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| **Joint Video Experts Team (JVET)**  **of ITU-T SG21 WP3/21 and ISO/IEC JTC 1/SC 29**  39th Meeting, Daejeon, KR, 26 June – 4 July 2025 | Document: JVET-AM\_notes\_d7 |

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| *Title:* | **Meeting Report of the 39th Meeting of the Joint Video Experts Team (JVET), Daejeon, 26 June – 4 July 2025** | | |
| *Status:* | Report document from the chair of JVET | | |
| *Purpose:* | Report | | |
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| *Source:* | Chair of JVET | | |

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# Summary

The Joint Video Experts Team (JVET) of ITU-T WP3/21 and ISO/IEC JTC 1/‌SC 29 held its thirty-ninth meeting during 26 June – 4 July 2025 at Daejeon Convention Complex, Republic of Korea. The meeting was held as a hybrid meeting, where remote participation was 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 0910 hours KST (UTC+9) on Thursday 26 June 2025. Meeting sessions were held on all days including the weekend days of Saturday and Sunday 29 and 30 June 2025, until the meeting was closed at approximately XXXX hours KST on Friday 4 July 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 coordination with a meeting of various SC29 Working Groups and Advisory Groups – where WG 5 is representing the Joint Video Coding Team(s) and their activities from the perspective of the SC 29 parent body, under whose auspices this JVET meeting was held. The subject matter of the JVET meeting activities consisted of work on further development and maintenance of the twin-text video coding technology standards *Advanced Video Coding* (AVC), *High Efficiency Video Coding* (HEVC), *Versatile Video Coding* (VVC)*, Coding-independent Code Points (Video)* (CICP), and *Versatile Supplemental Enhancement Information Messages for Coded Video Bitstreams* (VSEI), as well as related technical reports, reference software and conformance testing packages. Further important goals were reviewing the results of the Exploration Experiment (EE) on Neural Network-based Video Coding, of the EE on Enhanced Compression beyond VVC capability, of other technical input on novel aspects of video coding technology, and to plan next steps for investigation of candidate technology towards further standard development.

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

a) JVET documents

* JVET-AL1004 Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP
* JVET-AL1006 HEVC additional profiles and SEI messages (Draft 3), also issued as WG 5 DAM N 349
* JVET-AL1017 Support for additional VSEI messages in AVC (Draft 2), also issued as WG 5 CDAM N 345
* JVET-AL1018 HEVC with extensions and corrections (Draft 1)
* JVET-AL2005 Additions and corrections for VVC version 4 (Draft 12), also issued as WG 5 DAM N 351
* JVET-AL2006 Additional SEI messages for VSEI version 4 (Draft 6), also issued as WG 5 DAM N 347
* JVET-AL2010 VTM and HM common test conditions and software reference configurations for SDR 4:2:0 10 bit video
* JVET-AL2019 Description of algorithms version 1 and software version 13 in neural network-based video coding (NNVC)
* JVET-AL2020 Film grain synthesis technology for video applications ed. 2 (Draft 3)
* JVET-AL2023 Exploration experiment on neural network-based video coding (EE1)
* JVET-AL2024 Exploration experiment on enhanced compression beyond VVC capability (EE2)
* JVET-AL2025 Algorithm description of Enhanced Compression Model 17 (ECM 17
* JVET-AL2026 Draft Joint Call for Evidence on video compression with capability beyond VVC, also issued as WG 5 N 355
* JVET-AL2028 Additions and corrections for VVC conformance (draft 1)
* JVET-AL2030 Optimization of encoders and receiving systems for machine analysis of coded video content (draft 89, also issued as WG 5 DTR N 354
* JVET-AL2032 Technologies under consideration for future extensions of VSEI (version 8)

b) documents produced as WG 5 documents only:

* WG 5 N 346 Disposition of comments received on ISO/IEC 23002-7:2024/CDAM1
* WG 5 N 348 Disposition of comments received on ISO/IEC 23008-2:2025/CDAM 1
* WG 5 N 350 Disposition of comments received on ISO/IEC 23090-3:2024/CDAM1
* WG 5 N 352 Text of CD ISO/IEC 23090-15:202x (3rd ed.) Conformance testing for versatile video
* WG 5 N 353 Disposition of comments received on ISO/IEC CDTR 23888-3
* WG 5 N 356 Liaison statement to ISO/IEC JTC 1/SC 29/WG 1 (JPEG) on JPEG AI and explorations on video coding

As main results, the JVET produced 16 output documents from the current meeting (update):

* JVET-AL1004 Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP
* JVET-AL1006 HEVC additional profiles and SEI messages (Draft 3), also issued as WG 5 DAM N 349
* JVET-AL1017 Support for additional VSEI messages in AVC (Draft 2), also issued as WG 5 CDAM N 345
* JVET-AL1018 HEVC with extensions and corrections (Draft 1)
* JVET-AL2005 Additions and corrections for VVC version 4 (Draft 12), also issued as WG 5 DAM N 351
* JVET-AL2006 Additional SEI messages for VSEI version 4 (Draft 6), also issued as WG 5 DAM N 347
* JVET-AL2010 VTM and HM common test conditions and software reference configurations for SDR 4:2:0 10 bit video
* JVET-AL2019 Description of algorithms version 1 and software version 13 in neural network-based video coding (NNVC)
* JVET-AL2020 Film grain synthesis technology for video applications ed. 2 (Draft 3)
* JVET-AL2023 Exploration experiment on neural network-based video coding (EE1)
* JVET-AL2024 Exploration experiment on enhanced compression beyond VVC capability (EE2)
* JVET-AL2025 Algorithm description of Enhanced Compression Model 17 (ECM 17
* JVET-AL2026 Draft Joint Call for Evidence on video compression with capability beyond VVC, also issued as WG 5 N 355
* JVET-AL2028 Additions and corrections for VVC conformance (draft 1)
* JVET-AL2030 Optimization of encoders and receiving systems for machine analysis of coded video content (draft 89, also issued as WG 5 DTR N 354
* JVET-AL2032 Technologies under consideration for future extensions of VSEI (version 8)

The following 6 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 346 Disposition of comments received on ISO/IEC 23002-7:2024/CDAM1
* WG 5 N 348 Disposition of comments received on ISO/IEC 23008-2:2025/CDAM 1
* WG 5 N 350 Disposition of comments received on ISO/IEC 23090-3:2024/CDAM1
* WG 5 N 352 Text of CD ISO/IEC 23090-15:202x (3rd ed.) Conformance testing for versatile video
* WG 5 N 353 Disposition of comments received on ISO/IEC CDTR 23888-3
* WG 5 N 356 Liaison statement to ISO/IEC JTC 1/SC 29/WG 1 (JPEG) on JPEG AI and explorations on 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 3 – 12 October 2025 under ITU-T SG21 auspices in Geneva, CH; during 14 – 23 January 2026 under ISO/IEC JTC 1/‌SC 29 auspices, to be conducted as teleconference meeting; during 24 April – 1 May 2026 under ISO/IEC JTC 1/‌SC 29 auspices in Santa Eulària, ES; during 7 – 15 July 2026 under ITU-T SG21 auspices in Geneva, CH; during 14 – 23 October 2026 under ISO/IEC JTC 1/‌SC 29 auspices in Hangzhou, CN; during 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 in Tampere, FI; during 20 – 29 October 2027 under ISO/IEC JTC 1/‌SC 29 in Shenzhen, CN; and during January 2028 under ITU-T SG21 auspices, date and location t.b.d.

