be analysed if it requires more or less processing than the current method. The latter could be the case if more multiplications by zero occur.

[JVET-AN0313](https://jvet-experts.org/doc_end_user/current_document.php?id=16317) Crosscheck of JVET-AN0154 (Non-EE2: Position-dependent Weighted Prediction Extension) [S. Blasi (Nokia)] [late]

[JVET-AN0170](https://jvet-experts.org/doc_end_user/current_document.php?id=16154) Non-EE2: Additional OBIC candidates in MPM list [Y. Kim, S. Lee, S. Noh, H. Choi (HNU), W. Lim, S.-C. Lim (ETRI)]

In this contribution, a modification to MPM list construction is proposed. The MPM list provides a set of highly probable intra prediction modes for a coding unit, reducing signaling overhead and improving compression efficiency. However, the current MPM list relies only on DIMD, neighboring, and non-adjacent modes, which limits prediction diversity. Therefore, in the proposed method, additional Occurrence-Based Intra Coding (OBIC) modes are included in the MPM list. Moreover, OBIC modes already encompass non-adjacent spatial regions, restriction of search range for non-adjacent modes is applied.

On top of ECM-18.0, the reported PSNR-Y, Cb, Cr, BD-rate and {EncT, DecT} results are as follows:

* AI : -0.01%, 0.00 %, 0.06 % {101.7%, 102.7%}
* RA : x.x%, x.x%, x.x% {xxx%, xxx%}

Tradeoff is far from attractive – further study.

[JVET-AN0192](https://jvet-experts.org/doc_end_user/current_document.php?id=16176) Non-EE2: Modification of reconstructed area for EIP [W. Niu, S. Xie, Z. Li, M. Jia, Y. Bai, C. Huang (ZTE)]

This contribution proposes a replacement method of reconstructed areas for EIP mode. Smaller reconstructed areas are used to replace the existing reconstructed areas to reduce the complexity of ECM. The proposed method was implemented on top of ECM-18.0 software. The simulation results are summarized as follows,

AI: 0.00%/0.04%/0.05% Y/U/V, 99.3%/99.7% EncT/DecT

The area for deriving coefficients is reduced approximately by half.

Results confirmed by cross-checker, also expresses support for proposal.

Otherwise, no significant interest expressed.

[JVET-AN0280](https://jvet-experts.org/doc_end_user/current_document.php?id=16284) Crosscheck of JVET-AN0192 (Non-EE2: Modification of reconstructed area for EIP) [L. Xu (OPPO)] [late]

[JVET-AN0194](https://jvet-experts.org/doc_end_user/current_document.php?id=16178) Non-EE2: Extension on TMRL mode [Y. Liu, Y. Huo, Z. Zhang (Transsion)]

This contribution introduces two modifications to the Template-based Multiple Reference Line (TMRL) mode. The first modification is two distinct reference line sets for different coding unit (CU) sizes. The second is the use of differently sized templates for different CU sizes. The performance of the proposed method, evaluated against ECM-18.0, is summarized as follows {for Y, U, V, EncT, DecT, EncVmPeak, DecVmPeak}:

AI { -0.02%, 0.02%, 0.09%, 87.9%, 100.1%, 99.7%, 100.0%}

RA { xxx%, xxx%, xxx%, xxx%, xxx%, xxx%, xxx%}

Overall, the method in both aspects would increase the average complexity (using higher number of reference lines for larger blocks, and larger sets of templates for larger blocks as well). For reference line 1 always a template size of 1 is used.

Worst case complexity might not be affected.

Preliminary results in RA indicate loss in class C.

Encoding time is unreliable, an independent expert reports that he found roughly 100 %.

Not sufficient gain to justify complexity increase – further study recommended, e.g. why is loss occurring in RA, what is the benefit of the two aspects, and what is complexity impact in terms of processing on average and in worst case?

[JVET-AN0200](https://jvet-experts.org/doc_end_user/current_document.php?id=16184) Non-EE2: On improving CIIP Fusion [Y. Wang, X. Zeng, M. Jia, Z. Li, C. Huang (ZTE)] [late]

This contribution proposes a CIIP position-dependent weighted prediction method, that is not limited to fixed weights and makes the weight adjustment more relevant to position. The proposed method was implemented on top of ECM-18.0 software[1]. The simulation results are summarized as follows,

LDB: -0.04%/0.18%/0.07% Y/U/V, 99.9%/99.8% EncT/DecT.

RA (preliminary results): around -0.01% luma gain.

Weight derivation is sometimes changed from subblock level to pixel level.

Not enough interest expressed due to small gain, and it is not a simplification, additional processing at pixel level necessary.

[JVET-AN0354](https://jvet-experts.org/doc_end_user/current_document.php?id=16358) Crosscheck of JVET-AN0200 (Non-EE2: On improving CIIP Fusion) [Z. Zhang (Alibaba)] [late]

[JVET-AN0219](https://jvet-experts.org/doc_end_user/current_document.php?id=16203) AHG12 IntraTMP with DMVR [K. Naser, P. Bordes, F. Le Léannec, A. Robert (InterDigital)]

This contribution is about enabling DMVR (decoder side motion vector refinement) mode with IntraTMP coded blocks. Specifically, 2 block vectors from the IntraTMP list are selected and a block matching refinement is performed. The resulting predictors are blended using constant weights. The following results are obtained:

AI -0.05% 0.00% 0.03% 100.1% 100.1%

Basically this is applying a weighted bi prediction in the main mode in IntraTMP (only in case of full pixel). No new mode is introduced. Search is performed by block matching starting from the current vector, using a 3x3 search range, 2 iterations. The blending is done 3/4 and 1/4.

This is not the worst case of IntraTMP modes, which may be the reason that the decoding time is not largely increased. A report on the frequency of usage would be helpful.

Investigate in EE.

[JVET-AN0221](https://jvet-experts.org/doc_end_user/current_document.php?id=16205) AHG12: Reference sample generation for intra prediction [T. N. Canh, P. Yin, S. McCarthy (Dolby)]

This contribution proposes a reference sample generation (RSG) method to generate missing reference samples in intra prediction. For intra coding block in inter frames, RSG replaces simple repeated padding of missing reference samples with available collocated reference samples. On top of ECM-18.0, the BD-Rate achieved of RSG is as follows:

RA (Y/ Cb/ Cr): { 0.01%, -0.01%, 0.00%} {xx.xx%, xx.xx%}

LDB (Y/ Cb/ Cr): { -0.09%, 0.25%, -0.03%} {xx.xx%, xx.xx%}

Five rate points are copied from ECM-18.0 anchor in RA.

In RA, high loss in class A1, one sequence (Campfire)

Impact on runtime should be small, as only copying colocated samples.

Comments were made that it appears strange an encoder had selected intra, but still appropriate samples are found in a temporal reference.

It was commented that rather than just copying reference samples it would be appropriate to apply LMCS.

It was commented that there may be problems when GDR or RPR is used.

It was commented that usage of motion compensated samples might give better results, but that would also increase complexity.

Several experts expressed interest to study this in EE.

Investigate in EE, including study of applying LMCS, and reporting about possible interference with GDR and RPR. Also LDP results to be reported.

[JVET-AN0234](https://jvet-experts.org/doc_end_user/current_document.php?id=16218) Non-EE2: On filtering condition for angular modes [Z. Zhu, Y. Yin, H. Xu, S. Wan (NWPU), S. Xie, X. Zeng, C. Huang (ZTE)]

In ECM-18.0, the decision on whether to apply reference smoothing filter is determined based on the MDIS condition[1]. However, in the current ECM version, the existing condition may ​​not be appropriate​​ because of current prediction methods. This contribution proposes to disable usage of {1, 2, 1}-filtered reference samples in some larger blocks than those currently allowed, thereby avoiding switching between the cubic interpolation filter and the gaussian interpolation filter.​ On top of ECM-18.0, the overall coding performance for AI configuration are reported as below:

when the block size condition is modified from 32 to 64:

Natural: -0.01%, 0.02%, 0.04%, with 100.1% EncT, 99.7% DecT.

Class F: -0.06%, -0.14%, -0.24%, with xxx% EncT, xxx% DecT.

when the block size condition is modified from 32 to 256:

Natural: -0.01%, 0.04%, 0.04%, with 100.0% EncT, 100.0% DecT.

Class F: -0.10%, 0.08%, -0.17%, with 100.0% EncT, 98.9% DecT.

Almost no change in camera captured content, some gain in class F.

Decoding time seems unreliable.

Even though it is not completely avoiding switching, it could be a complexity advantage. It could be tested in EE what happens if the condition is modified for all blocks.

Investigate in EE. Also test a case where the cubic filter is used for all block sizes (and no boundary sample filtering is applied). Also report results for TGM.

[JVET-AN0279](https://jvet-experts.org/doc_end_user/current_document.php?id=16283) Crosscheck of AN0234 (Non-EE2: On filtering condition for angular modes) [L. Xu (OPPO)] [late]

[JVET-AN0270](https://jvet-experts.org/doc_end_user/current_document.php?id=16274) Non-EE2: CCCM with clipping [L.-C. Xu, C.-F. Liao, Y.-K. Lu, F. Liang (SYSU)] [late]

TBP

[JVET-AN0286](https://jvet-experts.org/doc_end_user/current_document.php?id=16290) Non-EE2: TMRL Angle Offset Refinement [G. Rath, K. Naser, F. Le Léannec, T. Dumas (InterDigital)] [late]

TBP

[JVET-AN0287](https://jvet-experts.org/doc_end_user/current_document.php?id=16291) Non-EE2: Combined Angular- and Gradient-PDPC [G. Kulupana, S. Blasi, N. Neumann, J. Lainema (Nokia)] [late]

TBP

[JVET-AN0299](https://jvet-experts.org/doc_end_user/current_document.php?id=16303) Non-EE2: Improvement for candidates on MPM [W. Niu, Z. Li, S. Xie, M. Jia, Y. Bai, C. Huang (ZTE)] [late]

TBP

[JVET-AN0309](https://jvet-experts.org/doc_end_user/current_document.php?id=16313) Crosscheck of JVET-AN0299 (Non-EE2: Improvement for candidates on MPM) [L. Xu (OPPO)] [late]

#### Inter (3)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0111](https://jvet-experts.org/doc_end_user/current_document.php?id=16095) Non-EE2: additional candidates for regular inter AMVP candidate list [C. Wang, Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AN0356](https://jvet-experts.org/doc_end_user/current_document.php?id=16360) Crosscheck of JVET-AN0111 (Non-EE2: additional candidates for regular inter AMVP candidate list) S. Hong (Nokia) [late]

[JVET-AN0218](https://jvet-experts.org/doc_end_user/current_document.php?id=16202) Non-EE2: Extension of Sub-Block Merge Mode Availability Conditions [Y. Liu, Y. Huo, Z. Zhang (Transsion)]

[JVET-AN0266](https://jvet-experts.org/doc_end_user/current_document.php?id=16252) Pairwise Merge Candidates with Motion Vector Scaling [S. Hong, L. Wang, K. Panusopone, D. Rusanovskyy (Nokia)]

#### GPM (3)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0142](https://jvet-experts.org/doc_end_user/current_document.php?id=16126) Non-EE2: GPM without blending for screen content [J.-Y. Kim, J.-H. Son, K. Kim, J.-S. Kwak (WILUS)]

[JVET-AN0155](https://jvet-experts.org/doc_end_user/current_document.php?id=16139) Non-EE2: On improving adaptive GPM blending [Z. Zhang, Y. Huo, Y. Liu (Transsion)]

[JVET-AN0283](https://jvet-experts.org/doc_end_user/current_document.php?id=16287) Crosscheck of JVET-AN0155 (Non-EE2: On improving adaptive GPM blending) [M. Abdoli (Xiaomi)] [late] [miss]

[JVET-AN0191](https://jvet-experts.org/doc_end_user/current_document.php?id=16175) Non-EE2: Binarization Improvement of GPM [X. Wang, J. Chen, C. Zhu, L. Luo, H. Guo (UESTC), Y. Huo, Y. Liu, Z. Zhang (Transsion)]

[JVET-AN0321](https://jvet-experts.org/doc_end_user/current_document.php?id=16325) Crosscheck of JVET-AN0191 (Non-EE2: Binarization Improvement of GPM) [K. Jia (Alibaba)] [late]

#### In-Loop Filters (7)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0086](https://jvet-experts.org/doc_end_user/current_document.php?id=16070) AHG12: Bug Fix for ALF Coefficient Calculation [R. Xu, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang, W. Song (Hisense)]

[JVET-AN0350](https://jvet-experts.org/doc_end_user/current_document.php?id=16354) Crosscheck of JVET-AN0086 (AHG12: Bug Fix for ALF Coefficient Calculation) [Z. Zhu, S. Wan (NWPU)] [late]

[JVET-AN0113](https://jvet-experts.org/doc_end_user/current_document.php?id=16097) Non-EE2: Additional candidates for merge mode in ALF-CCCM [H. Zhang, N. Song, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AN0331](https://jvet-experts.org/doc_end_user/current_document.php?id=16335) Crosscheck of JVET-AN0113 (Non-EE2: Additional candidates for merge mode in ALF-CCCM) [H.-J. Jhu (Kwai)] [late]

[JVET-AN0114](https://jvet-experts.org/doc_end_user/current_document.php?id=16098) Non-EE2: Local boosting CCP for ALF-CCCM [H. Huang, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AN0343](https://jvet-experts.org/doc_end_user/current_document.php?id=16347) Crosscheck of JVET-AN0114 (Non-EE2: Local boosting CCP for ALF-CCCM) [Z. Deng (Bytedance)] [late]

[JVET-AN0130](https://jvet-experts.org/doc_end_user/current_document.php?id=16114) Non-EE2: Improvement on Frame-level Inheritance Mode in ALF-CCCM [M. Jia, Y. Bai, X. Zeng, Z. Li, C. Huang (ZTE)]

[JVET-AN0347](https://jvet-experts.org/doc_end_user/current_document.php?id=16351) Crosscheck of JVET-AN0130 (Non-EE2: Improvement on Frame-level Inheritance Mode in ALF-CCCM) [Z. Xie (OPPO)] [late] [miss]

[JVET-AN0163](https://jvet-experts.org/doc_end_user/current_document.php?id=16147) AHG12: On improving the bi-filtering modes in TALF [P. Astola, D. Buğdayci Sansli, J. Lainema (Nokia)]

[JVET-AN0337](https://jvet-experts.org/doc_end_user/current_document.php?id=16341) Crosscheck of JVET-AN0163 (AHG12: On improving the bi-filtering modes in TALF) [N. Song (OPPO)] [late]

[JVET-AN0164](https://jvet-experts.org/doc_end_user/current_document.php?id=16148) Non-EE2: ALF coefficient coding group extension [I. Jumakulyyev, D. Buğdayci Sansli, J. Lainema (Nokia)]

[JVET-AN0297](https://jvet-experts.org/doc_end_user/current_document.php?id=16301) Crosscheck of JVET-AN0164 (Non-EE2: ALF coefficient coding group extension) [V. Shchukin (Ericsson)] [late] [miss]

[JVET-AN0269](https://jvet-experts.org/doc_end_user/current_document.php?id=16273) AHG12: BIF with before DBF samples [K. Takada, S. Deshpande (Sharp)]

#### Entropy coding, transforms, quantization, and transform coefficient coding (6)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0087](https://jvet-experts.org/doc_end_user/current_document.php?id=16071) AHG12: Budget Control for Transform Skip Residual Coding [R. Xu, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang, W. Song (Hisense)]

[JVET-AN0351](https://jvet-experts.org/doc_end_user/current_document.php?id=16355) Crosscheck of JVET-AN0087 (AHG12: Budget Control for Transform Skip Residual Coding) [Z. Zhu, S. Wan (NWPU)] [late]

[JVET-AN0088](https://jvet-experts.org/doc_end_user/current_document.php?id=16072) AHG12: Context Modeling for sig\_coeff\_flag in TSRC [R. Xu, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang, W. Song (Hisense)]