The document distribution site <https://jvet-experts.org/> was used for distribution of all documents. 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 thirty-ninth meeting during 26 June – 4 July 2025 at Daejeon Convention Complex, Republic of Korea. The meeting was held as a hybrid meeting, where remote participation was 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 is currently also preparing a call for evidence on video compression with capability beyond existing standards.

This report contains three important annexes, as follows:

* Annex A contains a list of the documents of the JVET meeting
* Annex B contains a list of the meeting participants, 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_06_AM_Daejeon/>.

## Primary goals

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

a) JVET documents

* JVET-AL1004 Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP
* JVET-AL1006 HEVC additional profiles and SEI messages (Draft 3), also issued as WG 5 DAM N 349
* JVET-AL1017 Support for additional VSEI messages in AVC (Draft 2), also issued as WG 5 CDAM N 345
* JVET-AL1018 HEVC with extensions and corrections (Draft 1)
* JVET-AL2005 Additions and corrections for VVC version 4 (Draft 12), also issued as WG 5 DAM N 351
* JVET-AL2006 Additional SEI messages for VSEI version 4 (Draft 6), also issued as WG 5 DAM N 347
* JVET-AL2010 VTM and HM common test conditions and software reference configurations for SDR 4:2:0 10 bit video
* JVET-AL2019 Description of algorithms version 1 and software version 13 in neural network-based video coding (NNVC)
* JVET-AL2020 Film grain synthesis technology for video applications ed. 2 (Draft 3)
* JVET-AL2023 Exploration experiment on neural network-based video coding (EE1)
* JVET-AL2024 Exploration experiment on enhanced compression beyond VVC capability (EE2)
* JVET-AL2025 Algorithm description of Enhanced Compression Model 17 (ECM 17
* JVET-AL2026 Draft Joint Call for Evidence on video compression with capability beyond VVC, also issued as WG 5 N 355
* JVET-AL2028 Additions and corrections for VVC conformance (draft 1)
* JVET-AL2030 Optimization of encoders and receiving systems for machine analysis of coded video content (draft 89, also issued as WG 5 DTR N 354
* JVET-AL2032 Technologies under consideration for future extensions of VSEI (version 8)

b) documents produced as WG 5 documents only:

* WG 5 N 346 Disposition of comments received on ISO/IEC 23002-7:2024/CDAM1
* WG 5 N 348 Disposition of comments received on ISO/IEC 23008-2:2025/CDAM 1
* WG 5 N 350 Disposition of comments received on ISO/IEC 23090-3:2024/CDAM1
* WG 5 N 352 Text of CD ISO/IEC 23090-15:202x (3rd ed.) Conformance testing for versatile video
* WG 5 N 353 Disposition of comments received on ISO/IEC CDTR 23888-3
* WG 5 N 356 Liaison statement to ISO/IEC JTC 1/SC 29/WG 1 (JPEG) on JPEG AI and explorations on 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 Thursday, 19 June 2025. Any documents uploaded after 1159 hours Paris/Geneva time on Friday 20 June 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-AM0245 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-AM0XXX (a proposal on …), uploaded 06-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-AM0XXX (a study on …), uploaded 06-XX,
* … .

All cross-verification reports at this meeting (except for JVET-AM0137) 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-AM0128, JVET-AM0151, JVET-AM0197, JVET-AM0207, JVET-AM0213, JVET-AM0244, JVET-AM0246, JVET-AM0268, … .

(this did not happen at the current meeting – kept for future use) The following cross-verification reports were still missing by the end of the meeting, but were uploaded later: JVET-AM0XXX, … . The following reports had not become available yet three weeks after the end of the meeting: JVET-AM0XXX, … . These were marked as withdrawn by the JVET chair, assuming the registration had become obsolete.

“Placeholder” contribution documents that were basically empty of content, or lacking any results showing benefit for the proposed technology, and obviously uploaded with an intent to provide a more complete submission as a revision, had been agreed to be considered unacceptable and to be rejected in the document management system until a more complete version was available (which would then be counted as a late contribution if the update was after the document deadline). At the current meeting, this situation did apply to document(s) JVET-AM0XXX, being initially empty of results and flagged as late in the list above, based on the time of the first reasonable document upload.

It was remarked that documents that are substantially revised after the initial upload can also be a problem, as this becomes confusing, interferes with study, and puts an extra burden on synchronization of the discussion. This can especially be a problem in cases where the initial upload is clearly incomplete, and in cases where it is difficult to figure out what parts were changed in a revision. For document contributions, revision marking is very helpful to indicate what has been changed. Also, the “comments” field on the web site can be used to indicate what is different in a revision, although participants tend to seldom notice what is recorded there.

As a general policy, missing documents were not to be presented, and late documents (and substantial revisions) could only be presented when there was a consensus to consider them and there was sufficient time available for their review. Again, an exception is applied for AHG reports, CE and HLS topic summaries, and other such reports which can only be produced after the availability of other input documents. There were no objections raised by the group regarding presentation of late contributions, although there may have been some expression of annoyance and remarks on the difficulty of dealing with late contributions and late revisions.

A few contributions may have had some problems relating to IPR declarations in the initial uploaded versions (missing declarations, declarations saying they were from the wrong companies, etc.). Any such issues were corrected by later uploaded versions in a reasonably timely fashion in all cases (to the extent of the awareness of the responsible coordinators).

Some other errors may have also noticed in other initial document uploads (wrong document numbers or meeting dates or meeting locations in headers, etc.) which were generally sorted out in a reasonably timely fashion. The document web site contains an archive of each upload.

### Outputs of the preceding meeting

All output documents of the previous meeting, particularly the meeting report JVET-AL1000, the Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP JVET-AL1004, the HEVC additional profiles and SEI messages (draft 3) JVET-AL1006, the Support for additional SEI messages in AVC (draft 2) JVET-AL1017, the HEVC with extensions and corrections (draft 1) JVET-AL1018, the Additions and corrections for VVC version 4 (Draft 12) JVET-AL2005, the Additional SEI messages for VSEI version 4 (Draft 6) JVET-AL2006, the VTM and HM common test conditions and software reference configurations for SDR 4:2:0 10 bit video JVET-AL2010, the Description of algorithms version 11 and software version 13 in neural network-based video coding (NNVC) JVET-AL2019 (not delivered yet by beginning of the 39th meeting but delivered during the meeting), the Film grain synthesis technology for video applications ed. 2 (Draft 3) JVET-AL2020 (not delivered yet by beginning of the 39th meeting but delivered during the meeting), the Description of the EE on Neural Network-based Video Coding JVET-AL2023, the Description of the EE on Enhanced Compression beyond VVC capability JVET-AL2024, the Algorithm description of Enhanced Compression Model 17 (ECM 17) JVET-AL2025, the Draft Joint Call for Evidence on video compression with capability beyond VVC JVET-AL2026, the Additions and corrections for VVC conformance (draft 1) JVET-AL2028, the Optimization of encoders and receiving systems for machine analysis of coded video content (draft 9) [JVET-AL2030](https://jvet-experts.org/doc_end_user/current_document.php?id=12584), and the Technologies under consideration for future extensions of VSEI (version 8) JVET-AL2032, had been completed and those which were available were approved. In a few cases, the corresponding WG 5 N-numbered documents had not yet been uploaded, and this was requested to be done as soon as possible. The software implementations of VTM version 23.9 and 23.10, ECM version 17.0, and NNVC version 13.0 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.

It was further commented that some modifications appear necessary to JVET-AL1004, which could be implemented in a new version at the current meeting.

Only minor editorial issues were found in the meeting report JVET-AL1000; 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 testing video coding technology beyond common testing conditions, assessment of implementation complexity of video coding technology, and preparation of a call for evidence towards future video coding standardization
* Consideration of contributions on aspects of ultra-low latency and packet loss resilience in the context of video compression
* Consideration of contributions on errata relating to standards in the domain of JVET
* Consideration of contributions on technical reports relating to standards and exploration study activities in the domain of JVET
* Consideration of contributions providing non-normative guidance relating to standards and exploration study activities in the domain of JVET
* Consideration of information contributions
* Consideration of future work items
* Coordination of visual quality testing
* Liaisons, coordination activities with other organizations
* Review of project editor and liaison assignments
* Approval of output documents and associated editing periods
* Future planning: Determination of next steps, discussion of working methods, communication practices, establishment of coordinated experiments (if any), establishment of AHGs, future meeting planning, other planning issues
* Other business as appropriate for consideration
* Closing

The agenda was approved as suggested.

The 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. KST 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 and IEC Code of Conduct reminders

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

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

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

These include points relating to:

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

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

## IPR policy reminder

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

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

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

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

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

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

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

## Software copyright disclaimer header reminder

It was noted that the VTM and ECM software implementation packages use the same software copyright license header as the HEVC reference software, where the latter had been agreed at the 5th meeting of the JCT-VC and approved by both parent bodies at their collocated meetings at that time. This license header language is based on the BSD license with a preceding sentence declaring that other contributor or third party rights, including patent rights, are not granted by the license, as recorded in [N 10791](https://dms.mpeg.expert/doc_end_user/documents/89_London/wg11/w10791.zip) of the 89th meeting of ISO/IEC JTC 1/‌SC 29/‌WG 11 of June/July 2009. Both ITU and ISO/IEC will be identified in the <OWNER> and <ORGANIZATION> tags in the header. This software header is also used in the process of designing the VTM and ECM software, and for evaluating proposals for technology to be potentially included in these designs. This software or parts thereof might be published by ITU-T and ISO/IEC as an example implementation of a future video coding standard and for use as the basis of products to promote adoption of such technology.

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

These considerations apply to the 360Lib video conversion software and HDRTools as well. The SADL and NNVC packages for neural network-based video coding use the same licensing terms.