[JVET-AN0112](https://jvet-experts.org/doc_end_user/current_document.php?id=16096) Non-EE2: Coding of a coefficient level in TSRC [Y. Yu, L. Xu, J. Gan, H. Yu, D. Wang (OPPO)]

[JVET-AN0284](https://jvet-experts.org/doc_end_user/current_document.php?id=16288) Crosscheck of JVET-AN0112 (Non-EE2: Coding of a coefficient level in TSRC) [M. Abdoli (Xiaomi)] [late] [miss]

[JVET-AN0125](https://jvet-experts.org/doc_end_user/current_document.php?id=16109) Non-EE2: On CABAC bin budget constraint [K.-Y. Kim, J.-H. Son, J.-Y. Kim, J.-S. Kwak (WILUS)]

[JVET-AN0325](https://jvet-experts.org/doc_end_user/current_document.php?id=16329) Crosscheck of JVET-AN0125 (Non-EE2: On CABAC bin budget constraint) [P. Nikitin (Xiaomi)] [late] [miss]

[JVET-AN0169](https://jvet-experts.org/doc_end_user/current_document.php?id=16153) Non-EE2: On inter multiple transform set selection and advanced SBT [J. Huo, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang, W. Song (Hisense)]

[JVET-AN0349](https://jvet-experts.org/doc_end_user/current_document.php?id=16353) Crosscheck of JVET-AN0169 (Non-EE2: On inter multiple transform set selection and advanced SBT) [Y. Yin, S. Wan (NWPU)] [late]

[JVET-AN0214](https://jvet-experts.org/doc_end_user/current_document.php?id=16198) AhG12: CABAC contexts retraining [F. Galpin (InterDigital)]

#### Other (2)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0211](https://jvet-experts.org/doc_end_user/current_document.php?id=16195) AhG12: Second reference frame for temporal partitioning prediction [G. Laroche, P. Onno, B. Galmiche (Canon)]

[JVET-AN0228](https://jvet-experts.org/doc_end_user/current_document.php?id=16212) Independent CTUs for TM-padding [N. Neumann (Nokia)]

### CTC for EE2/ECM and general ECM improvements (4)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0118](https://jvet-experts.org/doc_end_user/current_document.php?id=16102) AHG6: ECM software extension for RDO count information [Y. Tokumo, S. Hong, T. Ikai (Sharp)]

[JVET-AN0352](https://jvet-experts.org/doc_end_user/current_document.php?id=16356) Crosscheck of JVET-AN0118 (AHG6: ECM software extension for RDO count information) [B. Wang, R. Chernyak (Tencent)] [late] [miss]

[JVET-AN0151](https://jvet-experts.org/doc_end_user/current_document.php?id=16135) AHG6: Additional config files for ECM 2x and ECM 5x [T. Ikai, K.-W. Liang (Sharp)]

[JVET-AN0217](https://jvet-experts.org/doc_end_user/current_document.php?id=16201) AHG6: Software Implementation for Runtime Reporting [S.-Y. Lim, J. Gao, J.-Y. Thong, H.-B. Teo, C.-S. Lim, K. Abe (Panasonic)]

[JVET-AN0271](https://jvet-experts.org/doc_end_user/current_document.php?id=16275) Software optimization and complexity reduction of ECM [Y.-J. Chang, C.-C. Chen, M. Coban, K. Cui, P. Garus, N. Hu, M. Karczewicz, P.-H. Lin, X. Meng, B. Ray, V. Seregin, Y. Shao, G. Verba, H. Wang, E. Ye, R. Yu, Y. Zhang, Z. Zhang, W. Zhu (Qualcomm) [late]

# High-level syntax (HLS) and related proposals (91)

## AHG9: Aspects of SEI messages in VSEI, VVC, HEVC and AVC (6)

Contributions in this area were discussed during 0900–0955 on Saturday 4 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0071](https://jvet-experts.org/doc_end_user/current_document.php?id=16055) AHG9: On HEVC Omnidirectional viewport SEI in HEVC [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

It is asserted the polynomial describing the sample location remapping process in the HEVC Omnidirectional viewport SEI message semantics should begin at power one and not power zero. In addition, the technical description used when the number of coefficients is zero is recognized as a subset of the general polynomial case and the description may be simplified. Two options to address this issue are presented. This change is proposed for future HEVC errata such as AM1018. A delta text relative to AM1018 is also included.

1. (technical) Change exponent in equation D61 from j to j+1
2. (additional editorial) Change exponent in equation D61 and modify semantics when coefficients are not signalled to infer a polynomial and use equation D61 in all cases.
3. (technical) A third option is mentioned. A single sentence is added stating that the signalled DC coefficient is replaced by zero before applying equation D61.

It is noted that the proposed change is about the fisheye message, rather than the omnidirectional viewpoint.

It was suggested to check with the original contributor of the fisheye message.

Revisit.

[JVET-AN0072](https://jvet-experts.org/doc_end_user/current_document.php?id=16056) AHG9: On 3DRD, MAI and Alternative Depth information SEI messages in HEVC and VSEI [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

Several editorial changes in describing floating point values in 3DRD SEI message of HEVC, DA structure and MAI Alternate depth information messages included in both HEVC and VSEI are proposed. This change is proposed for HEVC errata such as AM1018 and VSEI. A delta text relative to AM1018 is also included.

1) (editorial). Transpose table G.2, of 3D references display SEI (HEVC only), for consistency between floating point descriptions i.e. Table G.4, G.5.

2) (editorial) Remove notes mentioning similarity to withdrawn specification IEC 60559:1989 used in 3DRA, DA, MAI, and Alternate Depth information messages.

3) (editorial) Clarify MAI semantics syntax elements in association table.

a) Introducing variables for length of different mantissa elements of the MAI message

b) Add an additional column to table G.5 to describe the length of mantissa elements of MAI floating point syntax.

4) (editorial) Renaming syntax elements corresponding to MAI floating point elements in MAI and Alternate Depth Information SEI messages.

Delegate all editorial improvements to the editors.

[JVET-AN0076](https://jvet-experts.org/doc_end_user/current_document.php?id=16060) AHG9: On floating point signaling in SEI [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

JVET- AN0076 also relates to JVET-AM2006 (VSEI) and in JVET-AM2032 TuC for VSEI

TBP

[JVET-AN0185](https://jvet-experts.org/doc_end_user/current_document.php?id=16169) AHG9: Miscellaneous on VSEI codec interfaces [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

JVET-AN0185 also relates to the NNPF, SPO, and DSC SEI messages

This contribution proposes miscellaneous modifications that are asserted to provide improvement to some aspects of the AVC / HEVC / VVC interface text for VSEI v4. The proposed modifications are as follows:

(Related to NNPFC SEI messages)

1 Modify a constraint on repetition of NNPFC SEI message.

(Related to SPO SEI messages)

2 Add constraints addressing cubemap projection SEI message in the AVC / HEVC interface text.

3 Add missing payloadType values of SeiProcessingOrderSeiList in the AVC / HEVC interface text.

(Related to DSC SEI messagess)

4 Add additional nal\_unit\_type values for NonVclDigitallySignedNalUnitsList.

Agreed to item 1 as a sensibility constraint.

Agreed to item 2, 3.

Regarding item 4, it is noted that in multi-layer AVC it depends on the profile if some NAL unit types are VCL or non-VCL. It may be desirable to not require the verifier to consider the profile.

Further discussion requested on item 4.

Further discussed on 5 Oct 2025.

Conditionally adopt item 4 with revised language regarding modifications to AVC interface of NAL unit type for types 20 and 21 to always be considered as VCL NAL unit for the purposes of signing, subject to review of text.

## AHG9: Aspects related to VSEI version 4 (30)

VSEI v4 is intended for FDIS and ITU-T consent at this meeting. There is a preference for design stability. Bug fixes and editorial improvements are OK. We intend to be cautious about adoptions that change the design. Small items with clear benefits may be considered.

### Editorial updates (4)

Contributions in this area were discussed during 0955–1205 on Saturday 4 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0067](https://jvet-experts.org/doc_end_user/current_document.php?id=16051) AHG9: Comments on Neural-network Post-filter in VSEI V4 and V3 [S. Deshpande (Sharp)]

JVET-AN0067 also relates to the NNPF SEI messages

Following asserted bug-fix is proposed related to neural-network post-filter in VSEI V4 and V3:

* Proposal 1: It is asserted that for certain value of y that can occur, the function InpSampleVal( y, x, picHeight, picWidth, croppedPic, cIdx ) does not specify what the sampleVal should be when nnpfc\_padding\_type is equal to 3. An else clause is proposed to be added to provide a valid value for sampleVal under those conditions.

Additionally following bug-fix and typo-fix are proposed related to neural-network post-filter in VSEI V4:

* Item 1: When TemporalExtrapolationFlag is equal to 1, equation 79 for computation of numPicsInOutputTensor should use the signalled syntax element nnpfc\_extrapolated\_pics\_minus1.
* Item 2: The missing descriptor of u(1) is specified for the syntax element nnpfa\_no\_foll\_clvs\_flag in neural-network post-filter activation SEI message
* Item 3: In Figure 12, on the right side the value “16” should be changed to the value “15” to correspond to the value on the left side. (Also applies to VSEI V3)

For proposal 1, it was suggested to use wrapping instead of clipping for the x component.

Adopt proposal 1 modified to use wrapping for the x component. A -v2 version of the document to be uploaded with this modification.

Delegate all editorial improvements to the editors.

[JVET-AN0133](https://jvet-experts.org/doc_end_user/current_document.php?id=16117) AHG9: Miscellaneous editorial changes for the VSEI v4 draft [J. Xu, Y.-K. Wang (Bytedance)]

This contribution proposes various asserted purely editorial changes to the current VSEI v4 draft, which are briefly summaried as follows:

1. Various asserted typos in the colour transform SEI message.
2. Change "decoders shall ignore ..." to "decoders conforming to this version of this document shall ignore ...".
3. Various other editorial changes in the GCMP, NNPFA, EOI, SPTI, TDI, GFE etc. SEI messages.

Delegate all editorial improvements to the editors.

[JVET-AN0156](https://jvet-experts.org/doc_end_user/current_document.php?id=16140) AHG9: Text fixes and cleanup for GFV and GFE SEI messages [J. Chen, Y. Ye, B. Chen (Alibaba)]

JVET-AN0156 also relates to the GFV SEI messages

TBP

[JVET-AN0186](https://jvet-experts.org/doc_end_user/current_document.php?id=16170) AHG9: Editorial updates for VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

This contribution proposes several editorial modifications for the VSEI v4 draft and the HEVC interface text. The proposed modifications are as follows:

(Related to OMI SEI messages)

1 Clarify the units of the syntax elements for specifying a position and a size of masks.

(Related to SPTI SEI messages)

2 Change the wording in the constraint on a frame-field SEI message.

(Related to PRI SEI messages)

3 Remove the unnecessary sentence in the semantics of pri\_persistence\_flag.

Item 1 clarifies that the units are in chroma samples rather than luma samples, which is already reflected in the equations.

Agreed item 1, item 2.

It was suggested that the sentence about ordering of SEI messages is general and can be included in a different spec location about output order. Delegate to the editors.

### Specification of syntax functions and descriptors (2+1)

Contributions in this area were discussed during 1020–1200 on Saturday 4 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0134](https://jvet-experts.org/doc_end_user/current_document.php?id=16118) AHG9: On the SEI message payload extension in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

This contribution proposes the following changes for the SEI message payload extension in VSEI:

1) Add a note to clarify the differences in referencing VSEI by different standards.

2) Editorial change of the definition of more\_data\_in\_payload( ).

3) Add definition of payload\_extension\_present( ).

Regarding item 1, the note seems to be directed to specification editors more than to implementers.

It is noted that other standards such as systems might have the same issue with extensions.

It was suggested that “MPEG Rec. ITU-T H.264 | ISO/IEC 14496-10 can only reference VSEI for enabling” would be better to move the “only”, for this wording: “ MPEG Rec. ITU-T H.264 | ISO/IEC 14496-10 can reference VSEI only for enabling”

Agreed to add the note. Exact wording is delegated to editors.

Agreed to items 2 and 3.

[JVET-AN0076](https://jvet-experts.org/doc_end_user/current_document.php?id=16060) AHG9: On floating point signaling in SEI [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

JVET- AN0076 also relates to VSEI, VVC, HEVC and AVC.

Chaired by S. Deshpande on 04 October 2025 from 11:00-11:15.

Several SEI messages include floating point values. Differences in naming of syntax elements and presentation of semantics are used. Common methods are noted. It may not be practical to modify all floating-point descriptions in already standardized SEI messages but a recommended procedure for unified presentation of floating-point values in draft and future SEI messages is provided. We also note HEVC and VSEI have notes that mention the withdrawn specification IEC 60559:1989.

1) (Editorial) Information describing several conventions related to floating point syntax and semantics collected form reviewing floating point elements in current SEI messages. Proposals in separate contributions, areas mentioned here for harmonization.

a) Suggested syntax naming convention.

b) Suggested syntax order convention. (One technical change for MI message is noted see JVET-AN0073 for the formal proposal.)

c) Semantics table convention including content and structure (see JVET-AN0072 for proposals for table alignments of current HEVC and VSEI messages)

2) (Editorial) Propose use of a floating-point helper function to section 5.8 of VSEI common floating-point construction. Use this helper function in current TuC and future SEI messages. This similar to the function defined in the Alternative depth information SEI message but that function is only used withing the single SEI message.

3) (Editorial) Propose to removal or modify mentions of withdrawn specification version IEC 60559:1989.

4) (Future) In addition to aligning existing SEI messages, these conventions are proposed for future use.

a) Syntax naming

b) Syntax order

c) Common structure for semantic association table.

d) Use of external floating point helper function.

V2 had one document number change only and was presented.

Regarding reference to ISO 60559, it was commented that the referencing rules require referencing a particular version of the standard.

There was a general agreement that the word “similar” in the NOTE 3 is unclear. See further discussion jointly with JVET-AN0242

[JVET-AN0242](https://jvet-experts.org/doc_end_user/current_document.php?id=16226) AHG9: Signalling of floating-point values in VSEI and graphics rendering information SEI [V. Zakharchenko, J. Boyce (Nokia)]

JVET- AN0242 also relates to the GRI messages

Chaired by S. Deshpande on 04 October 2025 from 11:15-11:45.

This contribution proposes to add to the VSEI TuC a definition of a descriptor type, fl(n), to specify representation of a floating-point value with a single syntax element, rather than using separate syntax elements for the sign, exponent, and mantissa. The fl(v) version of the descriptor may be used to support different lengths/precisions of floating-point numbers, with the length determined by other syntax elements. It is proposed to restrict the allowable lengths of the floating-point syntax element to those that are expected to be commonly implemented in hardware. A table associates each allowable syntax element length with an exponent length and mantissa length.

It is proposed to modify the graphics rendering information SEI message in the TuC to use this descriptor for syntax elements representing floating-point values. It is also suggested to consider its use for other SEI messages in the TuC that contain syntax elements representing floating-point values, including the lens optical correction SEI and the localization and mappingProponents thought that no change should be made to V4 SEIs, and thus the proposal is only for TuC.In the proposed table the fl(8) is additionally defined by proponents compared to ISO 60559:2020.

It was asked if we could copy and paste from ISO 60559:2020 in our speficiation. It was commented that normative referencing is better than copying and pasting. It was also suggested to add informative note in our specification in addition to normative reference.

For the fl(x) where x is not defined by the normative reference, a particular w, t may be possibly defined in our specification. However it does not prevent syntax elements in SEIs to define their own separate syntax elements which have different w, t.

It was commented that a more flexible floating point descriptor with different values for w, t could be defined.