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

## Communication practices

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

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

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

It was emphasized that reflector subscriptions and email sent to the reflector must use real names when subscribing and sending messages and subscribers must respond to inquiries regarding the nature of their interest in the work. The current number of subscribers on the JVET email list was 1315 (as of 24 June 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 14496-10:202x (Ed. 11) FDIS issued at 34th meeting 2024-04, DIS approved for registration as FDIS 2024-09-17, FDIS ballot issued 2025-01-14, FDIS ballot closed 2025-03-23; pending publication
  + Amendment to support some SEI messages of VSEI v4 requested at 37th meeting 2025-01, registered to work programme 2025-01-25, ready for action to issue ISO/IEC CDAM
  + Conformance testing (twin text)
    - ITU-T H.264.1 V6 Approved 2016-02-13, published 2016-06-17
    - Various amendments of ISO/IEC 14496-4:2004, including:
      * ISO/IEC 14496-4:2004/AMD 6:2005 Advanced Video Coding conformance
      * ISO/IEC 14496-4:2004/AMD 9:2006 AVC fidelity range extensions conformance
      * ISO/IEC 14496-4:2004/AMD 30:2009 Conformance testing for new profiles for professional applications
      * ISO/IEC 14496-4:2004/AMD 31:2009 Conformance testing for SVC profiles
      * ISO/IEC 14496-4:2004/AMD 38:2010 Conformance testing for Multiview Video Coding
      * ISO/IEC 14496-4:2004/AMD 41:2014 Conformance testing of MVC plus depth extension of AVC
      * ISO/IEC 14496-4:2004/AMD 42:2014 Conformance testing of Multi-Resolution Frame Compatible Stereo Coding extension of AVC
      * ISO/IEC 14496-4:2004/AMD 43:2015 3D-AVC conformance testing
      * ISO/IEC 14496-4:2004/AMD 45:2016 Conformance Testing for the Multi-resolution Frame Compatible Stereo Coding with Depth Maps Extension of AVC
  + Reference software (twin text)
    - ITU-T H.264.2 V7 Approved 2016-02-13, published 2016-05-30
    - Various amendments of ISO/IEC 14496-5:2001 have been published, including:
      * ISO/IEC 14496-5:2001/AMD 6:2005 Advanced Video Coding (AVC) and High Efficiency Advanced Audio Coding (HE AAC) reference software
      * ISO/IEC 14496-5:2001/AMD 8:2006 AVC fidelity range extensions reference software
      * ISO/IEC 14496-5:2001/AMD 15:2010 Reference software for Multiview Video Coding
      * ISO/IEC 14496-5:2001/AMD 18:2008 Reference software for new profiles for professional applications
      * ISO/IEC 14496-5:2001/AMD 19:2009 Reference software for Scalable Video Coding
      * ISO/IEC 14496-5:2001/AMD 33:2015 Reference software for MVC plus depth extension of AVC
      * ISO/IEC 14496-5:2001/AMD 34:2014 Reference software of the multi-resolution frame compatible stereo coding of AVC
      * ISO/IEC 14496-5:2001/AMD 35:2015 3D-AVC Reference software
      * ISO/IEC 14496-5:2001/AMD 39:2016 Reference software for the Multi-resolution Frame Compatible Stereo Coding with Depth Maps of AVC
      * ISO/IEC 14496-5:2001/AMD 42:2017 Reference software for the alternative depth information SEI message extension of AVC
* HEVC (twin text)
  + ITU-T H.265 V7 approved 2019-11-29, published 2020-01-10
  + ISO/IEC 23008-2:2020 (Ed. 4) FDIS ballot closed 2020-07-16, published 2020-08-27
  + ITU-T H.265 V8 Consented at the 22nd meeting (shutter interval information SEI message and miscellaneous corrections), published 2020-10-13
  + ISO/IEC 23008-2:2020/AMD 1:2021 (shutter interval information SEI message) published 2021-07-12
  + ISO/IEC 23008-2:2023 (Ed. 5) began as CDAM 2 High-range levels output of 25th meeting of January 2022, CDAM ballot closed 2022-04-15, conversion to 5th edition with miscellaneous corrections planned at 26th meeting of 2022-04, text submitted for DIS ballot 2022-07-10, DIS ballot closed 2023-01-10, FDIS issued 29th meeting of 2023-01, FDIS ballot opened 2023-08-06, closed 2023-10-02, published 2023-10-30
  + ITU-T H.265 V9 Consented at 31st meeting 2023-07, approved 2023-09-13, and pre-published 2023-09, published 2023-11-24.
  + Preliminary draft HEVC text for YCgCo-Re and YCgCo-Ro issued at 26th meeting 2022-04, second draft including SMPTE ST 2128 issued at 28th meeting 2022-10, third draft at 29th meeting 2023-01, fourth draft at 30th meeting 2023-04, formal work item requested and CDAM1 issued 31st meeting 2023-07, DAM issued with new (multiview) profiles and SEI messages at 32nd meeting 2023-10, DAM ballot closed 2024-04-08
    - H.265 V10 Consented 2024-04-26, last call opened 2024-07-01, closed 2024-07-28, approved 2024-07-29, pre-published 2024-08-06, published 2024-10-07
    - ISO/IEC 23008-2:2025 (Ed. 6) FDIS issued from 35th meeting 2024-04, DIS approved for registration as FDIS 2024-10-03, FDIS registered for formal approval 2024-10-13, FDIS ballot issued 2024-12-30, FDIS ballot closed 2025-02-24, published 2025-03-20
  + Amendment to support additional (multiview) profiles and some SEI messages of VSEI v4, project requested at 36th meeting 2024-11, project registered in ISO/IEC work programme 2025-01-25, CDAM issued at 37th meeting, consulation began 2025-02-01, pending closure of comment period
  + Conformance testing (twin text)
    - ITU-T H.265.1 V3 approved 2018-10-14, published 2019-01-15
    - ISO/IEC 23008-8:2018 (Ed. 2) Conformance specification for HEVC, published 2018-08-06
    - ISO/IEC 23008-8:2018/AMD 1:2019 Conformance testing for HEVC screen content coding (SCC) extensions and non-intra high throughput profiles, published 2019-10-15
  + Reference software (twin text)
    - ITU-T H.265.2 V4 approved 2016-12-22, published 2017-04-10
    - ISO/IEC 23008-5:2017 (Ed. 2) Reference software for high efficiency video coding, FDIS issued from 2016-02 meeting, published 2017-03-01
    - ISO/IEC 23008-5:2017/AMD 1:2017 Reference software for screen content coding extensions, FDAM issued from 2017-04 meeting, FDAM ballot opened 2017-08-10, closed 2017-10-07, published 2017-11-09
* VVC (twin text)
  + ITU-T H.266 V1 approved 2020-08-29, published 2020-11-10
  + ISO/IEC 23090-3:2021 (Ed. 1) published 2021-02-16
  + ITU-T H.266 V2 with operation range extensions, Consented 2022-01-28, Last Call began 2022-04-01, Approved 2022-04-29, pre-published 2022-06-06, published 2022-07-12
  + ISO/IEC 23090-3:2022 (Ed. 2) with operation range extensions, approval at WG level to proceed to FDIS 2022-01-21, FDIS ballot opened 2022-06-29, closed 2022-08-24, published 2022-09-25
  + ISO/IEC 23090-3:2024 (Ed. 3), initated as (Ed. 2) / Amd.1 New level and systems-related supplemental enhancement information, CDAM 1 issued from 26th meeting, ballot closed 2022-07-14, DAM 1 issued from 27th meeting, ballot closed 2023-01-03, FDIS issued at WG level 2023-07, FDIS ballot opened 2024-05-11, closed 2024-06-26, published 2024-07-17
  + ITU-T H.266 V3 Consented 2023-07, approved 2023-09-29 and pre-published 2023-09, published 2023-11-29
  + ISO/IEC 23090-3:2024/CDAM 1 Request & CDAM issued 2024-04, consultation deferred due to meeting timing, updated text issued 2024-07, consultation initiated 2024-09-05, closed 2024-10-31, ready for action to issue ISO/IEC DAM (or DIS)
  + Conformance testing (twin text)
    - ITU-T H.266.1 V1 Consented 2022-01-28, Last Call began 2022-04-01, Approved 2022-04-29, pre-published 2022-05-17, published 2022-07-12
    - ISO/IEC 23090-15:2022 (Ed. 1) approval at WG level to proceed to FDIS 2022-10-15, upgraded to “DIS approved for registration” in ISO Projects system 2021-10-24, upgraded to “FDIS registered for formal approval” 2022-07-11, FDIS ballot closed 2022-11-04, published 2022-11-24
    - ISO/IEC 23090-15:2024 (Ed. 2) began as Amd.1 Operation range extensions – CDAM 1 issued from 24th meeting 2021-10, DAM 1 issued from 25th meeting 2022-01-21, upgraded to “CD approved for registration as DIS” status in ISO Projects system 2022-05-31, upgraded to “DIS registered” 2022-06-22, DAM ballot closed 2022-11-15, consolidated into FDIS 2nd edition issued as an output of the 29th meeting in January 2023, ballot opened 2024-04-08, closed 2024-06-03, published 2024-07-04.
    - ITU-T H.266.1 V2 Consented 2023-07, approved 2023-09-13 and pre-published 2023-09, published 2023-10-19
    - ISO/IEC 23090-15 (Ed. 3) project requested at 37th meeting, project registered in work programme 2025-01-25, ready for action to issue CD.
  + Reference software (twin text)
    - ITU-T H.266.2 V1 Consented 2022-01-28, Last Call began 2022-04-01, Approved 2022-04-29, pre-published 2022-05-17, published 2022-07-12
    - ISO/IEC 23090-16:2022 V1 approval at WG level to proceed to FDIS 2022-01-21, upgraded to “DIS approved for registration” status in ISO Projects system 2022-04-21, upgraded to “FDIS registered for formal approval” 2022-04-22, FDIS ballot initiated 2022-07-24, FDIS ballot closed 2022-09-19, published 2022-10-23
    - H.266.2 V2 Consented 2024-04-26, last call opened 2024-05-16, closed 2024-06-12, approved 2024-06-13, pre-published 2024-08-06, published 2024-10-09
    - ISO/IEC 23090-16:202x (Ed. 2) Request & CD issued 2024-04, consultation deferred due to meeting timing, consultation initiated 2024-09-06, closed 2024-11-01, DIS issued at 36th meeting 2024-11, approved for registration as DIS 2024-12-18, DIS registered 2025-01-7, DIS ballot opened 2025-03-09, no action at the current meeting (Roughly corresponding to H.266.2 V2 already approved and published in ITU-T)
* VSEI (twin text)
  + ITU-T H.274 V1 approved 2020-08-29, published 2020-11-10
  + ISO/IEC 23002-7:2021 (Ed. 1) published 2021-01-28
  + ITU-T H.274 V2 Consented 2022-01-28, Last Call began 2022-04-01, Approved 2022-05-22 (after 1 Last Call comment and Additional Review), pre-published 2022-06-17, published 2022-07-25
  + ISO/IEC 23002-7:2022 (Ed. 2) approval at WG level to proceed to FDIS 2022-01-21, upgraded to “DIS approved for registration” status in ISO Projects system 2022-05-05 and “FDIS registered for formal approval” 2022-05-08, FDIS ballot closed 2022-09-27, published 2022-10-30
  + ISO/IEC 23002-7:2024 (Ed. 3) began as (2nd Ed.) Amd.1 Request for new edition and CD for additional SEI messages issued at 27th meeting, ballot closed 2022-10-10, DAM registered 2022-11-13, DAM ballot closed 2022-04-06, FDIS 3rd edition issued 2023-07, FDIS ballot began 2024-07-25, closed 2024-09-20, published 2024-10-30
  + ITU-T H.274 V3 Consent 2023-07, approved 2023-09-29, pre-published 2023-10-11, published 2024-03-12.
  + ISO/IEC 23002-7:202x (Ed. 4) Request & CDAM 1 issued 2024-04, consultation deferred due to meeting timing, updated text issued 2024-07, CD consultation initiated 2024-09-05, closed 2024-10-31, ready for action to issue ISO/IEC DAM (or DIS)
* CICP (twin text)
  + ITU-T H.273 V2 (with 4:2:0 sampling alignment and corrections for range of values for sample aspect ratio, ICTCP equations for HLG, and transfer characteristics function for sYCC of IEC 61966-2-1) Consented on 2021-04-30, Last Call closed during the 23rd meeting with approval on 2021-07-14, published 2021-09-24
  + ISO/IEC 23091-2:2021 (Ed. 2) had been forwarded from DIS directly for publication in 2021-04 and published 2021-10-18
  + ITU-T H.273 V3 Consent 2023-07, approved 2023-09, not published due to waiting for publication of SMPTE ST 2128.
  + ITU-T H.273 V4 Consented 2024-04-26, last call opened 2024-06-16, closed 2024-07-13, approved 2024-07-14, pre-published 2024-08-06, published 2024-10-07.
  + ISO/IEC 23091-2:2025 (Ed. 3) Request for new edition and CD for new edition (including YCgCo-Re and YCoCg-Ro) issued at 27th meeting, ballot closed 2022-10-10, DIS registered 2022-11-13, DIS ballot closed 2023-04-06, preliminary draft text for including SMPTE ST 2128 issued at 28th meeting, incorporated into preliminary FDIS at 30th meeting 2023-04, FDIS issued 2024-04 (after waiting for publication of SMPTE ST 2128, then proceeding), FDIS registered for formal approval 2024-10-24, FDIS ballot issued 2024-12-03, FDIS ballot closed 2025-01-28, published 2025-02-25.
* Conversion and coding practices for HDR/WCG Y′CbCr 4:2:0 video with PQ transfer characteristics (twin text)
  + 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
  + Edition 2 planned but not yet in formal work programme of ISO/IEC
* Optimization of encoders and receiving systems for machine analysis of coded video content (twin text)
  + ISO/IEC 23888-3 (Ed. 1) Request for subdivision issued from 33rd JVET meeting 2024-01, CDTR issued from 34th meeting 2024-04, consultation deferred due to meeting timing, updated text issued from 35th meeting 2024-07, consultation further deferred due to meeting timing, further updated text issued from 36th meeting 2024-11, consultation initiated 2025-01-14, consultation period ended 2025-03-11, ready for action to issue DTR
  + ITU-T provisional name H.Sup-MACVC
* The following freely available standards are published here in ISO/IEC:  
  <https://standards.iso.org/ittf/PubliclyAvailableStandards/index.html> as of the time of the current meeting (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 next meeting – perhaps it would be best to compile a list of all relevant software and conformance parts of AVC, HEVC, MPEG-2 aka H.262, CICP, and request these in bulk.

## Draft standards progression status for active work items (update)

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

## Opening remarks

Remarks during the opening session of the meeting Thursday 26 June at XXXX-XXXX KST were as follows.

* Timing and organization of the meeting and online access and calendar posting of session plans were reviewed
  + The initial number of documents was slightly lower than for last meeting (approximately 200 vs. 215 by the time of opening the meeting) – parallel sessions were announced to be necessary.
  + Start of parallel sessions (HLS) Thursday afternoon?
  + JVET will not meet during the MPEG information exchange sessions on Monday 30 June (0900-1200 KST), Wednesday 2 July (0900-1000 KST), and Friday 4 July (1400-1600 KST). The closing session (with final approval of WG 5 recommendation) is scheduled later on Friday.
* Plans for subsequent hybrid meetings (with best-effort remote access) were reviewed: Oct. 2025 (Geneva), April 2026 (Santa Eulària), June/July 2026 (Geneva), October 2026 (Hangzhou), and January 2027 (Australia).
* The January 2026 meeting is currently planned to be virtual.
* Depending on the status of preparing future standardization activities, it may be necessary to extend the duration of meetings, 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 make a step forward in the Call for Evidence. Before start discussion, the viewing for dry-run of CfE test cases needs to be conducted (Friday afternoon, whole day Saturday). During the last AHG telco, it was suggested to have no discussion of low-level tools (EE, etc.) during the viewing – up to 144 volunteers are needed for viewing sessions. Joint meetings with parent bodies are also expected next week.
* 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-AL1000 were reviewed (which was finalized only shortly before the meeting, but sufficiently mature drafts had been available 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 was recorded via the traditional sign-in sheet. Participants were asked to correct their affiliation and email in case these changed. In the previous meeting, a few cases were found (mostly for those mentioned in the previous bullet point) where the affiliation was outdated. Remote attendance (of those not present in person) will be recorded via the zoom records. 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:
  + CDAM AVC [m73164](https://dms.mpeg.expert/doc_end_user/current_document.php?id=99765&id_meeting=203)
  + DIS on VVC software 2nd ed. [m73167](https://dms.mpeg.expert/doc_end_user/current_document.php?id=99768&id_meeting=203)
  + FDIS 11th ed. AVC [m73178](https://dms.mpeg.expert/doc_end_user/current_document.php?id=99779&id_meeting=203)
  + CD on VVC conformance 3rd ed. [m73679](https://dms.mpeg.expert/doc_end_user/current_document.php?id=100280&id_meeting=203)
* DAMs for HEVC, VVC and VSEI, as well as the DTR on machine optimization are currently under ballot in ISO/IEC, ballot results should be available prior to the October meeting, such that the final versions could be issued (when also submission of new editions for ITU consent is planned).
* It is planned to produce DAM on AVC and DIS on VVC conformance. In October, submission of new editions for ITU consent is planned, whereas the ISO/IEC versions could only be issued in January or April next year (depending on editing period).
* The DIS of VVC software is currently matching the ITU edition that was issued in April. FDIS could be issued, starting work towards an amendment or a next edition could be targeted for October, considering the implementation maturity of new SEI messages. Alternatively, another ITU edition could be issued then, and the FDIS aligned with that.
* The primary goals of the meeting were:
  + AVC DAM text for ISO/IEC ballot
  + VVC conformance and software for ISO/IEC ballot?
  + Various aspects of SEI in AVC, HEVC, VVC/VSEI, and TuC
  + New software versions VTM/HM/JM – support for SEI messages?
  + Lot of activity in AHG17 – final CfE as output appears possible
  + Exploration Experiments
    - Neural network-based video coding
    - Enhanced compression beyond VVC
  + Liaison communication?
  + VSEI and VVC white papers
* 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 meeting, parent bodies conducted discussion about future JVET management structures. It is likely that a subgroup structure will be introduced (which would allow more consistent parallelism during meetings rather than establishing BoGs), and JVET will be chaired in the future by two persons again. Both aspects are consistent with the JVET terms of reference.
* 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 KST 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.