* General discussion of the above two proposals (JVET-AN0076, JVET-AN0242):agreed that making some changes for the future SEIs is reasonable.
* Regarding already defined SEIs, no change should be made to SEIs other than possibly the modality SEI (which is yet to be finalized in v4). After further discussion even modality SEI is kept as it is.
* For the future (including SEIs in Tuc) the choices include defining:
  + Fl(s,w,t) s= sign
  + Fl(w,t)
  + Fl(n) – referencing ISO 60559:2020

Additional parameter could be base 10 or base 2.

Another option could be to define both Fl(w, t), and Fl(n). The end goal of these is to define w, t.

Regarding defining a common descriptor for floating point syntax for future VSEI specification only: it was agreed to do this, while still allowing a flexibility for some SEIs to define their own separate floating point syntax elements.

It was commented to not put multiple options in TuC, but rather to further study and put one in future.suggested and agreed that if we define Fl(n), we should not define n values in our specification other than those defined in the normative reference.

V3 was discussed on 5 October from 17:40-17:xx.

It was commented that it may be useful to add a sign column to the table X. In this case sign is always one bit.

It was asked what is the advantage of defining both flf(w,t) and fl(n). It was commented that doing it gives more flexibility and simplified notation (fl(n)) in some cases.

It was asked if the referred to ISO/IEC document is expected to have longevity.

It was commented that some consideration of bias should be taken into account.

Agreed to add the yellow highlighted text from V3 into TuC.

About using the fl(n) notation for graphics rendering information SEI, the proponents mentioned that the current u(v) definition in TuC for that SEI was underspecified and this is somewhat of a “bug-fix”/ clarification for it.

Agreed to use fl(n) as the descriptor for various syntax elements in graphic rendering information SEI.

### Film grain characteristics SEI message (1)

Contributions in this area were discussed during 1205–1300 on Saturday 4 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0229](https://jvet-experts.org/doc_end_user/current_document.php?id=16213) AHG9: On the film grain characteristics SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

1) Move the payload extension inside the if( ) loop for fg\_characteristics\_cancel\_flag.

2) Remove the ChromaFormatIdc condition in the VSEI interface text

3) Add two notes on the presence of fg\_matrix\_coeffs

4) Change the semantics of fg\_comp\_model\_present\_flag[ c ] when it is equal to 0 to reflect the actual process.

5) Add a sensibility constraint for fg\_intensity\_interval\_upper\_bound[ c ][ i ] and fg\_intensity\_interval\_lower\_bound[ c ][ i ].

6) Add inference for fg\_comp\_model\_value[ c ][ i ][ 0 ] when it is not present.

7) Various editorial changes.

Agreed to item 1.

For item 2, there is a problem with misalignment between the VVC and VSEI interfaces. An alternate suggestion is to change the inference of fg\_bit\_depth\_chroma\_minus8 to not use BitDepthC, but to infer it to be equal to the luma bit depth.

It was noted that there is an issue with the bit depth of the FGC SEI – there is a bit depth of the coded picture and a bit depth that is used for the model, which may differ. This is not addressed in this contribution.

Agreed to item 2.

Revisit item 3.

Item 4 proposes that the fg\_comp\_model\_present\_flag[ c ] not be used to indicate whether or not the film grain modeling of colour components take place. A proponent suggested that this was not the design intent.

OK to add the cyan text, but don’t remove the yellow highlighted text.

It was suggested that the existing wording “film grain is not modelled on the c-th colour component” be changed to allow more flexibility to the decoder.

Delegate the editors adding the presence text, without removing the wording about modelling the colour components.

Regarding item 5, a concern was raised about backwards compatibility.suggested to add a note.

No action on item 5.

Regarding item 6, it was suggested that the inference value for fg\_comp\_model\_value[ ][ ][ ] be 0 rather than 1 as proposed.

Agreed on item 6 with an inferred value of 0.

Delegate editorial changes in item 7 to the editors.

### SEI processing order and processing order nesting SEI messages (3+2)

Contributions in this area were discussed during 1430–1540 on Saturday 4 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0059](https://jvet-experts.org/doc_end_user/current_document.php?id=16043) AHG9: On the SPO and PON SEI messages in VSEI version 4 and in the AVC, HEVC, and VVC interface text [M. M. Hannuksela, F. Cricri (Nokia)]

JVET- AN0059 also relates to the JVET-AM1006 (HEVC), JVET-AM1017 (AVC), and JVET-AM2005 (VVC).

Chaired by S. Deshpande on 04 October 2025 from 14:00-14:50.

This contribution proposes the following changes related to the SEI processing order (SPO) and processing order nesting (PON) SEI messages:

1. The requirement that the nnpfc\_for\_human\_viewing\_idc and nnpfc\_for\_machine\_analysis\_idc shall be equal to po\_for\_human\_viewing\_idc and po\_for\_machine\_analysis\_idc, respectively, when the NNPFA SEI message has the greatest value of po\_sei\_processing\_order[ i ] is asserted to miss the case when the NNPF is the last process but is followed by property SEI message type(s) in a processing chain. It is proposed that the requirement applies when the NNPFA SEI message has the greatest value of po\_sei\_processing\_order[ i ] among all processes of a processing chain.

Decision: Agreed

1. The semantics of the PON SEI message include a number of payload-type-specific constraints ensuring that the semantics and effect of an SEI message that is not a PON-nested SEI message shall not depend on any PON-nested SEI message. Among those payload-type-specific constraints, there is a constraint that when an NNPFC SEI message with nnpfc\_id nnpfId is a PON-nested SEI message, any associated NNPFA SEI messages with nnpfa\_target\_id equal to nnpfId shall also be PON-nested SEI messages.

It is proposed to relax the constraint to concern the same value of the base flag, i.e., when an NNPFC SEI message with nnpfc\_id nnpfId **and nnpfc\_base\_flag nnpfBaseFlag** is a PON-nested SEI message, any associated NNPFA SEI messages with nnpfa\_target\_id equal to nnpfId **and nnpfa\_target\_base\_flag equal to nnpfBaseFlag** shall also be PON-nested SEI messages.

Additionally, it is proposed to limit the scope of the constraint to SEI messages within the same CLVS.

The proposal relaxes a constraint for an assertedly reasonable use case.

There was some support to relaxing a few constraints at this meeting. There was also specific support for the proposed changes.

Decision: Agreed

1. It is proposed to add a constraint requiring that when a PON-nested NNPFC SEI message with nnpfc\_base flag equal to 1 is present, all other NNPFC SEI messages with the same value of nnpfc\_id shall also be PON-nested.

It was asked if in the proposed text the word “associated” should be removed. Proponent agreed to this change. There was support for adding this constraint.

Decision: Agreed

1. Because the same constraint appears in both VSEI and VVC, it is proposed to remove the following from VVC, clause D.12.13: "When a generalized cubemap project SEI message is present with gcmp\_persistence\_flag equal to 1 that is not a PON-nested SEI message, there shall not be an associated generalized cubemap project SEI message in the same CLVS that is a PON-nested SEI message."

Decision: Agreed to remove the constraint from VVC to avoid duplication.

1. AVC and HEVC include the following constraint: "The SEI messages contained in a PON SEI message are referred to as PON-nested SEI messages. When a cubemap projection SEI message is present with cmp\_persistence\_flag equal to 1 that is not a PON-nested SEI message, there shall not be an associated cubemap projection SEI message in the same {CVS|CLVS} that is a PON-nested SEI message."

It is proposed to clarify "an associated cubemap projection SEI message" in AVC and HEVC with phrasing that is similar to a NOTE that appears in VSEI:

When a cubemap projection SEI message is present with cmp\_persistence\_flag equal to 1 that is not a PON-nested SEI message **and is associated with an SEI message type indicated by an SEI processing order SEI message seiMsgSpo**, there shall not be an associated cubemap projection SEI message in the same {CVS|CLVS} that is a PON-nested SEI message **associated with seiMsgSpo**.

Decision: Agreed as a clarification of existing intent.

[JVET-AN0065](https://jvet-experts.org/doc_end_user/current_document.php?id=16049) AHG9: On the SPO and PON SEI message in VSEI v4 [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm), Y.-K. Wang (ByteDance), H. Tan (LG Electronics Inc.), Y. Sanchez (Fraunhofer HHI), M. M. Hannuksela (Nokia)]

This contribution proposes the following bug fix and constraints to the SPO and PON SEI message in VSEI v4.

1. A bug fix on the multiple processing chains constraint
2. Constrain the SPO SEI message content space
3. Remove a redundant condition from the PON-nested SEI message dependency constraint for consistency

Agree on item 1

For item 2, it was commented that the design intent was to allow flexibility to modify the prefix indication and data. No action.

For item 3, it was noted that the two SEI messages for the proposed changes both have an ID value.

Further discussion requested on item 3.

Further discussed 5 Oct 2025, chaired by S. Deshpande.

There were multiple co-authors who preferred option 2.

Agreed to option 2 with the final wording in -v3 to be uploaded.

[JVET-AN0181](https://jvet-experts.org/doc_end_user/current_document.php?id=16165) AHG9: On process SEI messages in processing chain in SPO SEI message [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

This contribution asserts that a display orientation a packed regions information (PRI), and neural-network post-filter activation (NNPFA) SEI messages that follows region-wise packing SEI message in processing order have a problem that may breaks a projected picture. The following is proposed to address the problem:

1 On a RWP SEI message and a display orientation SEI message in a processing chain

– Disallow the presence of both a RWP SEI message and a DOI SEI message in a processing chain.

2 On a RWP SEI message and a PRI SEI message in a processing chain

– Option 1: Disallow the presence of both the RWP SEI message and the PRI SEI message in a processing chain.

– Option 2: Disallow the PRI SEI message from following the RWP SEI message in the processing order.

3 On a RWP SEI message and a NNPFA SEI message in a processing chain

– Disallow an NNPFA SEI message that is associated with an NNPF including spatial extrapolation from following a RWP SEI message in processing order

In the v2 of this document, some editorial errors were fixed.

Regarding option 3, it was suggested that the combination of NNPF SEI with spatial extrapolation and RWP SEI might be useful and shouldn’t be disallowed.

It was suggested that a note could be added to indicate that some combinations of SEI messages in the same processing chain could lead to odd behavior.

Revisit after language for a note is available.

[JVET-AN0184](https://jvet-experts.org/doc_end_user/current_document.php?id=16168) AHG9: Miscellaneous on VSEI v4 draft [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

JVET- AN0184 also relates to the EOI and SPTI SEI messages

This contribution proposes miscellaneous modifications that are asserted to provide improvement to some aspects of VSEI v4 draft. The proposed modifications are as follows:

(Related to SPO SEI messages)

1 Clarify that a processing order applies to the PRI SEI message only in the current CLVS.

(Related to PON SEI messages)

2 Modify the constraints on the presence of PON-nested and non-PON-nested SEI messages.

(Related to EOI SEI messages)

3 Change the constraint on eoi\_orig\_pic\_width\_minus1 and eoi\_orig\_pic\_height\_minus1 values.

(Related to SPTI SEI messages)

4 On signaling of the spti\_max\_sublayers\_minus1 value

– Option 1: Add the constraint on the upper limit of spti\_max\_sublayers\_minus1 in HEVC / VVC interface document.

– Option 2: In addtion to the changes of Option 1, change the descriptor of spti\_max\_sublayers\_minus1 from u(3) to ue(v).

In the v2 of this document, the title of clause 2 was modified.

For item 1, a question was raised of where in the text the proposed language would go.

It is noted that PRI SEI has a CVS scope while SPO SEI has a CLVS scope, which may require some change.

It was suggested that the language be modified.

Revisit item 1.

No action on item 2.

### NNPF SEI extensions (5+2)

Contributions in this area were discussed during 1540–1800 on Saturday 4 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0058](https://jvet-experts.org/doc_end_user/current_document.php?id=16042) AHG9: On the NNPF SEI messages in VSEI version 4 [M. M. Hannuksela, F. Cricri (Nokia)]

Chaired by S. Deshpande on 04 October 2025 from 17:25-17:50.

The following changes are proposed to neural-network post-filter SEI messages in VSEI version 4:

1. It is proposed to make the presence of the u(v)-coded syntax element nnpfc\_reserved\_metadata\_extension conditional so that its length is greater than 0.

It is asserted that u(0) is not defined.

Decision: Agreed

1. Temporally extrapolated pictures are handled similarly to temporally interpolated pictures in most places of the NNPF SEI message semantics. It is asserted that in two instances, the NNPFC SEI message semantics discusses only interpolated pictures, when the semantics should refer to both interpolated pictures and temporally extrapolated pictures. These two instances are proposed to be fixed to refer to both interpolated pictures and temporally extrapolated pictures.

Decision: Agreed

1. It is asserted that nnpfa\_prompt\_update\_flag is allowed to be equal to 1 in an NNPFA SEI message even when text prompt auxiliary input is not enabled in the respective NNPFC SEI message. However, nnpfa\_seed\_update\_flag is disallowed to be equal to 1 in an NNPFA SEI message when seed auxiliary input is not enabled in the respective NNPFC SEI message. It is proposed to require nnpfa\_prompt\_update\_flag to be equal to 0, when text prompt auxiliary input is not in use.

Decision: Agreed

1. When an NNPFA SEI message is not included in a PON SEI message, it is proposed that nnpfa\_num\_input\_pic\_shift shall be equal to 0 rather than shall not be present. It is remarked that when nnpfa\_num\_input\_pic\_shift is not present, it is inferred to be equal to 0.

It was suggested to instead add a gating flag for nnpfa\_num\_input\_pic\_shift and code the syntax element with a minus1.

It was commented that nnpfa\_num\_pic\_shift syntax element was added at the end for supporting the case where it may not be signalled. But the proposal changes that usage.

Decision: Agreed to add a gating flag before nnpfa\_num\_input\_pic\_shift and to code the syntax element as nnpfa\_num\_input\_pic\_shift\_minus1.

1. There exists one instance of nnpfc\_extrapolated\_pics, which should be corrected to nnpfc\_extrapolated\_pics\_minus1.

Delegated to the editors.TBP

1. Editorial suggestions.

Delegated to the editors.

[JVET-AN0063](https://jvet-experts.org/doc_end_user/current_document.php?id=16047) AHG9: On the NNPF SEI messages in VSEI v4 [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

This contribution proposes the following bug fixes and constraints on the NNPFC and NNPFA SEI messages in VSEI v4.

1. Constrain NNPFC metadata extension syntax elements, nnpfc\_scan\_type\_idc, nnpfc\_for\_human\_viewing\_idc and nnpfc\_for\_machine\_analysis\_idc, shall be the same as the base NNPFC.
2. Bug fix on NNPFC and NNPFA SEI messages order constraint
3. Editorial change on nnpfa\_output\_flag[ i ] semantic

It was suggested by a participant that it is desirable to allow nnpfc\_for\_human\_viewing\_idc and nnpfc\_for\_machine\_analysis\_idc to differ for updates and for the base.

No action on item 1.

Agreed on item 2.

On item 3, agreed on moving of the constraint, but not to change the inference value.

[JVET-AN0064](https://jvet-experts.org/doc_end_user/current_document.php?id=16048) AHG9: On the resampling constraint in VSEI v4 [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

JVET- AN0064 also relates to the PRI SEI message

JVET-AM0094 proposed to constrain the resampling display overlay ratio to be in the range of 1/16 to 16, and it was concluded such constraint is not needed. This contribution proposes to remove the similar resampling constraint on NNPFC specified in VSEI v3 and PRI SEI messages specified in VSEI v4.

It was noted that making this change could have backwards compatibility issues with VSEI v3. No action for NNPF.

No action for PRI.

[JVET-AN0140](https://jvet-experts.org/doc_end_user/current_document.php?id=16124) AHG9: On the neural-network post-filter characteristics SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

This contribution proposes the following changes for the neural-network post-filter characteristics (NNPFC) SEI message:

1. Change the condition for the inference for nnpfc\_matrix\_coeffs.
2. Change the inference for VUI-related syntax elements.
3. Add a constraint for nnpfc\_separate\_colour\_description\_present\_flag.
4. Complete the note on nnpfc\_matrix\_coeffs.
5. Add a note to notify decoders the need to keep multiple NNPFC SEI messages.
6. Add a flag to tell whether NNPFC SEI message reordering exists or not.
7. Various editorial NNPFC-related changes.