* Thu. 26 June, 1st day
  + Morning sessions:
    - 0910–1000 Opening remarks, review of practices, agenda, IPR policy reminder
    - 1000–1320 Reports of AHGs 1-18
  + Afternoon sessions:
    - 1500–1620 Review of EE1 summary report (Rm. 201)
    - 1650–1950 Review of EE2 summary report EE2-1…EE2-3 (Rm. 201)
    - 1500–2000 HLS 6.1, 6.2 (Rm. 202, chaired by Jill Boyce)
* Fri. 27 June, 2nd day
  + Morning sessions:
    - 0800–1230 Planning CfE dry run, review of EE2 summary report EE2-4, EE2 related and non-EE (Rm. 201)
    - 0900–1300 HLS 6.1, 6.2.3, 6.2.4, 6.2.5, 6.2.6 (Rm. 202, chaired by Jill Boyce)
  + Afternoon sessions:
    - 1330–2000 Viewing for CfE dry-run (no low-level tool discussion in parallel)
    - 1400–2000 HLS 6.2.5 … 6.2.8 (Rm. 202, chaired by Jill Boyce)
* Sat. 28 June, 3rd day
  + Morning sessions:
    - 0900–1330 Viewing sessions for CfE dry-run
    - 0900–1300 HLS 6.2.2, 6.2.10, revisits, 6.3, 6.4 (Rm. 202, chaired by Jill Boyce)
  + Afternoon sessions:
    - 1430–1900 Viewing sessions for CfE dry-run
    - 1400–2000 HLS 6.2.5, revisits, 6.3, 6.4 (Rm. 202, chaired by Jill Boyce)
    - 1500–1730 ITU-T Q6/21 VCEG (outside of JVET, Rm. 201)
* Sun. 29 June, 4th day
  + Morning sessions:
    - 0800–1230 EE1 related (5.1.3/5.1.4) (Rm. 201)
    - 0900–1300 HLS 6.x (Rm. 202, chaired by Jill Boyce)
  + Afternoon sessions:
    - 1400–2000 Non-EE2 (5.2.4 (Rm. 201, chaired by Yan Ye from 1750 onwards)
    - 1400–2000 HLS 6.x (Rm. 202, chaired by Jill Boyce)
* Mon. 30 June, 5th day
  + 0900–1200 MPEG information sharing session
  + Afternoon sessions:
    - 1300–1350 JVET plenary: Coordination, planning, reports/issues from tracks (Rm. 201)
    - 1400–1700 Review CfE related topics from AHG7 (4.8) and AHG17 (4.16) (Rm. 201)
    - 1700–1800 Joint with AG 5: Review CfE dry-run results, Multi-layer verification testing (Rm. 201)
    - 1400–1800 HLS 6.x (Rm. 202, chaired by Jill Boyce)
    - 1800–2030 Review topics from CICP (4.18), AHG18 (4.17)
* Tue 1 July, 6th day
  + Morning sessions:
    - 0900–1300 Continue review CfE related topics (4.16), EE1/2 remaining docs and revisits (Rm. 201)
    - HLS remaining topics & revisits (Rm. 202, chaired by Jill Boyce)
  + Afternoon sessions (potentially single track, or BoGs in parallel):
    - 1400–1700 JVET main session: Remaining 4.17 document review (Rm. 201)
    - 1400–XXXX BoG on tool complexity analysis (Rm. 202, chaired by Xiang Li)
    - XXXX–XXXX BoG on CfE updates (Rm. 202, chaired by Frank Bossen)
* Wed. 2 July, 7th day
  + 0900–1015 MPEG information sharing session
  + Morning sessions:
    - 1030–1300 JVET main session: Coordination, planning, BoG reports, report/revisits from HLS, CICP
  + Afternoon sessions:
    - 1400–1600 JVET main session: CICP cont., revisits 4.16, CfE review & planning,
    - 1615-1645 Joint with WG 4 and WG 7 on Gaussian splat coding
* Thu. 3 July, 8th day
  + Morning sessions:
    - 0900–1300 JVET main session: CfE review & planning, remaining doc review & revisits 4.x, other business
  + Afternoon sessions:
    - 1400–1600 Joint with VCEG, WG 2, AG 5: next generation video standardization (Rm. 201)
    - 1600–1800 JVET plenary: Remaining doc review, revisits, DoCR and other output doc review/planning, AHG planning
* Fri. 04 July, 9th day
  + 0900–1300 JVET wrap-up plenary:
    - EE review
    - CfE planning
    - Establishment of AHGs
    - Approval of output docs
    - Review of WG 5 meeting recommendations
    - Software timeline
    - Future planning, a.o.b.
  + 1400–XXXX MPEG information sharing session
  + XXXX–XXXX WG 5 approval of meeting recommendations, 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: Development, deployment and advertisement of standards (0)
  + AHG2: Text development and errata reporting (0)
  + AHG3: Software development (1) 1 TBP
  + AHG3: Test conditions (3) 3 TBP
  + AHG4: Subjective quality testing and verification testing (1) 1 TBP
  + AHG4: Test and training material (0)
  + 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) 1 TBP
  + Implementation studies (3) 2 TBP
  + Profile/tier/level specification (0)
  + AHG15: Gaming content compression (0)
  + AHG16: Generative face video (1) 1 TBP
  + AHG17: CfE preparation (15) 2 TBP
  + AHG18: Ultra-low latency and error resilience (12)
  + CICP (2)
* 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 (25) (section 5.1)
  + AHG6/AHG12 and EE2: Enhanced compression beyond VVC capability (69) (section 5.2)
* AHG9: High-level syntax (HLS) proposals (section 6) with subtopics
  + Aspects of SEI messages in VSEI, VVC, HEVC and AVC (5) (section 6.1)
  + Aspects of SEI messages in VSEI v4 (27) (section 6.2)
  + Extensions of SEI messages in VSEI (2) (section 6.3)
  + SEI messages in TuC for VSEI (30) (section 6.4)
  + SEI messages on other topics (6) (section 6.5)
  + SEI software and showcases (3) (section 6.6)
* Joint meetings, plenary discussions, BoG reports (2) 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 1000–1320 on Thursday 26 June 2025 (chaired by JRO).

[JVET-AM0001](https://jvet-experts.org/doc_end_user/current_document.php?id=15895) 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 1315 (compared to 1292 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 – 679 subscribers
* JVT-experts – 2073 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.

1. **Goals and activity**

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

Output documents from the preceding meeting had been made initially available at the JVET web site (<https://jvet-experts.org/>) or the ITU-based JVET ftp site (<http://wftp3.itu.int/av-arch/jvet-site/2025_03_AL_Virtual/>). 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-AL1004 Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP [Posted 2025-05-31]
* JVET-AL1006 HEVC additional profiles and SEI messages, also issued as WG 5 CDAM N 336 [Posted 2025-04-14]
* JVET-AL1017 Support for additional VSEI messages in AVC (draft 2) [Posted 2025-04-16]
* JVET-AL1018 HEVC with extensions and corrections (draft 1) [Posted 2025-05-31]
* JVET-AL2005 Additions and corrections for VVC version 4 (Draft 12), also issued as WG 5 DAM N 351 [Posted 2025-04-26]
* JVET-AL2006 Additional SEI messages for VSEI version 4 (Draft 6), also issued as WG 5 DAM N 347 [Posted 2025-04-11, last update 2025-04-23]
* JVET-AL2010 VTM and HM common test conditions and software reference configurations for SDR 4:2:0 10 bit video [Posted 2025-06-23]
* JVET-AL2019 Description of algorithms version 11 and software version 13 in neural network-based video coding (NNVC) [Posted 2025-06-26, after beginning of meeting]
* JVET-AL2020 Film grain synthesis technology for video applications ed. 2 (Draft L) [Posted 2025-06-XX, not available yet by beginning of meeting]
* JVET-AL2023 Exploration experiment on neural network-based video coding (EE1) [Posted 2025-04-04, last update 2025-04-21]
* JVET-AL2024 Exploration experiment on enhanced compression beyond VVC capability (EE2) [Posted 2025-04-04, last update 2025-05-05]
* JVET-AL2025 Algorithm description of Enhanced Compression Model 17 (ECM 17) [Posted 2025-06-20]
* JVET-AL2026 Draft Joint Call for Evidence on video compression with capability beyond VVC [Posted 2025-04-15, last update 2025-04-30]
* JVET-AL2028 Additions and corrections for VVC conformance (draft 1) [Posted 2025-05-02]
* JVET-AL2030 Optimization of encoders and receiving systems for machine analysis of coded video content (draft 9, also issued as WG 5 DTR N 354) [Posted 2025-04-30]
* JVET-AL2032 Technologies under consideration for future extensions of VSEI (version 8) [Posted 2025-05-16]

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

The arrangements for the 39th meeting had been announced in the JVET reflector, in the JVET logistics document (<https://www.itu.int/wftp3/av-arch/jvet-site/2025_06_AM_Daejeon/JVET-AM_Logistics.docx>), and in the WG 5 calling notice (N 358) and agenda (N 359) for the 20th WG 5 meeting.

Software integration was finalized approximately according to the plan.

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

Roughly 200 input contributions (not counting the AHG reports, summary reports and crosschecks) had been registered for consideration at the current meeting.

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

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

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

A preliminary basis for the document subject allocation and meeting notes for the 38h meeting had been made publicly available on the ITU-hosted ftp site as <http://wftp3.itu.int/av-arch/jvet-site/2025_06_AM_DaejeonJVET-AM_notes_d0.docx>.

Discussion has been conducted with the parent bodies how the expected need for more parallelism during JVET meetings in future standardization activities can be better managed, beyond the current practice of appointing BoGs. In this context, the JVET chair has proposed to establish a permanent subgroup structure, as foreseen in the JVET terms of reference, but never implemented so far.

1. **Recommendations**

* The AHG recommends its continuation.

The AHG recommends establishment of a subgroup structure in JVET, such that the necessary parallelization of activities during meetings can be conducted in a more formalized fashion.

[JVET-AM0002](https://jvet-experts.org/doc_end_user/current_document.php?id=15896) 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)]

2.1 Output documents produced

2.1.1 JVET-AL1004 Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP [Y.-K. Wang, B. Bross, I. Moccagatta, C. Rosewarne, G. J. Sullivan]

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

Incorporated items at the JVET-AL meeting:

• For HEVC:

o Removed items that have been integrated into JVET-AL1006 and JVET-AL1018.

• For VVC:

o Removed items that have been integrated into JVET-AL2005.

• For AVC:

In subclauses I.7.4.1.1 and I.8.2.3, there are two instances of "view oder", which should be changed to be "view order".

2.1.2 JVET-AL1006 HEVC additional profiles and SEI messages (draft 3) [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 38th JVET meeting in March-April 2025:

1) JVET-AL0059 AHG9: Inclusion of the packed regions information SEI message in HEVC

2) "JVET-AL0324 (incl. aspects of AL0072 AL0098 AL0120 AL0122 AL0129 AL0303)" AHG9: A summary of proposals on the PRI SEI message

3) JVET-AL0061 AHG 9: Encoder optimization information for AVC and HEVC

4) JVET-AL0123 AHG9: On the encoder optimization information (EOI) SEI message

5) JVET-AL0117 AHG9: On association of NAL units to DSC verification substreams

6) JVET-AL0148 AHG9: Generative face video and generative face video enhancement SEI messages for HEVC and AVC

7) JVET-AL0210 AHG9: On SEI processing order SEI message for HEVC and AVC

8) JVET-AL0130 AHG9: Source picture timing for interlaced video with SPTI SEI message

9) JVET-AL0062 AHG 9: AI usage restrictions SEI message for AVC and HEVC

10) JVET-AL0339 Merged text of JVET-AL0086 and JVET-AL0204 for the FGC SEI message

11) JVET-AL0223 AHG2: Corrections and clarifications for profile-related aspects of the draft text for HEVC

12) Changes per the errata document JVET-AK1004.

13) Changes per the DoCR document WG5 N0348.

2.1.3 JVET-AL1017 Support for additional SEI messages in AVC (draft 2) [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 38th JVET meeting in March 2025:

1) JVET-AL0061 AHG 9: Encoder optimization information for AVC and HEVC

2) JVET-AL0062 AHG 9: AI usage restrictions SEI message for AVC and HEVC

3) JVET-AL0148 AHG9: Generative face video and generative face video enhancement SEI messages for HEVC and AVC

4) JVET-AL0222 AHG9: On Digitally Signed Content SEI messages

5) JVET-AL0117 AHG9: On association of NAL units to DSC verification substreams

6) JVET-AL0210 AHG9: On SEI processing order SEI message for HEVC and AVC

7) JVET-AL0130 AHG9: Source picture timing for interlaced video with SPTI SEI message

2.1.4 JVET-AL1018 HEVC with extensions and corrections (draft 1) [G. J. Sullivan, Y.-K. Wang]

This document provides a draft text with all changes in JVET-AL1006 integrated to the full text of Rec. ITU T H.265 (V10) (07/2024), plus some minor editorial changes that are not included in JVET-AL1006. The draft text is provided in an attachment to this document. The draft text is intended to be used as the basis for generating the ITU-T consent text for the next version of ITU T H.265.

2.1.5 JVET-AL2005 Additions and corrections for VVC version 4 (Draft 12) [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 38th JVET meeting in March-April 2025:

1) Item 8 of JVET-AL0155 AHG9: Further fixes and cleanup on GFV and GFVE SEI messages

2) JVET-AL0117 AHG9: On association of NAL units to DSC verification substreams

3) For the PRI SEI message, make the interface variables for width, height, max width, and max height to be layer specific, in both VSEI and VVC. (JVET-AL0120 item 1, JVET-AL0129 item 10, JVET-AL0303 item 3)

4) For the PRI SEI message, add the constraint that chroma format, luma bit depth and chroma bit depth layer are all equal. (JVET-AL0324 item 1.d alternative)

5) Constraint for the value of eoi\_quant\_threshold\_delta (JVET-AL0056 item 2b / JVET-AL0123 item 12).

6) JVET-AL0339 Merged text of JVET-AL0086 and JVET-AL0204 for the FGC SEI message

7) Addition of setting of the interface variables CroppedWidth and CroppedHeight for the EOI SEI message as part of JVET-AL0123 integration

8) For the OMI SEI message, extend the interface variables CroppedWidth and CroppedHeight to CroppedWidth[ lId ] and CroppedHeight[ lId ] and impose two constraints (item 4 and 5 of JVET-AL0067)

9) Miscellaneous elements from JVET-AG1004 (errata), and bug fixes from JVET-AH0002, tickets #1609 (NoBackwardPredFlag derivation ambiguity), #1617 (Not initialized NumCtusInSlice[ 0 ] to 0), #1624 (Incorrect indexing in computation of motion vector offset), #1627 (palette mode explicit instruction to put the array of reconstructed samples into the picture array), #1628 (Derivation of ModeTypeCondition should say “one or more”), #1630 (Missing equations for applying AmvrShift), #1631 (Should “Motion vector storing process for geometric partitioning mode” store HpelIfIdx? BBross: HpekIfIdx should always be written since it might be accessed later so it is definitely missing in "Motion vector storing process for geometric partitioning mode".), #1632 (Incorrect indexing used for choosing matrix intra sample prediction), #1634 (Matrices QStateTransTable, levelScale, AlfFixFiltCoeff, AlfClassToFiltMap incorrectly transposed), #1635 (tu\_y\_coded\_flag inference when cu\_coded\_flag is equal to 0), #1644 (correcting subclause cross-reference for DpbOutputInterval[ n ]), US-007 decoding order clarification, US-012 (avoiding the expression “Y = !X”), US-033 (sn\_zero\_bit coding type should be f(1) rather than u(1)).

2.1.6 JVET-AL2006 Additional SEI messages for VSEI version 4 (Draft 6) [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 video enhancement, 13) AI usage restrictions, 14) packed regions information, and 15) image format metadata. The changes also include updates to some of the existing SEI messages, including the two neural-network post-filter (NNPF) SEI messages, as well as some corrections to the previous version of the VSEI standard.

Editors’ notes and changes yet to be integrated:

• All automatically generated numbering and cross-reference fields will need to be updated after the changes are integrated into the basis text. Check the use of “pertain”; the word is not used in a similar way anywhere in the existing standard.

• payloadType values are to be specified the corresponding VVC, HEVC or AVC draft text. The use of prefix SEI NAL unit was enabled for all new SEI messages, whereas the use of suffix SEI NAL unit was enabled for encoder optimization information and object mask information SEI messages, since their content may be determined while the encoder encodes the associated picture.