For item 1, it isn’t clear if a change is necessary.

Revisit item 2.

Item 3 is not necessary.

Agreed to item 4.

Regarding items 5 and 6, it is noted that the NNC signaling of a NN allows updates of just indicate deltas in the network.

No action on items 5 and 6.

Delegate editorial changes to the editors.

[JVET-AN0342](https://jvet-experts.org/doc_end_user/current_document.php?id=16346) AHG9: On the neural-network post-filter activation SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance) [late]

This contribution proposes (option 1) adding a NOTE on a case when the NNPFC persistence scope may be smaller than that of the associated NNPFA or (option 2) changing the semantics of nnpfa\_persistence\_flag to simply the case.

The proposed option 2 may cause a backwards compatibility issue with version 3.

Revisit.

### Encoder optimization information SEI message *(*0+1)

Contributions in this area were discussed during 1800–1815 on Saturday 4 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0184](https://jvet-experts.org/doc_end_user/current_document.php?id=16168) AHG9: Miscellaneous on VSEI v4 draft [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

JVET- AN0184 also relates to the SPO, PON, and SPTI SEI messages

(Related to EOI SEI messages)

3 Change the constraint on eoi\_orig\_pic\_width\_minus1 and eoi\_orig\_pic\_height\_minus1 values.

It was noted that the picture input to an encoder has the cropped picture width and height. It was suggested to not change the constraint to apply to coded picture width and height.

The contribution also proposes derivation of the CroppedWidth and CroppedHeight for the AVC interface which was missing.

Agreed to add the derivation of CroppedWidth and CroppedHeight for the AVC interface.

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

Contributions in this area were discussed during 1815–2000 on Saturday 4 Oct. 2025 and during 0945-1015 on Sunday 5 Oct 2025 (chaired by J. Boyce).

[JVET-AN0060](https://jvet-experts.org/doc_end_user/current_document.php?id=16044) AHG9: On the OMI SEI message in VSEI version 4 [M. M. Hannuksela, J. Boyce (Nokia)]

Chaired by S. Deshpande on 05 October 2025 from 09:45-10:00.

The following asserted bug fixes are proposed to the object mask information (OMI) SEI message:

1. In three instances, the for loop end condition is proposed to be fixed to use less than or equal to, i.e., "i <= omi\_num\_aux\_pic\_layer\_minus1".

Already handled during the discussion JVET-AN0135, JVET-AN0161.

1. It is proposed that the derivation of OmiAuxSampleRangeDeltaMax[ i ] and the constraint related to consecutive tolerance value ranges are changed so that omi\_aux\_sample\_value[ i ][ j ] + OmiAuxSampleRangeDeltaMax[ i ] indicates the greatest luma sample value that belongs to the mask area.

It is asserted that the range of exactly 1 sample value cannot be specified due to the calculation equations. Also it is asserted that the ranges can currently overlap.

It was commented that this was a mistake added during editing.

Further editorial simplification of the equation is possible and delegated to the editors.

Decision: Agreed.

1. It is asserted that a requirement for omi\_mask\_id\_new\_object\_flag[ i ][ j ] to be equal to 1 could be understood to refer to decoding order, since it uses "is parsed for the first time" in its phrasing. The requirement for omi\_mask\_id\_new\_object\_flag[ i ][ j ] to be equal to 1 is proposed to be phrased to refer to output order.

This is related to item 11 in JVET-AN0135.

It was commented that this approach and item 11 in JVET-AN0135 resolve the same issue.

Based on a non-proponent support, the language from item 11 of JVET-AN0135 is agreed (possibly further improved by the editors).

1. It is proposed to be clarified that omi\_mask\_depth[ i ][ j ] less than omi\_mask\_depth[ m ][ n ] indicates that the distance to the the j-th object of the i-th object mask auxiliary layer is less than the distance to the the n-th object of the m-th object mask auxiliary layer.

Decision: Agreed.

1. It is proposed to add: When omi\_mask\_depth[ i ][ j ] is not present, the object depth associated with the j-th object mask of the i-th object mask auxiliary layer is unknown or unspecified.

It was commented that there is an existing constraint that make sure the asserted problem never happens

In addition to the changes proposed above, the accompanying specification text document proposes other changes that are asserted to be editorial.

Delegated these to the editors.

[JVET-AN0135](https://jvet-experts.org/doc_end_user/current_document.php?id=16119) AHG9: On the object mask information SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

1. Fix a for( ) loop error in the syntax table.
2. Change the constraint for object\_mask\_info( ).
3. Change the signalling position of omi\_tolerance\_present\_flag in the syntax table.
4. Change the condition to signal omi\_aux\_sample\_tolerance.
5. Switch the positions of omi\_mask\_top and omi\_mask\_left.
6. Clarify the PU association of an OMI SEI message.
7. Clarify the semantics of omi\_mask\_label\_language.
8. Change the semantics for the omi\_mask\_pic\_update\_flag.
9. Change the range for omi\_num\_mask\_in\_pic.
10. Change the range specification for the omi\_aux\_sample\_value constraint.
11. Clarify the order for the omi\_mask\_id\_new\_object\_flag constraint.
12. Fix a for( ) loop error in the MaskId derivation process.
13. Specify the processing order to derive MaskId.
14. Change the condition of the same MaskId.
15. Fix some typos about SubHeightC.
16. Change the confidence derivation equation.
17. Change the omi\_depth semantics.
18. Various other editorial changes.

Agreed on item 1, 2.

On item 3, it was suggested to not move the omi\_tolerance\_present\_flag but to add it to the constraint to be same for all SEI messages in a CLVS.

Agreed to above suggestion for item 3.

It was questioned if the current inference for omi\_tolerance\_present\_flag is appropriate if this new condition is added.

Agreed on item 4.

For item 5, don’t change the order but fix the semantics. It was noted that other SEI messages that use top/left should be checked, which include annotated regions and region-wise packing.

Delegate to editors the semantics fix.

Item 6: It was suggested to modify the proposed language to: in a PU in a primary layer

Delegate items 6, 7, and 8 to editors.

Agreed to item 9, 10.

JVET-AN0060 item 3 is related to item 11. item 11 was discussed when JVET-AN0060 is presented. See notes under item 3 of JVET-AN0060.

Agreed to item 12.

Regarding item 13, an additional suggestion is to add a constraint on the value of omi\_mask\_pic\_update\_flag[ ] to require it to 1 for the first OMI SEI in a CLVS in output order.

Some description of the processing order is seen to be helpful, but it should be based on output order rather than decoding order.

Agreed to add a description of the processing to follow output order and to add a constraint on the value of omi\_mask\_pic\_update\_flag[ ] as described above. Exact language delegated to editors.

Regarding item 14, an alternate suggestion is to add a bullet with an additional condition:

omi\_persistence\_flag of omiA is equal to 1 or omi\_persistence\_flag of omiB is equal to 0

Revisit item 14.

Delegate items 15 to editors.

Regarding item 16, the current design does not allow signalling a confidence of 1, just near to it. For 8-bit numbers, the contribution would divide by 255 instead by 256, allowing a value of 1.

It was noted that the proposed equation needs another parenthesis.

No action on item 16.

Regarding item 17, an alternate suggestion is to add a note clarifying what the signalled value of depth means.

Further discussed requested for item 17 to review proposed language for a note.

The attachment includes proposed text of a note regarding semantics of omi\_persistence\_flag. No action on the note.

Delegate editorial modifications in item 18 to the editors.

Further discussed 5 Oct 2025.

The following language for a note was provided:

NOTE: Values of omi\_mask\_depth[ i ][ j ] represent a depth order between objects and do not have to be proportional to physical distance of objects.

Agreed to add the note for item 17.

[JVET-AN0161](https://jvet-experts.org/doc_end_user/current_document.php?id=16145) AHG9: On OMI SEI message [H. Tan, J. Lee, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

This contribution proposes modifications that are asserted to provide improvement to OMI SEI messages in v4 draft. The proposed modifications are as follows:

1 On the loop over auxiliary layers.

2 On constraint for omi\_mask\_sample\_value\_length\_minus8 in VVC interface text.

3 On constraint for auxiliary sample values and tolerance values.

4 On constraint for value range of auxiliary sample values in each auxiliary layer.

5 On the number of bits for signalling tolerance values.

Item 1 agreed, see notes for JVET-AN0165 and JVET-AN0160.

Item 3 agreed, see notes for JVET-AN0060.

Agreed to Item 2.

For item 4, it is suggested that this constraint would reduce flexibility to assign the highest value allowed by the bit depth

Item 5 is for bitrate savings. It is considered late for v4 to make this change. No action.

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

Contributions in this area were discussed during 0900–0945 on Sunday 5 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0062](https://jvet-experts.org/doc_end_user/current_document.php?id=16046) AHG9: On the AI usage restrictions SEI message in VSEI version 4 [M. M. Hannuksela, F. Cricri, K. Kammachi Sreedhar (Nokia)]

Chaired by S. Deshpande on 05 October 2025 from 09:25-09:45.

This document proposes the following changes to the AI usage restrictions SEI message:

1. It is asserted that it would be better to indicate whether restrictions apply to generative AI only separately from the category of AI application indicated by aur\_restriction[ i ]. Therefore, the following changes are proposed:
   1. Addition of aur\_generative\_flag[ i ]. When equal to 1, it specifies that the AI application category defined by aur\_restriction[ i ] is constrained to include generative AI only. aur\_generative\_flag[ i ] equal to 0 does not constrain the AI application category defined by aur\_restriction[ i ].
   2. Removal of "unusable for generative AI" entry from the values of aur\_restriction[ i ].
   3. Removal of the constraint "For any i and j values with i not equal to j, aur\_restriction[ i ] shall not be equal to aur\_restriction[ j ]", because entries i and j can have the same value of aur\_restriction and different values of aur\_generative\_flag, aur\_context, and aur\_sei\_exclusion\_flag.

It is asserted that unusable for generative AI overlaps with unusable for AI training and unusable for AI inference.

It was commented that the genesis of the current table entries is motivated by regulatory reason.

Generative AI cases discussed:

-Not allowed to modify the content but you can train on it.

-You can’t train with the content but you can change the content.

It was asked if more entries can be added to the table (although entries are ue(v) coded) instead of adding a new flag.

It was commented that adding a new flag at this late stage should be considered very carefully as now the aur\_restriction[i] needs to be interpreted together with a new flag.

It was suggested and agreed to move forward by adding more entries to the aur\_restriction[i] table instead of adding a new flag.

Revisit the text for the exact table entries wording.

1. Some options are proposed to editorially rephrase the introduction paragraph of the AI usage restriction SEI message to clarify that it does not impose a conformance requirement for decoding systems.

Delegated to the editors, the option A was preferred by proponents and non-proponents.

[JVET-AN0136](https://jvet-experts.org/doc_end_user/current_document.php?id=16120) AHG9: On the AI usage restrictions SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance), A. Hinds (Tencent)]

This contribution proposes the following changes for the AI usage restrictions (AUR) SEI message:

1. Change the range constraint for aur\_num\_restrictions\_minus1.
2. Change the value 0 restriction for aur\_context[ i ].
3. Modify the semantics of aur\_sei\_exclusion\_flag[ i ] to restrict AI processes.

In -v2 of this document, an alternative text change for item 3 is described.

For item 1, it was suggested to also add language about the decoder for future compatibility: Decoders conforming to this version of this document shall allow any value of aur\_num\_restrictions\_minus1 in the range of 0 to 255, inclusive.

Agreed for item 1, with additional language about decoder, as described above.

Agreed for item 2.

Agreed for item 3, with the exact language delegated to the editors.

### Digitally signed content SEI messages (1+1)

Contributions in this area were discussed during 1015–1200 on Sunday 5 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0182](https://jvet-experts.org/doc_end_user/current_document.php?id=16166) AHG9: On DSC SEI messages in VSEI v4 draft [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

This contribution proposes modifications that are asserted to provide improvement to DSC SEI messages in v4 draft. The proposed modifications are as follows:

1 On DSCI SEI messages when SEI signing is enabled.

– Option 1: disallow any DSCI SEI messages to be signed (by any verification system).

– Option 2: disallow the DSCI SEI message to be signed by its own verification system.

2 On DSCV SEI messages when SEI signing is enabled.

– Option 1: disallow any DSCV SEI messages to be signed (by any verification system).

– Option 2: disallow the DSCV SEI message to be signed by its own verification system.

3 On signing SEI NAL unit containing only DSCS SEI messages.

4 On DSCS SEI messages with substream Id 0 that do not precede all verification inclusion NAL units.

5 On DSCS SEI messages with substream Id not equal to 0 that do not precede all verification inclusion NAL units

6 On the presence of more than one DSCS SEI message when implicit mode and SEI signing are enabled.

7 On the presence of DSCS SEI messages in a PU SEI signing is enabled.

8 On the presence of DSCS SEI message that is not the last verification inclusion NAL unit in a PU when implicit association mode and SEI signing are enabled

In the v2 of this document, option 2 of item 2 is updated to clarify the intension. In addition, some typos are fixed.

For item 1 Option 1, it was suggested to clarify what an associated DSCS SEI message is, e.g. has the same value of dsci\_id.

Agreed for Item 1, option 1, with exact language delegated to the editors.

Agreed for Item 2 Option 1.

For item 3, it was suggested that the proposal adds some complexity to the verifier. No action.

Revisit item 4.

For item 5, it was suggested that the existing language is sufficient. It was suggested that a note may be helpful.

Revisit item 5.

For item 6, it was suggested that if this bullet were removed, a DSCS SEI message in a suffix SEI NAL unit could only be used for the implicitly associated substream ID. It may be possible rephrase the bullet rather than to remove it.

Revisit item 6.

For item 7, alternative wording was suggested.

Revisit item 7.

Agreed on Item 8.

### Packed regions information SEI message *(*3+1)

Contributions in this area were discussed during 1200–1300 on Sunday 5 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0064](https://jvet-experts.org/doc_end_user/current_document.php?id=16048)[JVET-AN0180](https://jvet-experts.org/doc_end_user/current_document.php?id=16164) AHG9: On PRI SEI message in processing chain [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

This contribution proposes allowing a PRI SEI message to specify a property or process in the processing chain.

The summary of the proposed modifications are as follows:

– Introduce a list of payloadTypes ‘currSpoProcessSeiList’ for each processing chain.

– ‘currSpoProcessSeiList’ includes the PRI SEI type when the PRI SEI message is used as a process, and other SEI types that are used in the processing chain.

– ‘SpoProcessSeiList’ in current text are changed to ‘currSpoProcessSeiList’.

In the v2 of this document, the proposed modifications are changed for simplification.

It was noted that because the PRI type is included in both property and process lists, does not mean that it cannot be used to indicate property.

It was noted that with this proposal, special handling of the processing chain would be required for PRI SEI.

[JVET-AN0183](https://jvet-experts.org/doc_end_user/current_document.php?id=16167) AHG9: On PRI SEI message in VSEI v4 draft [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

This contribution proposes modifications that are asserted to provide improvement to PRI SEI messages in v4 draft. The proposed modifications are as follows:

1 On constraint for PRI SEI message when present in PON SEI message.

2 On repetition of PRI SEI message in an AU and in a PU.

3 On the presence of PRI SEI message when its regions refer to multiple layers.

4 On layers included in PRI SEI message and OLS.

JVET-AN0065 item 3 relates to removing the constraints.

Based on JVET-AN0065, no action on item 3.

For item 2, it was suggested that for a single layer PRI, there doesn’t need to be a constraint, because each layer with a PRI SEI could different contents. For single layer PRI, there is an inference of the layer ID.

It was suggested that repetition of PRI SEI messages should be allowed.

It was suggested there is an issue with the current text because the PRI SEI applies to an AU.

Some support was expressed for item 4.

Revisit items 2 and 4.

[JVET-AN0310](https://jvet-experts.org/doc_end_user/current_document.php?id=16314) AHG9: On PRI ID [Y. Li (SJTU), Y.-K. Wang (Bytedance), K. Yang, Y. Xu (SJTU)] [late]

This contribution proposes to add an ID to the PRI SEI message, such that multiple PRI SEI messages can be associated with an AU for different purposes, e.g., for support of different target pictures. Two options are provided, the first targeting VSEI v4, and the second targeting VSEI TuC.

A suggested use case is that some users would be interested in some player but not others.

It was noted that display rectangles SEI in the TuC also addresses the use case described above.

### Source picture timing information SEI message (0+1)

Contributions in this area were discussed during 1545–1510 on Sunday 5 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0184](https://jvet-experts.org/doc_end_user/current_document.php?id=16168) AHG9: Miscellaneous on VSEI v4 draft [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

JVET- AN0184 also relates to the SPO. PON, and EOI SEI messages

4 On signaling of the spti\_max\_sublayers\_minus1 value

– Option 1: Add the constraint on the upper limit of spti\_max\_sublayers\_minus1 in HEVC / VVC interface document.

– Option 2: In addtion to the changes of Option 1, change the descriptor of spti\_max\_sublayers\_minus1 from u(3) to ue(v).

It was noted that most bitstreams won’t use all of the allowable temporal sublayers, so this proposal doesn’t guarantee that the info signaled in the SPTI all is useful.

Agreed for item 4 option 1.

### Modality information SEI message (2)

Contributions in this area were discussed during 1510–1600 on Sunday 5 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0073](https://jvet-experts.org/doc_end_user/current_document.php?id=16057) AHG9: On MI SEI message in VSEI version 4 [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

Examples using the MI syntax for various wavelength values are presented. It is asserted the current syntax has multiple representations of a single value wavelength and the precision is insufficient. Several proposals are described to address these limits and harmonize with other floating point uses.

1) (Editorial) Use units of nanometres rather than metres for these wavelength values.

2) (Technical) Reverse order of mantissa and exponent syntax elements for consistency with other floating point uses i.e. Multiview acquisition information, 3D reference displays information, Depth representation information element, etc.

3) (Technical) Reduce the number of bits for the exponents while keeping the range from IR to UV, 1nm to 1mm = 106 nm.

4) (Technical) Eliminating the need for minus 15 in exponent elements, rename syntax names and modify semantics to support this.

5) (Technical) Increase the number of bits allocated for mantissa for greater precision.

6) (Technical) Modify semantics for computing reconstructed floating point values using other changes to be unique, increase precision, and consistent with the other floating point representation formats.

7) (Editorial) Introduce an associate table between floating-point values and syntax elements to be consistent with other floating-point use in SEI messages.

Agreed for item 2, reversing order of syntax elements for mantissa and exponent.

Regarding item 1, ISO 20473-2007 uses meters in its specification. It specifies from 1 nm to 10^6 nm, which is 1 mm.

It is noted that the exponent and mantissa are base 10.

[JVET-AN0138](https://jvet-experts.org/doc_end_user/current_document.php?id=16122) AHG9: On the modality information SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

This contribution proposes the following changes for the modality information (MI) SEI message:

1. Remove inference for mi\_modality\_type.
2. Specify range constraints for wavelength values according to mi\_modality\_type.
3. Change the coding lengths for wavelength mantissa and exponent.

Inference not needed, since mi\_modality\_type is always present, except for when cancel flag is set.

Agreed to item 1.

It is noted that the proposed constraint would be problematic for content that has wavelengths that span more than one range.Revisit item 2.

It is preferred to keep the syntax stable at this stage.

It was suggested to modify the wording in the semantics about optical radiation to indicate more flexibility.

Revisit to consider proposed modified semantics wording.

### Text description information SEI message (2)

Contributions in this area were discussed during 1600–1615 on Sunday 5 Oct. 2025 (chaired by XXX).

[JVET-AN0061](https://jvet-experts.org/doc_end_user/current_document.php?id=16045) AHG9: On the text description information SEI message in VSEI version 4 [M. M. Hannuksela (Nokia)]

Chaired by S. Deshpande on 05 October 2025 from 04:00-04:07

The following changes are proposed for the text description information (TDI) SEI message:

1. It is asserted that the syntax table accidentally uses gating by tdi\_cancel\_by\_purpose\_flag, which does not exist in the syntax. Instead, the gating is proposed to be based on tdi\_purpose\_cancel\_flag.

Editorial fix agreed.

1. It is asserted that the impact of tdi\_purpose\_cancel\_flag in a subsequent TDI SEI message in output order is not specified for the persistence of the current the TDI SEI message. It is proposed to add a bullet that the persistence of the current TDI SEI message ends when a picture in the current layer associated with a TDI SEI message with the same value of tdi\_descr\_purpose and tdi\_purpose\_cancel\_flag equal to 1 is output that follows the current picture in output order.

Reviewed together with item 1 in JVET-AN0139.

Agreed [JVET-AN0139](https://jvet-experts.org/doc_end_user/current_document.php?id=16123) AHG9: On the text description information SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

Chaired by S. Deshpande on 05 October 2025 from 04:07-04:12

This contribution proposes the following changes for the text description information (TDI) SEI message:

1. Change the presistence scope to include the case of tdi\_id\_cancal\_flag being equal to 1.

This item was discussed together with item 2 of JVET-AN0061. See notes above.

1. Change the name of tdi\_persistence\_flag to tdi\_id\_persistence\_flag.

No change as the persistence has id and purpose.

### Generative face video SEI messages (1+1)

Contributions in this area were discussed during 1615–XXXX on Sunday 5 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0141](https://jvet-experts.org/doc_end_user/current_document.php?id=16125) AHG9: On the generative face video SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance)]

This contribution proposes the following changes for the generative face video (GFV) SEI message.

1. Specify a range costraint for gfv\_chroma\_key\_purpose\_idc.
2. Require gfv\_base\_pic\_flag equal to 1 when a GFV SEI message is the first GFV SEI message in output order.
3. Various editorial changes.

Related to item 1, it is suggested to add a row in the table to indicate values 3 .. 25 are reserved values.

Agreed to item 1, delegate the editors if the table should be updated.

Agreed to item 2.

Delegate the editorial fixes to the editors.

[JVET-AN0156](https://jvet-experts.org/doc_end_user/current_document.php?id=16140) AHG9: Text fixes and cleanup for GFV and GFE SEI messages [J. Chen, Y. Ye, B. Chen (Alibaba)]

JVET- AN0156 also relates to editorial aspects for JVET-AM2006

This contribution proposes bug fixes, text cleanup and general editorial improvements to the current text of generative face video (GFV) and generative face enhancement (GFE) SEI messages. The proposed text was implemented on top of JVET-AM2006 and attached to this contribution.

The proposed changes include:

1. Add missing inference to gfe\_matrix\_element\_sign\_flag[ i ][ j ][ k ] and gfe\_matrix\_delta\_element\_sign\_flag[ i ][ j ][ k ];
2. Remove two conditions asserted to be redundant in the GFV SEI message;
3. Suggest to rename “generative face enhancement (GFE)” SEI message to “generative enhancement face video (GEFV)” SEI message;
4. Text cleanups and editorial improvements;
5. Text bug and typo fixes.

Agreed to items 1, 2, 5.

Delegate to editors item 3, 4.

### Image format metadata SEI message (1)

Contributions in this area were discussed during 1710–1720 on Sunday 5 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0137](https://jvet-experts.org/doc_end_user/current_document.php?id=16121) AHG9: On the image format metadata SEI message in VSEI v4 [J. Xu, Y.-K. Wang (Bytedance), A. Hinds (Tencent)]

This contribution proposes the following changes for the image format metadata (IFM) SEI message:

1. Change the range specification for ifm\_num\_metadata\_payloads\_minus1
2. Specify a range constraint for ifm\_type\_id[ i ].
3. Change the range specification for ifm\_payload\_len\_minus1[ i ].
4. Specify a constraint on the value of ifm\_payload\_len\_minus1 when ifm\_type\_id[ i ] is equal to 5.
5. Change the condition of ICCmajorVer and ICCminorVer derivation.

In -v2 of this document, an alternative text change for item 4 is described.

Agreed items 1, 2, 3,

Agreed item 4, with the first wording.

Agreed item 5.

## AHG9: Aspects on new and extended SEI messages in TuC for VSEI (47)

### Scalability dimension information SEI message *(*2)

Contributions in this area were discussed during 1810–XXXX on Sunday 5 Oct. 2025 (chaired by J. Boyce ).

[JVET-AN0235](https://jvet-experts.org/doc_end_user/current_document.php?id=16219) AHG9: on the SDI SEI message dependency [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

JVET- AN0235 also relates to the FGRC, GRI, and PSI SEI messages

This proposal introduces SDI SEI message dependency constraints for the SEI messages listed in the VSEI TuC that currently lack explicit dependency signaling:

1. GRI SEI messages
2. PSI SEI messages
3. ASAI SEI messages
4. FGRC SEI messages

Agreed for item 1, 2.

Revisit for item 3.

For item 4, it was suggested to reword the first constraint to consider an inference value of . fgr\_alpha\_channel\_adapation\_flag equal when not present.

It was suggested to reword the second constraint : when the CVS does not contain an SEI with aux\_type equal to 1 for at least one value of i, the adaptation flag shall be equal to 0.Revisit item 4.

[JVET-AN0265](https://jvet-experts.org/doc_end_user/current_document.php?id=16251) AHG9: On confidence auxiliary layer design [E. Thomas, E. Potetsianakis, E. Alexiou, M.-L. Champel (Xiaomi)]

In this contribution, it is asserted that the current SDI SEI message does not support hierarchical reference chains between confidence and depth layers based on the changes in the VSEI TuC document. This contribution proposes to modify the syntax to enable a confidence auxiliary layer to reference an auxiliary depth layer as well as precising the interpretation of the confidence image sample values.

It was noted that the SDI extension design in the TuC includes a described layer idx value to indicate an auxiliary layer.

The proposal first item proposes renaming and modifying the semantics of sdi\_associated\_primary\_layer\_idx[ ][ ] to allow it to reference an auxiliary layer. A concern was raised about backwards compatibility. It was suggested that it might be possible to have wording that addresses backwards compatibility of bitstreams and decoders.

If there was more than one associated primary layer, there could be ambiguity as to which layer was the described layer of the confidence info.

A suggestion was made the wording of the interpretation of the sample value should just describe the min and max values as 0 and 2^n – 1, and not try to calculate a number.

Additional discussion chaired by S. Deshpande.

For item 1, there is non-proponent support, however the exact language including the backwards compatibility aspects need to be specified. Revisit.

For item 2, the wording of the interpretation of the sample values was changed to apply to all aux type values and clarifies that the 2^bitdepth– 1 represents the maximum value.

Agreed to item 2.

### Shutter interval information SEI message *(*1)

Contributions in this area were discussed during 0725–0730 on Sunday 5 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0145](https://jvet-experts.org/doc_end_user/current_document.php?id=16129) AHG9: On the shutter interval information extension in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

This contribution proposes to add a gated flag for the newly introduced syntax elements in the extension to the shutter interval information (SII) SEI message.

Agreed.

### NNPF SEI messages *(*3)

Contributions in this area were discussed during 0730–XXXX on Sunday 5 Oct. 2025 (chaired by J. Boyce).

[JVET-AN0068](https://jvet-experts.org/doc_end_user/current_document.php?id=16052) AHG9: On Neural-network Post-filter Information Signaling and Semantics [S. Deshpande (Sharp)]

Following modifications are proposed related to NNPF signaling and semantics in VSEI Technologies under Consideration (TuC) document:

* Proposal 1: It is asserted that there are issues in Neural-network post-filter characteristics SEI in VSEI TuC related to the signaling of text prompt for temporal extrapolation (nnpfc\_prompt[ i ]) and its semantics. Two alternative options are proposed.
  + Option 1: It is proposed to bug-fix the asserted issues and to separate the signaling of the text prompt information for temporal extrapolation purpose compared with the signaling of the text prompt information for spatial extrapolation purpose which is already in VSEI V4.
  + Option 2: Bug-fixes are proposed for the asserted issues related to the text prompt signalling for temporal extrapolation purpose.
* Proposal 2: In Neural-network post-filter characteristics SEI message an asserted bug-fix is proposed for the semantics of nnpfc\_mul\_intefaces\_flag equal to 1, to be consistent with the derivation of NNPfInferenceProcess.
* Proposal 3: In Neural-network post-filter activation SEI message it is proposed to update a constraint as follows: When nnpfc\_inband\_prompt\_flag is equal to 0 *in the NNPFC SEI message with nnpfc\_id equal to nnpfa\_target\_id*, the value of nnpfa\_prompt\_update\_flag**[** i ], if present, shall be equal to 0. This also applies to V4.

Option 1 proposes more changes than option 2. Option 1 allows separation of temporal extrapolation spatial extrapolation. It was suggested that a single prompt could be worded to specifying both an instruction for both temporal extrapolation and for spatial extrapolation.

It was suggested to modify the option 2 loop to reference nnpfc\_num\_alt\_instances\_minus1 rather than the variable nnpfNumInferences.

Agreed for proposal 1 option 2, with the modification to loop described above.

Agreed for proposal 2.Regarding proposal 3, it was suggested that fix also applies to VSEI v4, and was considered to be the original design intent.

Agreed for proposal 3 for TuC and for VSEI v4.

[JVET-AN0176](https://jvet-experts.org/doc_end_user/current_document.php?id=16160) AHG9: On multi-purpose NNPFs [C.-H. Demarty, E. François, A. Ak (InterDigital)]

[JVET-AN0264](https://jvet-experts.org/doc_end_user/current_document.php?id=16249) AHG9: Support for implicit representations with the Gaussian splatting information SEI message [S. Lee, S. Sasse, Y. Sanchez, R. Skupin, T. M. Borges, C. Hellge, T. Schierl (Fraunhofer HHI)]

JVET- AN0264 also relates to the Gaussian splatting information SEI message

### Constituent rectangles SEI message (4)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0102](https://jvet-experts.org/doc_end_user/current_document.php?id=16086) AHG9: On the CR SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0116](https://jvet-experts.org/doc_end_user/current_document.php?id=16100) AHG9: On the colour mapping information SEI message [C. Kim, H. Tan, J. Lee, J. Nam, J. Lim, S. Kim (LGE)]

JVET- AN0116 also relates to the BRI, ECFI, and CMI SEI messages

[JVET-AN0149](https://jvet-experts.org/doc_end_user/current_document.php?id=16133) AHG9: On the constituent rectangles SEI message in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0160](https://jvet-experts.org/doc_end_user/current_document.php?id=16144) AHG9: On DR SEI, DOI SEI, and CR SEI messages [K. Abe, T. Nishi (Panasonic)]

JVET- AN0160 also relates to the DOI and DR SEI messages

### Display rectangles SEI message (1+1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0124](https://jvet-experts.org/doc_end_user/current_document.php?id=16108) AHG9: Additional features in display rectangles SEI message [R. Imichi, Y. Tokumo, T. Ikai (Sharp)]

[JVET-AN0160](https://jvet-experts.org/doc_end_user/current_document.php?id=16144) AHG9: On DR SEI, DOI SEI, and CR SEI messages [K. Abe, T. Nishi (Panasonic)]

JVET- AN0160 also relates to the CR and DOI SEI messages

### SEI processing order and processing order nesting SEI messages (1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0108](https://jvet-experts.org/doc_end_user/current_document.php?id=16092) AHG9: On the SPO SEI message extension complexity information [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

### Encoder optimization information SEI message (1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0208](https://jvet-experts.org/doc_end_user/current_document.php?id=16192) AHG8/AHG9: Depth-aware optimization for Encoder optimization information SEI message [G. Teniou, S. Wenger, A. Hinds, J. Ricard (Tencent)]

### Digitally signed content messages (4+1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0078](https://jvet-experts.org/doc_end_user/current_document.php?id=16062) AHG9: Digitally signed content (DSC): On subpicture signing [I. Sodagar, C. Fersch, S. McCarthy (Dolby)]

[JVET-AN0107](https://jvet-experts.org/doc_end_user/current_document.php?id=16091) AHG9: On scalable-nested DSCI SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

JVET- AN0107 also relates to the study of SEI messages in VSEI, VVC, HEVC and AVC

[JVET-AN0187](https://jvet-experts.org/doc_end_user/current_document.php?id=16171) AHG9: On DSC SEI messages for subpicture-based signing in TuC of VSEI [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AN0188](https://jvet-experts.org/doc_end_user/current_document.php?id=16172) AHG9: On signing parameter sets in DSC SEI messages for subpictures in TuC of VSEI [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AN0210](https://jvet-experts.org/doc_end_user/current_document.php?id=16194) AHG9: On subpicture signing in the DSC SEI messages [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

### Film grain regions characteristics SEI message (2+1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0069](https://jvet-experts.org/doc_end_user/current_document.php?id=16053) AHG9/AHG13: Updates for the film grain regions SEI message [E. François, F. Urban, P. de Lagrange, D. Doyen (InterDigital), G. Teniou (Tencent)]

[JVET-AN0146](https://jvet-experts.org/doc_end_user/current_document.php?id=16130) AHG9: On the film grain regions characteristics SEI message in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0235](https://jvet-experts.org/doc_end_user/current_document.php?id=16219) AHG9: on the SDI SEI message dependency [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

JVET- AN0235 also relates to the SDI, GRI, and PSI SEI messages

### Quality metrics SEI message (3)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0066](https://jvet-experts.org/doc_end_user/current_document.php?id=16050) AHG9: On the QM SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0246](https://jvet-experts.org/doc_end_user/current_document.php?id=16230) AHG9: Metric value range for quality metrics SEI [J. Boyce, M. M. Hannuksela, T. Biatek (Nokia)]

[JVET-AN0247](https://jvet-experts.org/doc_end_user/current_document.php?id=16231) AHG9: Quality metrics SEI for concatenated encoding [J. Boyce, T. Biatek, M. M. Hannuksela (Nokia)]

### Lens optical correction SEI message (1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0074](https://jvet-experts.org/doc_end_user/current_document.php?id=16058) AHG9: On Lens Optical Correction SEI [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

### Display overlays information SEI message (6+1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0104](https://jvet-experts.org/doc_end_user/current_document.php?id=16088) AHG9: On the DOI SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0105](https://jvet-experts.org/doc_end_user/current_document.php?id=16089) AHG9: On applying display overlay on CR target picture [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0117](https://jvet-experts.org/doc_end_user/current_document.php?id=16101) AHG9: On display overlays information SEI message [C. Kim, H. Tan, J. Lee, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AN0148](https://jvet-experts.org/doc_end_user/current_document.php?id=16132) AHG9: On the display overlays information SEI message in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0160](https://jvet-experts.org/doc_end_user/current_document.php?id=16144) AHG9: On DR SEI, DOI SEI, and CR SEI messages [K. Abe, T. Nishi (Panasonic)]

JVET- AN0160 also relates to the CR and DR SEI messages

[JVET-AN0207](https://jvet-experts.org/doc_end_user/current_document.php?id=16191) AHG9: Overlay purpose indicator for Display overlays information SEI message [G. Teniou, S. Wenger, A. Hinds (Tencent)]

[JVET-AN0248](https://jvet-experts.org/doc_end_user/current_document.php?id=16232) AHG9: Overlay set purpose indicator for Display overlays information SEI message [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

### Bitdepth range information SEI message (1+1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0116](https://jvet-experts.org/doc_end_user/current_document.php?id=16100) AHG9: On the colour mapping information SEI message [C. Kim, H. Tan, J. Lee, J. Nam, J. Lim, S. Kim (LGE)]

JVET- AN0116 also relates to the CR, ECFI, and CMI SEI messages

[JVET-AN0147](https://jvet-experts.org/doc_end_user/current_document.php?id=16131) AHG9: On the bitdepth range information SEI message in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

### Colour mapping information SEI message (4+1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0116](https://jvet-experts.org/doc_end_user/current_document.php?id=16100) AHG9: On the colour mapping information SEI message [C. Kim, H. Tan, J. Lee, J. Nam, J. Lim, S. Kim (LGE)]

JVET- AN0116 also relates to the CR, BRI, and ECFI SEI messages

[JVET-AN0231](https://jvet-experts.org/doc_end_user/current_document.php?id=16215) AHG9: on the CMI SEI message [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

[JVET-AN0244](https://jvet-experts.org/doc_end_user/current_document.php?id=16228) AHG9: Prespecified colour maps for the colour mapping info SEI message [J. Boyce, M. M. Hannuksela, T. Biatek (Nokia)]

[JVET-AN0245](https://jvet-experts.org/doc_end_user/current_document.php?id=16229) AHG9: On colour mapping info SEI message [J. Boyce, M. M. Hannuksela, T. Biatek (Nokia)]

[JVET-AN0357](https://jvet-experts.org/doc_end_user/current_document.php?id=16361) AHG9: On prespecified colour maps for the colour mapping information SEI message [J. Samuelsson-Allendes, S. Deshpande (Sharp)] [late]

### Auxiliary sampling alignment information SEI message (1+1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0233](https://jvet-experts.org/doc_end_user/current_document.php?id=16217) AHG9: On ASAI SEI Message applied to primary and auxiliary layers [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

[JVET-AN0235](https://jvet-experts.org/doc_end_user/current_document.php?id=16219) AHG9: on the SDI SEI message dependency [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

JVET- AN0235 also relates to the SDI, FGRC, GRI, and PSI SEI messages

### Localization and mapping information SEI message (4)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0075](https://jvet-experts.org/doc_end_user/current_document.php?id=16059) AHG9: On Localization and Mapping SEI [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0150](https://jvet-experts.org/doc_end_user/current_document.php?id=16134) AHG9: On the localization and mapping SEI message in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0167](https://jvet-experts.org/doc_end_user/current_document.php?id=16151) AHG9: On localization and mapping SEI message [C. Kim, H. Tan, J. Lee, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AN0260](https://jvet-experts.org/doc_end_user/current_document.php?id=16245) AHG9: Suggested modifications for the LAM SEI [V. Zakharchenko, J. Boyce (Nokia)]

### Danmu information SEI message (5)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0115](https://jvet-experts.org/doc_end_user/current_document.php?id=16099) AHG9: On the danmu Information SEI message [C. Kim, H. Tan, J. Lee, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AN0232](https://jvet-experts.org/doc_end_user/current_document.php?id=16216) AHG9: on the Danmu SEI message [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

[JVET-AN0259](https://jvet-experts.org/doc_end_user/current_document.php?id=16244) AHG9: Enable the regional display in the Danmu information SEI message [S. Xie, P. Wu, W. Niu, Y. Gao, C. Huang (ZTE)]

[JVET-AN0261](https://jvet-experts.org/doc_end_user/current_document.php?id=16246) AHG9: Comments on the Danmu information SEI message [S. Xie, P. Wu, W. Niu, Y. Gao, C. Huang (ZTE)]

[JVET-AN0262](https://jvet-experts.org/doc_end_user/current_document.php?id=16247) AHG9: On danmu information SEI message [E. Thomas, E. Potetsianakis, E. Alexiou, M.-L. Champel (Xiaomi)]

### Graphics rendering information SEI message (2+2)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0144](https://jvet-experts.org/doc_end_user/current_document.php?id=16128) AHG9: On the graphics rendering information SEI message in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AN0230](https://jvet-experts.org/doc_end_user/current_document.php?id=16214) AHG9: on the GRI SEI message [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

[JVET-AN0235](https://jvet-experts.org/doc_end_user/current_document.php?id=16219) AHG9: on the SDI SEI message dependency [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

JVET- AN0235 also relates to the SDI, FGRC, and PSI SEI messages

[JVET-AN0242](https://jvet-experts.org/doc_end_user/current_document.php?id=16226) AHG9: Signalling of floating-point values in VSEI and graphics rendering information SEI [V. Zakharchenko, J. Boyce (Nokia)]

JVET- AN0242 also relates to specification of syntax functions and descriptors

### Enhanced colour information SEI message (1+1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0116](https://jvet-experts.org/doc_end_user/current_document.php?id=16100) AHG9: On the colour mapping information SEI message [C. Kim, H. Tan, J. Lee, J. Nam, J. Lim, S. Kim (LGE)]

JVET- AN0116 also relates to the CR, BRI, and CMI SEI messages

[JVET-AN0143](https://jvet-experts.org/doc_end_user/current_document.php?id=16127) AHG9: On the enhanced colour format information SEI message in TuC of VSEI [J. Xu, Y.-K. Wang (Bytedance)]

## Identify potential needs for additional SEI messages, including study of AVC and HEVC SEI messages for use in VVC (6)

### Gaussian splatting information SEI message (3+1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0100](https://jvet-experts.org/doc_end_user/current_document.php?id=16084) AHG9: Gaussian splatting information SEI message [Y. He, J. Jung, A. Akhtar, L. Kerofsky, G. van der Auwera, A. Akhtar, M. Karczewicz (Qualcomm), J. Xu, Y.-K. Wang, L. Zhang (Bytedance)]

[JVET-AN0205](https://jvet-experts.org/doc_end_user/current_document.php?id=16189) AHG9: Gaussian Splat Information SEI message [J. Ricard, G. Teniou, S. Wenger, A. Hinds (Tencent)]

[JVET-AN0206](https://jvet-experts.org/doc_end_user/current_document.php?id=16190) AHG9: Gaussian Splat compression experiment platform [J. Ricard, G. Teniou, S. Wenger, A. Hinds (Tencent)]

JVET- AN0206 also relates to software and showcase information for SEI messages

[JVET-AN0264](https://jvet-experts.org/doc_end_user/current_document.php?id=16249) AHG9: Support for implicit representations with the Gaussian splatting information SEI message [S. Lee, S. Sasse, Y. Sanchez, R. Skupin, T. M. Borges, C. Hellge, T. Schierl (Fraunhofer HHI)]

JVET- AN0264 also relates to NNPF SEI messages

### Other (3)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0077](https://jvet-experts.org/doc_end_user/current_document.php?id=16061) AHG9: Sample Grouping SEI message [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AN0226](https://jvet-experts.org/doc_end_user/current_document.php?id=16210) AHG9: Spatial and bit depth restoration SEI message [X. Xu, M. Xu, S. Liu (Tencent)]

[JVET-AN0227](https://jvet-experts.org/doc_end_user/current_document.php?id=16211) AHG9: Temporal resampling information SEI message [X. Xu, S. Liu (Tencent)]

## SEI Software and showcases (1+1)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

[JVET-AN0122](https://jvet-experts.org/doc_end_user/current_document.php?id=16106) AHG9/AHG11: Demo of real-time NNPF inference with banding reduction [S. Schwarz, H. Sethi, J. Funnell, M. Santamaria, R. Yang, F. Cricri, M.M. Hannuksela (Nokia)]

[JVET-AN0206](https://jvet-experts.org/doc_end_user/current_document.php?id=16190) AHG9: Gaussian Splat compression experiment platform [J. Ricard, G. Teniou, S. Wenger, A. Hinds (Tencent)]

JVET- AN0206 also relates to identifying potential needs for additional SEI messages

## Non-SEI HLS aspects (2)

Contributions in this area were discussed during XXXX–XXXX on XXday X Oct. 2025 (chaired by XXX).

(to be discussed in JVET plenary)

[JVET-AN0162](https://jvet-experts.org/doc_end_user/current_document.php?id=16146) AHG9: On subpicture sub-bitstream extraction in VVC [H. Tan, J. Lee, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AN0178](https://jvet-experts.org/doc_end_user/current_document.php?id=16162) VVC multilayer extension for an external base layer [F. Urban, Y. Chen, F. Galpin, E. François, P. de Lagrange, P. Bordes (InterDigital)]

# Plenary meetings, joint meetings, BoG reports, and liaison communications

## General

The following topics were discussed in JVET plenary XXday X Oct. XXXX–XXXX:

* Status of last meeting’s output documents
  + …
* Liaison communication
  + …
* Scheduling for the remaining week (further detail on scheduling is recorded in section 2.12)
  + …
* Joint meetings
  + …
* Standards progression and outputs
  + DoCR preparation …
  + Preparation of documents to be submitted to SG21 …
* Review status from tracks and discussion on potential open issues

### Review of documents at plenary level

…

## MPEG information sharing meetings (update)

Information sharing sessions with other WGs and AGs of the MPEG community were held on Monday 31 June 0900–1230, Wednesday 2 July 0900–1015, and Friday 4 July 1400–1550.

The status and plans for the work in the MPEG WGs and AGs was reviewed at these information sharing sessions.

## Joint meetings

### Joint sessions XXXX-XXXX XXday X Oct. on XXX: MPEG WG X / XXX, MPEG WG 5 / JVET, …

This joint session was chaired by Jens-Rainer Ohm (JVET) and XXX (WG X).

The notes were taken by XXX.

…

### Joint session XXXX-XXXX XXday X Oct. on next generation video standardization: MPEG WG 2 / Requirements, MPEG WG 5 / JVET, MPEG AG 5 Visual Quality Assessment, and VCEG (ITU-T Q6/21)

This joint session was chaired by Jens-Rainer Ohm (JVET Chair and WG 5 Convenor), Gary Sullivan (VCEG Rapporteur and SC 29 Chair), Mathias Wien (AG 5 Convenor), and Jörn Ostermann (AG 2 Convenor), on behalf of Igor Curcio (WG 2 Convenor)

Notes were taken by XXX.

## BoGs (X)

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## Liaison communications (1)

The following liaison statements were received at this meeting (section retained as a template for future use).

The liaison document WG 5 N XXX was reviewed in JVET on XXday XX July at XXXX-XXXX. The draft reply was also presented in the MPEG AG 3 Communication meeting Thursday 03 July during 1500-1800.

# Project planning

## Software timeline (update)

ECM 18.0 software (including all adoptions) was planned to be available 3 weeks after the meeting (25 July).

The NNVC 14.0 codebase software was planned to be available 3 weeks after the meeting (25 July), including all elements needed for CTC and EE1. Additional integration and harmonization with VTM to be deferred for version 14.1.

VTM23.11 software will be released 1 week after the meeting at latest. Additional versions will be released as appropriate(e.g. for integration and updates of SEI messages included in JVET-AM2006).

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-AM1006 and JVET-AM1017 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-AN2023.

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-AN2024.

Initial versions of these documents were presented and approved (see section 10).

## 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). In cases where combinations of different elements are planned to be tested, mutual cross-checking of the individual elements by other parties of the combination is discouraged. The combination must be cross-checked by an independent party. 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 was previously described at:

<https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/wikis/Core-experiment-development-workflow>

However, it was noted that the link doesn’t seem to exist anymore.

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 0800 on 4 July, preferably copy from the table below and sending with changemarks or yellow highlight of changes.

Review of AHG plans was conducted during the plenary on Friday 4 July 2025 at 1050–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. * Conduct consultation with parent bodies on future JVET management structures. | 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-AM1006, JVET-AM1017, JVET-AM2005 and JVET-AM2006). * Collect reports of errata for VVC, VSEI, HEVC, AVC, CICP, and the published related technical reports. * Coordinate with AHG3 to address issues relating to mismatches between software and text. | 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 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, as well as studying objective metrics in that context. * Coordinate with AHG17 on investigating sequences and making arrangements for viewing at the next meeting. * Coordinate with AHG18 on investigating visual impact of data losses. * 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) | Y (tel., 2 weeks notice) |
| **Conformance testing (AHG5)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study DIS of VVC conformance 3rd edition and suggest improvements to JVET-AL2028, as appropriate. * Study the draft conformance bitstreams for new HEVC multiview profiles in JVET-AM1008, 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-18.0 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. * Prepare an input document to the next meeting on criteria for detailed complexity analysis with 1-2 tools from each group as examples. * 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. * 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 potential improvements to JVET-AL2030 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. | S. Liu, J. Ström, S. Wang, M. Zhou (AHG chairs) | N |
| **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-AM1006, JVET-AM1017, JVET-AM2005, and JVET-AM2006, identify any issues and propose solutions as appropriate. * Study JVET-AM2032, including study of SEI messages with different options, when those are present, 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. * Study SEI messages specified in HEVC and AVC for potential use in the VVC context and SEI messages in VSEI for potential use in the HEVC or AVC context. * Study the alignment of the same SEI messages in different standards. * Coordinate with AHG3 for software support of SEI messages for JM, HM, and VTM. | S. McCarthy, J. Boyce, Y.-K. Wang (co-chairs), T. Chujoh, S. Deshpande, 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, AHG6, and AHG17. * 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) | N |
| **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 investigate bit-exact reproducibility of NN-based methods on various platforms. * 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 development of missing features of the interface in the NNVC software branch allowing to perform evaluation tests for end-to-end optimized AI coded reference pictures. | E. Alshina, F. Galpin, S. Liu (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 July 28, second on August 23 |
| **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 ECM18 algorithm description JVET-AM2025. * 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-AM2024 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-AL2020. * 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, M. Radosavljević, 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-14.0 software version (and potential updates), based on updated VTM with adopted contributions and hybrid framework, 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. * Continue to bridge the gap between NNVC and most recent VTM as necessary. * Continue to develop missing functionalities for hybrid end-to-end framework exploration. * 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-AM2019) 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 software development, and development of an interface to NNVC software branch allowing to perform evaluation tests for end-to-end optimized AI coded reference pictures. | 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 July 28, second on August 23 |
| **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) | N |
| **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-AM2006. | 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))   * Disseminate the Call for Evidence (CfE) JVET-AM2026. * Coordinate the generation of VTM and ECM bitstreams for the test cases defined in the CfE, and make them available according to the timeline. * Communicate with parties who intend to make submissions to the CfE. * Prepare logistics and plans for conducting the CfE at the next meeting. | J.-R. Ohm, M. Wien, F. Bossen (co-chairs), M. Abdoli, E. Alshina, V. Baroncini, J. Chen, R. Chernyak, Z. Deng, P. de Lagrange, L. Li, P. Nikitin, D. Rusanovskyy (vice chairs) | Y   * tel., 2 weeks notice |
| **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. * Coordinate with AHG4 on investigating visual impact of data losses. | 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 368) 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 368, as noted in section 9.

[JVET-AM1000](https://jvet-experts.org/doc_end_user/current_document.php?id=16010) Meeting Report of the 39th JVET Meeting [J.-R. Ohm] [WG 5 N 361] (2025-08-01)

Initial versions of the meeting notes (d0 … dX) 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.

Remains valid – not updated: [JVET-AL1004](https://jvet-experts.org/doc_end_user/current_document.php?id=15674) Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP [Y.-K. Wang, B. Bross, I. Moccagatta, C. Rosewarne, G. J. Sullivan]

Primary editor: Y.-K. Wang.

This includes changes from new bug tickets, some items removed that are resolved and include elements from JVET-AL0317.

[JVET-AM1005](https://jvet-experts.org/doc_end_user/current_document.php?id=16011) Future CICP extensions (Draft 1) [J. Boyce, E. Thomas, A. Tourapis] (2025-08-01)

Primary editor: J. Boyce.

Including updates from JVET-AM0089 and JVET-AM0335.

[JVET-AM1006](https://jvet-experts.org/doc_end_user/current_document.php?id=16012) HEVC additional profiles and SEI messages (Draft 4) [Y.-K. Wang, B. Bross, S. Deshpande, G. J. Sullivan, A. Tourapis] (2025-08-01)

Primary editor: Y.-K. Wang.

Editorial improvements and bug fixes agreed at this meeting, elements from:

* [JVET-AM0048](https://jvet-experts.org/doc_end_user/current_document.php?id=15695) AHG9/AHG2: Miscellaneous changes for HEVC
* [JVET-AM0118](https://jvet-experts.org/doc_end_user/current_document.php?id=15765) AHG9: Digital signing of selected SEI messages
* [JVET-AM0121](https://jvet-experts.org/doc_end_user/current_document.php?id=15768) AHG9: On the SEI processing order SEI message
* [JVET-AM0324](https://jvet-experts.org/doc_end_user/current_document.php?id=15992) Correction to the Alpha Channel Information SEI message processing order

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]

[JVET-AM1008](https://jvet-experts.org/doc_end_user/current_document.php?id=16013) Conformance testing for HEVC multiview extended and monochrome profiles [I. Moccagatta, T. Fu, S. Paluri, A. Tourapis] (2025-07-25)

Two new multiview streams are added.

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]

Update of bug tracking system description expected in next meeting.

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-AM1017](https://jvet-experts.org/doc_end_user/current_document.php?id=16014) Support for additional SEI messages in AVC (Draft 3) [K. Sühring, J. Boyce, G. J. Sullivan, Y.-K. Wang] [WG 5 DAM N 363] (2025-07-18)

Primary editor: K. Sühring

A DoC WG 5 N 362 on the CDAM was reviewed and approved on Friday 4 July at 0930-0940.

Changes agreed at this meeting:

* Editorial improvements and bug fixes

Resolved bug fixes carried over from JVET-AL1004 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.

[JVET-AM1018](https://jvet-experts.org/doc_end_user/current_document.php?id=16015) HEVC with extensions and corrections (Draft 2) [G. J. Sullivan, Y.-K. Wang] (2025-09-30)

Primary editor: Y.-K. Wang.

To prepare the next edition of H.265 – changes from the differential text JVET-AM1006 (e.g., new SEI messages) to be included.

No output: JVET-Axx1019 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 (kept for future use):

* …

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-AM2005](https://jvet-experts.org/doc_end_user/current_document.php?id=16016) Additions and corrections for VVC version 4 (Draft 13) [G. J. Sullivan, B. Bross, M. M. Hannuksela, Y.-K. Wang] (2025-08-01)

Changes agreed at this meeting:

* [JVET-AM0118](https://jvet-experts.org/doc_end_user/current_document.php?id=15765) AHG9: Digital signing of selected SEI messages
* [JVET-AM0121](https://jvet-experts.org/doc_end_user/current_document.php?id=15768) AHG9: On the SEI processing order SEI message
* Editorial improvements and bug fixes

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.

Editors are requested to make preparations for integration into a new edition until the next meeting.

[JVET-AM2006](https://jvet-experts.org/doc_end_user/current_document.php?id=16017) Additional SEI messages for VSEI version 4 (Draft 7) [J. Boyce, J. Chen, S. Deshpande, M. M. Hannuksela, S. McCarthy, G. J. Sullivan, H. Tan, Y.-K. Wang] (2025-08-01)

Changes agreed at this meeting:

Multiple SEI messages

* [JVET-AM0189](https://jvet-experts.org/doc_end_user/current_document.php?id=15836) AHG9: On semantics of persistence flag of SEI messages in VSEI v4 and v3
* [JVET-AM0174](https://jvet-experts.org/doc_end_user/current_document.php?id=15821) AHG9: On general SEI payload constraints
* [JVET-AM0047](https://jvet-experts.org/doc_end_user/current_document.php?id=15694) AHG9: Miscellaneous changes for VSEI
* [JVET-AM0052](https://jvet-experts.org/doc_end_user/current_document.php?id=15699) AHG9: Editorial changes for VSEI
* [JVET-AM0191](https://jvet-experts.org/doc_end_user/current_document.php?id=15838) AHG9: Editorial updates for VSEI v4
* [JVET-AM0165](https://jvet-experts.org/doc_end_user/current_document.php?id=15812) AHG9: On value range and reserved values for syntax elements in VSEI v4

SEI processing order (SPO) and processing order nesting (PON)

* [JVET-AM0292](https://jvet-experts.org/doc_end_user/current_document.php?id=15960) AHG9/AHG2: On the semantics of po\_num\_bits\_in\_prefix\_indication\_minus1[ i ] and po\_sei\_prefix\_data\_bit[ i ][ j ]
* [JVET-AM0081](https://jvet-experts.org/doc_end_user/current_document.php?id=15728) AHG9: On the PON dependency constraint
* [JVET-AM0082](https://jvet-experts.org/doc_end_user/current_document.php?id=15729) AHG9: On the PON nested FGC SEI message
* [JVET-AM0121](https://jvet-experts.org/doc_end_user/current_document.php?id=15768) AHG9: On the SEI processing order SEI message
* [JVET-AM0166](https://jvet-experts.org/doc_end_user/current_document.php?id=15813) AHG9: Miscellaneous aspects in VSEI v4
* [JVET-AM0321](https://jvet-experts.org/doc_end_user/current_document.php?id=15989) AHG9: On SEI message types indicated by an SPO SEI message

AI usage restrictions (AUR)

* [JVET-AM0112](https://jvet-experts.org/doc_end_user/current_document.php?id=15759) AHG9: On AI usage restrictions SEI message
* [JVET-AM0152](https://jvet-experts.org/doc_end_user/current_document.php?id=15799) AHG9: AI usage restrictions for entities other than decoded pictures
* [JVET-AM0117](https://jvet-experts.org/doc_end_user/current_document.php?id=15764) AHG9: On the AI usage restrictions SEI message

Digitally signed content (DSC)

* [JVET-AM0118](https://jvet-experts.org/doc_end_user/current_document.php?id=15765) AHG9: Digital signing of selected SEI messages
* [JVET-AM0119](https://jvet-experts.org/doc_end_user/current_document.php?id=15766) AHG9: On start and end flags of digitally signed
* [JVET-AM0164](https://jvet-experts.org/doc_end_user/current_document.php?id=15811) AHG9: On DSC SEI
* [JVET-AM0190](https://jvet-experts.org/doc_end_user/current_document.php?id=15837) AHG9: On implicit association mode in digitally-signed content SEI messages in VSEI v4
* [JVET-AM0210](https://jvet-experts.org/doc_end_user/current_document.php?id=15857) AHG9: On miscellaneous aspects in digitally-signed content SEI messages in VSEI v4 draft

Packed regions info (PRI)

* [JVET-AM0075](https://jvet-experts.org/doc_end_user/current_document.php?id=15722) AHG9: On packed regions information SEI message
* [JVET-AM0211](https://jvet-experts.org/doc_end_user/current_document.php?id=15858) AHG9: On the packed regions information SEI message
* Generative face video (GFV)
* [JVET-AM0334](https://jvet-experts.org/doc_end_user/current_document.php?id=16002) AHG9: Common specification text for GFV SEI message

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.

Editors are requested to make preparations for integration into a new edition until the next meeting.

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>.

A DoC WG 5 N 366 on the DIS was reviewed and approved on Thursday 3 July at 1640. The text was requested to be published as IS with editorial improvements as requested by ISO editor in the context of the ballot. Public availability was also requested.

Primary editor: F. Bossen.

Remains valid – not updated: [JVET-AL2010](https://jvet-experts.org/doc_end_user/current_document.php?id=15680) 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] (2025-04-18)

Add alternative configuration from JVET-AL0055 and clarification about intra picture period (see discussion under JVET-AL0114). 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.

It was also commented that it might be good to add conditions relating to HDR, even though currently no HDR tests are conducted in CTC.

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-AM2019](https://jvet-experts.org/doc_end_user/current_document.php?id=16018) Description of algorithms version 12 and software version 14 in neural network-based video coding (NNVC) [F. Galpin, Yue Li, Yun Li, D. Rusanovskyy, T. Shao, J. Ström, L. Wang] (2025-09-30)

New elements in text and software from notes elsewhere in this report:

* Decision: Adopt JVET-AM0135 EE1-2.1.
* Decision: Adopt JVET-AM0175 EE1-3.2 (non CTC, also provide training script).

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-AL2020](https://jvet-experts.org/doc_end_user/current_document.php?id=15682) Film grain synthesis technology for video applications ed. 2 (Draft 3) [W. Husak, P. de Lagrange, A. Norkin, A. Tourapis] (2025-08-15)

Output of last meeting not yet available by the time of closing the current meeting.

[JVET-AM2021](https://jvet-experts.org/doc_end_user/current_document.php?id=16019) Verification test plan for VVC multilayer coding (update 6) [O. Chubach, P. de Lagrange, M. Wien] (2025-09-15)

Developed from JVET-AM0223.

HHI (B. Bross) expresses interest for participating in bitstream generation.

To be discontinued if no increase of activity is observed over the next two meeting cycles.

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]

Number might be re-used (activity discontinued) as there has been no activity for 3 meeting cycles.

[JVET-AM2023](https://jvet-experts.org/doc_end_user/current_document.php?id=16008) Exploration experiment on neural network-based video coding (EE1) [E. Alshina, R. Chang, F. Galpin, Yue Li, Yun Li, M. Santamaria, T. Shao, J. Ström, Z. Xie (EE coordinators)] (2025-XX-XX)

An initial draft of this document was reviewed and approved at 1125-1140 on Friday 4 July.

This round of EE1 tests includes:

* EE1-1: LOP in-loop filter
  + EE1-1.1 – LOP with Overlapped Feature Integration (JVET-AM0131)
  + EE1-1.2 –Backbone Block Enhancement of LOP In-Loop Filter with Over-Parameterized Training and Variable Channels (JVET-AM0122)
  + EE1-1.3 – Conditional LOP loop-filter (JVET-AM0053)
* EE1-2: VLOP in-loop filter
  + EE1-2.1 – Conditional VLOP loop-filter (JVET-AM0053)
  + EE1-2.2 – Decomposed Content-Adaptive VLOP (JVET-AM0185)
* EE1-3: NN-inter prediction
  + EE1-3.1 – Deep Reference Frame Generation for Inter Prediction Enhancement with Structural Re-parameterization (JVET-AM0177)
  + EE1-3.2 – RA/LDB Reference Frame Synthesis for VVC Inter Coding (JVET-AM0115)
  + EE1-3.3 – Network architecture from EE1-3.1 with training from EE1-3.2
  + EE1-3.4 – Network architecture from EE1-3.2 with training from EE1-3.3
* EE1-4: NN-based super-resolution
  + EE1-4.1 NNSR with new backbone block based on Spatial-Channel Mixing (SCM) (JVET-AM0199)
  + EE1-4.2 Cross-component enhanced NNSR (JVET-AM0257)

[JVET-AM2024](https://jvet-experts.org/doc_end_user/current_document.php?id=16009) Exploration experiment on enhanced compression beyond VVC capability (EE2) [V. Seregin, D. Buğdayci Sansli, J. Chen, R. Chernyak, K. Naser, J. Ström, F. Wang, M. Winken, X. Xiu, K. Zhang (EE coordinators)] (2025-XX-XX)

An initial draft of this document was reviewed and approved at 0920-0925 on Friday 4 July.

This round of EE2 tests will include:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | Tester | **Cross-checker** |
| 1 Partitioning | | | |
| 1.1a | Restrictions for TT splitting | G.Wang (vivo) |  |
| 1.1b | Test 1.1a as encoder-only change | G.Wang (vivo) |  |
| 1.1c | Temporal partitioning prediction optimization | G.Wang (vivo) |  |
| 1.1d | Test 1.1a + Test 1.1c | G.Wang (vivo) |  |
| 1.1e | Test 1.1b + Test 1.1c | G.Wang (vivo) |  |
| 2 Intra prediction | | | |
| 2.1 | TMRL blend | S. Blasi  (Nokia) | V. Rufitskiy (TCL) |
| 2.2a | Alignment of interpolation filters used in reference samples unwrapping and predictor generation | V. Rufitskiy  (TCL) |  |
| 2.2b | Disabling smoothing in interpolation and reference sample processing operations for DIMD and TIMD | V. Rufitskiy  (TCL) |  |
| 2.3a | Unification of unwrapping interpolation filters in TIMD template and block prediction | T. Dong  (TCL) |  |
| 2.3b | 8-tap interpolation filter for template generation in TIMD | T. Dong  (TCL) |  |
| 2.4 | Longer tap interpolation filtering | V. Rufitskiy  (TCL) |  |
| 2.5 | Combination of Test 2.2, Test 2.3, and Test 2.4 | V. Rufitskiy  (TCL) |  |
| 2.6a | Adaptive subsampling filter selection for CCLM/intra-CCCM/ALF-CCCM | Y. Kidani  (KDDI) |  |
| 2.6b | Adaptive subsampling filter selection for inter-CCCM | Y. Kidani  (KDDI) |  |
| 2.6c | Test 2.6a + Test 2.6b | Y. Kidani  (KDDI) |  |
| 2.7 | Reducing candidate modes in decoder derived CCP | S. Wan(NWPU)  S. Xie(ZTE) |  |
| 2.8 | Enhanced CCP Fusion mode | P.Bordes (InterDigital) |  |
| 3 Inter prediction | | | |
| 3.1 | Generated merge candidates | D. Buğdayci Sansli  (Nokia) |  |
| 3.2a | Joint reordering of GPM with affine prediction | L. Zhang  (OPPO) |  |
| 3.2b | Modifications to the affine merge list | L. Zhang  (OPPO) |  |
| 3.2c | Test 3.2a + Test 3.2b | L. Zhang  (OPPO) |  |
| 3.3 | Joint reordering of GPM with intra prediction | Z. Sun  (OPPO) |  |
| 3.4 | Test 3.2c + Test 3.3 | Z. Sun  (OPPO) |  |
| 4 Transform and coefficients coding | | | |
| 4.1 | Linked sign prediction | Y. Zhang  (OPPO) |  |
| 4.2a | Shifting quantization center for TSRC under non-CTC (RDOQ on) | Y. Yu  (OPPO) |  |
| 4.2b | Shifting quantization center for RRC under non-CTC (DQ disabled, RDOQ on) | Y. Yu  (OPPO) |  |
| 4.2c | Test 4.2a + Test 4.2b | Y. Yu  (OPPO) |  |
| 4.2d | Shifting quantization center for TSRC under CTC | Y. Yu  (OPPO) |  |
| 4.2e | Shifting quantization center for RRC under CTC | Y. Yu  (OPPO) |  |
| 4.2f | Test 4.2d + Test 4.2e | Y. Yu  (OPPO) |  |
| 4.2g | Shifting quantization center for RRC under non-CTC (DQ disabled, RDOQ disabled) | M. Le Pendu (InterDigital) |  |
| 4.2h | Shifting quantization center for TSRC under non-CTC (DQ disabled, RDOQ disabled) | M. Le Pendu (InterDigital) |  |
| 4.2i | Test 4.2g + Test 3.2h | M. Le Pendu (InterDigital) |  |
| 4.3a | Residual sign prediction restriction | C. Hollmann  (TCL) |  |
| 4.3b | RSP context modelling | C. Hollmann  (TCL) |  |
| 4.3c | Test 4.3a with retraining of existing contexts | C. Hollmann  (TCL) |  |
| 4.3d | Test 4.3a + Test 4.3b | C. Hollmann (TCL) |  |
| 5 In-loop filtering | | | |
| 5.1a | Regularization of ALF-CCCM | Z. Xie  (OPPO) |  |
| 5.1b | Regularization for ALF-CCCM enabled in I slice | Z. Xie  (OPPO) |  |
| 5.2a | Non-downsampled ALF-CCCM | L. Xu  (OPPO) |  |
| 5.2b | Reuse of CU partition in ALF-CCCM | L. Xu  (OPPO) |  |
| 5.2c | Test 5.2a + Test 5.2b | L. Xu  (OPPO) |  |
| 5.3a | Remove single model of ALF-CCCM | N. Song  (OPPO) |  |
| 5.3b | Separate “bad window” condition for Cb and Cr components | N. Song  (OPPO) |  |
| 5.3c | Test 5.3a + Test 5.3b | N. Song  (OPPO) |  |
| 5.4 | Additional models for ALF-CCCM | F. Wang  (OPPO) |  |
| 5.5a | Test 5.1 + Test 5.2 | L. Xu  Z. Xie  (OPPO) |  |
| 5.5b | Test 5.1 + Test 5.2 + Test 5.4 | L. Xu  Z. Xie  F. Wang  (OPPO) |  |
| 5.5c | Test 5.1 + Test 5.2 + Test 5.3 + Test 5.4 | N. Song  L. Xu  Z. Xie  F. Wang  (OPPO) |  |
| 5.6 | Reuse of TALF control information | Y. Bai  (ZTE) |  |

[JVET-AM2025](https://jvet-experts.org/doc_end_user/current_document.php?id=16020) Algorithm description of Enhanced Compression Model 18 (ECM 18) [M. Coban, R.-L. Liao, K. Naser, J. Ström, L. Zhang] (2025-09-30)

New elements from notes elsewhere in this report:

* Decision: Adopt JVET-AM0307 test 1.12.
* Decision: Adopt JVET-AM0163 test 1.7a.
* Decision: Adopt JVET-AM0157 test 1.8.
* Decision: Adopt JVET-AM0106 test 2.1b.
* Decision: Adopt JVET-AM0215 test 2.2a.
* Decision: Adopt JVET-AM0056 Test 3.1.
* Decision: Adopt JVET-AM0209 test 4.2.
* Decision: Adopt JVET-AM0063 test 4.3c.
* Decision: Adopt JVET-AM0231 (non-CTC) test 4.5c (non-CTC).
* Decision: Adopt JVET-AM0104 on top of EE2-1.7a.
* Decision (SW): add the missing implementation of JVET-AE0102 and JVET-AG0100 encoder operations to the next version of ECM.

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-AM2026](https://jvet-experts.org/doc_end_user/current_document.php?id=16021) Joint Call for Evidence on video compression with capability beyond VVC [J.-R. Ohm, M. Wien, F. Bossen] [WG 5 N 367] (2025-07-04)**

Final version was reviewed in a BoG meeting Fri 4 July 0800-0915, where the substantial changes made were adjustments of bit rates and adding an annex for registration of submissions. The content of the document was approved by JVET at 0955 on Friday 4 July. The latest draft with all changes was uploaded as an attachment to the BoG report JVET-AM0336. Experts were asked to carefully review and inform the editors about possible need of changes until the end of the meeting.

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]

Remains valid: [JVET-AL2028](https://jvet-experts.org/doc_end_user/current_document.php?id=15685) Additions and corrections for VVC conformance (draft 1) [S. Iwamura, P. de Lagrange, I. Moccagatta] (2025-05-02)

This is a delta change document, some aspects related to bitstream corrections and editorial notes to be removed. For DIS, WG 5 N 365 (with editing period 2025-7-25) was issued integrating additional corrected bitstreams (as per JVET-AM0005) together with the valid previous bitstreams as an attachment.

A DoC WG 5 N 364 on the CD was reviewed and approved on Thursday 3 July at 1700.

Editors are requested to make preparations for integration into a new edition of ITU-T H.266.1 until the next meeting.

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]

Remains valid – not updated: [JVET-AL2030](https://jvet-experts.org/doc_end_user/current_document.php?id=15686) Optimization of encoders and receiving systems for machine analysis of coded video content (Draft 9) [S. Liu, J. Chen, J. Ström] [WG 5 DTR N 354] (2025-05-02)

Primary editor: S. Liu.

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-AM2032](https://jvet-experts.org/doc_end_user/current_document.php?id=16022) Technologies under consideration for future extensions of VSEI (version 9) [S. McCarthy, J. Boyce, J. Chen, S. Deshpande, M. M. Hannuksela, H. Tan, Y.-K. Wang] (2025-08-31)

New elements from notes elsewhere in this report:

Encoder optimization info (EOI)

* [JVETAM0126](https://jvet-experts.org/doc_end_user/current_document.php?id=15773) AHG9: Temporal quality indication for EOI SEI message

Scalability dimension info (SDI) SEI

* [JVET-AM0090](https://jvet-experts.org/doc_end_user/current_document.php?id=15737) AHG9: SDI SEI extension for signalling described layer of confidence layer

Shutter interval

* [JVET-AM0100](https://jvet-experts.org/doc_end_user/current_document.php?id=15747) AHG9: Shutter interval information SEI message extension for rolling shutter cameras

Alpha channel info (ACI)

* [JVET-AM0324](https://jvet-experts.org/doc_end_user/current_document.php?id=15992) Correction to the Alpha Channel Information SEI message processing order

NNPF

* [JVET-AM0087](https://jvet-experts.org/doc_end_user/current_document.php?id=15734) AHG9: Comments on VSEI TuC
* [JVET-AM0173](https://jvet-experts.org/doc_end_user/current_document.php?id=15820) AHG9: NNPFA SEI message extension for multi-purpose NNPFs

Constituent rectangles (CR)

* [JVET-AM0092](https://jvet-experts.org/doc_end_user/current_document.php?id=15739) AHG9: Editorial changes on the CR SEI
* [JVET-AM0093](https://jvet-experts.org/doc_end_user/current_document.php?id=15740) AHG9: On the CR SEI message

Display rectangles (DR)

* [JVET-AM0095](https://jvet-experts.org/doc_end_user/current_document.php?id=15742) AHG9: On the DR SEI message
* [JVET-AM0146](https://jvet-experts.org/doc_end_user/current_document.php?id=15793) AHG9: On display rectangles with same display aspect ratio as cropped decoded picture

Digitally signed content (DSC)

* [JVET-AM0193](https://jvet-experts.org/doc_end_user/current_document.php?id=15840) AHG9: On digitally-signed content SEI messages for subpicture support in TuC of VSEI

Film grain regions characteristics (FGRC)

* [JVET-AM0085](https://jvet-experts.org/doc_end_user/current_document.php?id=15732) AHG9/AHG13: On Film Grain Regions Characteristics SEI message
* [JVET-AM0124](https://jvet-experts.org/doc_end_user/current_document.php?id=15771) [AHG9/AHG13]: On typo fix and interface software contribution to the FGRC SEI message

Lens optical correction (LOC)

* [JVET-AM0102](https://jvet-experts.org/doc_end_user/current_document.php?id=15749) AHG9: Additional models for the LOC SEI message
* [JVET-AM0101](https://jvet-experts.org/doc_end_user/current_document.php?id=15748) AHG9: On Lens Optical Correction SEI message

Display overlays info (DOI)

* [JVET-AM0094](https://jvet-experts.org/doc_end_user/current_document.php?id=15741) AHG9: On the DOI SEI
* [JVET-AM0147](https://jvet-experts.org/doc_end_user/current_document.php?id=15794) AHG9: On applying display overlays on display rectangles
* [JVET-AM0180](https://jvet-experts.org/doc_end_user/current_document.php?id=15827) AHG9: Overlay purpose indicator for Display overlays information SEI message

Picture segment info (PSI)

* [JVET-AM0097](https://jvet-experts.org/doc_end_user/current_document.php?id=15744) AHG9: On the PSI SEI message
* [JVET-AM0192](https://jvet-experts.org/doc_end_user/current_document.php?id=15839) AHG9: On picture segmentation SEI message in TuC of VSEI

Danmu information

* [JVET-AM0154](https://jvet-experts.org/doc_end_user/current_document.php?id=15801) AHG9: On danmu information SEI message
* [JVET-AM0161](https://jvet-experts.org/doc_end_user/current_document.php?id=15808) AHG9: On display timing in the danmu information SEI message
* [JVET-AM0182](https://jvet-experts.org/doc_end_user/current_document.php?id=15829) AHG9: On the Danmu SEI message

Photosensitive content

* [JVET-AM0086](https://jvet-experts.org/doc_end_user/current_document.php?id=15733) AHG9: On Photosensitive Content Information Signalling

Quality metric QM

* [JVET-AM0096](https://jvet-experts.org/doc_end_user/current_document.php?id=15743) AHG9: On the QM SEI message

Bitdepth range info (BRI)

* [JVET-AM0099](https://jvet-experts.org/doc_end_user/current_document.php?id=15746) AHG9: On the BRI SEI message

Colour mapping info (CMI)

* [JVET-AM0108](https://jvet-experts.org/doc_end_user/current_document.php?id=15755) AHG9: On colour mapping information SEI message

Referred to editors for consideration:

* [JVET-AM0079](https://jvet-experts.org/doc_end_user/current_document.php?id=15726) AHG9: On the SPO SEI message
* [JVET-AM0155](https://jvet-experts.org/doc_end_user/current_document.php?id=15802) AHG9: On the SPO SEI message complexity signalling

New messages:

* [JVET-AM0083](https://jvet-experts.org/doc_end_user/current_document.php?id=15730) AHG9: Auxiliary sampling alignment and transformation information SEI
* [JVET-AM0181](https://jvet-experts.org/doc_end_user/current_document.php?id=15828) AHG9: Proposed new SEI message on localization and mapping

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-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-AM2038](https://jvet-experts.org/doc_end_user/current_document.php?id=16023) White paper on VSEI [J. Boyce, S. McCarthy, S. Deshpande, G. J. Sullivan, Y. Sanchez, Y.-K. Wang] [AG 3 N209] (2025-09-15)

Was presented to AG 3, and target to release the final version by October.

# 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 October.

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, or AHG meetings might be scheduled prior to the meeting. 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 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 physical meeting with remote participation,
* During 14 – 23 October 2026, 44th meeting under ISO/IEC JTC 1/‌SC 29 auspices in Hangzhou, CN, to be conducted as hybrid meeting,
* 13 – 22 January 2027, 45th meeting under ISO/IEC JTC 1/‌SC 29 auspices in Brisbane, AU, to be conducted as hybrid meeting,
* During April 2027, 46th meeting under ITU-T SG21 auspices, date and location t.b.d.
* During 7 – 16 July 2027, 47th meeting under ISO/IEC JTC 1/‌SC 29 auspices in Tampere, FI, to be conducted as hybrid meeting,
* During 20 – 29 October 2027, 48th meeting under ISO/IEC JTC 1/‌SC 29 auspices in Shenzhen, CN, to be conducted as hybrid meeting,
* During January 2028, 49th meeting under ITU-T SG21 auspices, date and location t.b.d.
* During April 2028, 50th meeting under ISO/IEC JTC 1/‌SC 29 auspices, date and location t.b.d.

The agreed document deadline for the 41st JVET meeting was planned to be Wednesday 7 Jan. 2026.

TCL was thanked for providing 4K displays used in the CfE viewing. Fraunhofer HHI and RWTH Aachen were thanked for providing play-out equipment. Mathias Wien was thanked for organizing and supervising the test, and Christian Lehmann was thanked for helping with the test setup. Kenneth Andersson, Philippe de Lagrange, and Adam Wieckowski were thanked for assistance in preparing and conducting the viewing. Numerous experts who volunteered to participate in the viewing were also thanked.

Alibaba, BossenTech, Bytedance, Dolby, Ericsson, Google, Huawei, InterDigital, KDDI, Nokia, OPPO, Panasonic, Qualcomm, Samsung, Sharp, Tencent, vivo, and Xiaomi were thanked for generating VTM and ECM bitstreams that were used in the experts viewing, and will also be used in the context of the Call for Evidence.

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 40th JVET meeting was closed at approximately XXXX hours CEST on Sunday 12 October 2025.

# Annex A to JVET report: List of documents

Dates and times in the table below are in Paris/Geneva time (2 hr. ahead of UTC). 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 B1 to JVET report: List of meeting participants attending in person

The participants who were personally present at the meeting site of the fortieth meeting of the JVET, according to a sign-in sheet circulated in the JVET meeting rooms (approximately XXX people in total), were as follows:

1. …

# Annex B2 to JVET report: List of meeting participants attending remotely

The remote participants of the fortieth 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 had attended the meeting in person at least part-time (see annex B1), and not including those who attended only the joint sessions with other groups), were as follows:

1. …

# Annex C to JVET report: Recommendations of the 21st 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**

**…**