Changes that have been integrated:

A description of the contributions reflected in this document relative to JVET-AK2006:

• SPO

o JVET-AL0063 AHG9: On SPO SEI message

o JVET-AL0064 AHG9: On the SPO SEI message complexity signaling

o JVET-AL0208 AHG9: On SPO root-process signaling constraint

• NNPF

o JVET-AL0075 AHG9: On nnpfa\_num\_input\_pic\_shift

o JVET-AL0096 AHG9: On signalling of extension syntax elements in NNPFA SEI message

• EOI

o JVET-AL0056 AHG0: On the encoder optimization information SEI message

o JVET-AL0123 AHG9: On the encoder optimization information (EOI) SEI message

o JVET-AL0310 On signalling of resampling type for EOI SEI message

• IFM

o JVET-AL0068 AHG9: On image format metadata (IFM) SEI

o JVET-AL0094 AHG9: On payload length of image format metadata (IFM) SEI

o JVET-AL0128 AHG9: On image format metadata SEI message

o Item 4 of JVET-AL0132 AHG9: Editorial updates for VSEI v4

• AUR

o JVET-AL0058 AHG9: On the AI usage restrictions SEI message

• TDI

o JVET-AL0077 AHG9: On the text description information SEI message

• FGC

o JVET-AL0339 AHG9: Merged text of JVET-AL0086 and JVET-AL0204 for the FGC SEI message

• GFV

o JVET-AL0155 AHG9: Further fixes and cleanup on GFV and GFVE SEI messages

• DSC

o JVET-AL0078 AHG9: On Digital Signing

o JVET-AL0103 AHG9: Editorial changes for the three DSC SEI messages

o JVET-AL0117 AHG9: On association of NAL units to DSC verification substreams

o JVET-AL0118 AHG9: Miscellaneous changes for the three DSC SEI messages

o JVET-AL0222 AHG9: On Digitally Signed Content SEI messages

o JVET-AL0327 AHG9: Handling of multiple DSC systems

• PRI

o JVET-AL0070 AHG9: On packed regions information SEI message

o "JVET-AL0324 (incl. aspects of AL0072 AL0098 AL0120 AL0122 AL0129 AL0303)" AHG9: A summary of proposals on the PRI SEI message

• OMI

o JVET-AL0066 AHG9: Lossy compression with Object mask info SEI

o JVET-AL0067 AHG9: On the OMI SEI

o JVET-AL0071 AHG9: On OMI SEI message

o Item 2 of JVET-AL0249 AHG9: Proposed modifications to VSEI to address national body comments

• Multiple

o JVET-AL0301 AHG9: VSEI specification changes to reference the 3rd edition of video CICP

o Item 1 of JVET-AL0249 AHG9: Proposed modifications to VSEI to address national body comments

o Items 2 and 3 (on AUR) of JVET-AL0131 AHG9: Proposed changes for miscellaneous aspects of SEIs in VSEI v4

• General editorial improvements

o JVET-AJ0185 Editorial updates for NNPFC, SPO and TDI SEI messages

 Item 2

o Editorial correction for SII SEI message

• SPTI

o JVET-AL0130 AHG9: Source picture timing for interlaced video with SPTI SEI message

3 Related input contributions

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

• JVET-AM0048 AHG9/AHG2: Miscellaneous changes for HEVC [Y.-K. Wang, J. Xu (Bytedance)]

• JVET-AM0292 AHG9/AHG2: On the semantics of po\_num\_bits\_in\_prefix\_indication\_minus1[ i ] and po\_sei\_prefix\_data\_bit[ i ][ j ] [Y.-K. Wang (Bytedance)]

4 Remaining VVC spec tickets

Closed since JVET-AL0002 was reported:

• (none)

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

• #1609 NoBackwardPredFlag derivation ambiguity (Addressed in JVET-AI1004)

• #1617 Not initialized NumCtusInSlice[0] to 0. (Addressed in JVET-AI1004)

• #1624 Incorrect indexing in computation of motion vector offset. (Addressed in JVET-AI1004)

• #1627 "Decoding process for palette mode" does not say what to do with output samples. (Discussed in JVET-AI1004)

• #1628 Derivation of ModeTypeCondition should say "one or more". (Addressed in JVET-AI1004)

• #1629 mtt\_split\_cu\_vertical\_flag context uses undefined variable chType. (Discussed in JVET-AI1004)

• #1630 Missing equations for applying AmvrShift. (Discussed in JVET-AI1004)

• #1631 Should "Motion vector storing process for geometric partitioning mode" store HpelIfIdx? (addressed in JVET-AI1004)

• #1632 Incorrect indexing used for choosing matrix intra sample prediction. (Addressed in JVET-AI1004)

• #1634 Matrices QStateTransTable, levelScale, AlfFixFiltCoeff, AlfClassToFiltMap are incorrectly transposed. (Addressed in JVET-AI1004)

• #1635 Incorrect inference for tu\_y\_coded\_flag. (Discussed in JVET-AI1004)

• #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 Incorrect indexing for the h location component in ALF process. (Discussed in JVET-AJ1004)

• #1651 References to various non-existent syntax elements relating to sps\_partition\_constraints\_override\_enabled\_flag.

• #1652 Incorrect heading style in JVET-S2001-v17.

New (since JVET-AK0002 was reported)

• (none)

5 Remaining HEVC spec tickets

Closed since JVET-AL0002 was reported:

• (none)

Carried over:

• #1427 (8-155) and (8-157) do not seem to be used

• #1491 Duplicate invocation of 9.3.4.3 arithmetic decoding process

• #1498 Typos in the Table 9-43

• #1500 Typo in equation (8-69),(8-70)

• #1504 Small typos in profile\_tier\_level syntax in tabular form (7.3.3)

• #1505 Misleading bitstream requirement related to EOB NAL unit

• #1507 Duplicate row entries for CU QP delta syntax elements in Table 9-48

• #1520 Some smaller errors in the multiview spec

• #1522 Offset issue in clause 8.5.4.3

• #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-AL0002 was reported):

• (none)

6 Recommendations

The AHG recommends to:

• Approve JVET-AL1004, JVET-AL1006, JVET-AL1017, JVET-AL1018, JVET-AL2005, and JVET-AL2006 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.

[JVET-AM0003](https://jvet-experts.org/doc_end_user/current_document.php?id=15897) 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 23.10](https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/-/releases/VTM-23.10) (May 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 23.9 was tagged on Apr. 12, 2025. VTM 23.10 was tagged on May 7, 2025. VTM 23.11 is expected during the 39th JVET meeting.

VTM 23.9 was tagged on Apr. 12, 2025. Changes include:

* JVET-AJ0170: Flag to indicate the direction of the signalled source picture intervals
* JVET-AK0194 related: add VPS to list of signed non-VCL NAL units
* Add cmake option ENABLE\_SEARCH\_OPENSSL
* JVET-AK0181: Fix to remove enabling of the DMVR encoder control when GOPbasedRPR is enabled
* Check minimum required version of OpenSSL
* Update copyright header to include the year 2025
* Fix the JVET document number reference in the macro
* JVET-AK0072 items 1 and 2: nnpfc\_input\_pic\_filering flag inference and constraint
* JVET-AK0075: QP threshold for object-based optimization in EOI SEI
* JVET-AJ0048: Update SeiProcessingOrderSeiList
* fixes for multilayer
* JVET-AJ0104\_AJ0114: Implementation of input prompt and input picture shift in NNFPA SEI message
* fix memory leak
* JVET-AK0072 item 3: NNPF prompt null string constraint
* Rename "high performance" configuration folder for better reference in CTC
* JVET-AK0181: alternative configurations
* Merge and move configuration files for RA adaptive resolution
* JVET-AK0239: GFVE SEI message
* JVET-AH0174/JVET-AJ0073: Add nnpfc\_scan\_type\_idc syntax element in the NNPFC SEI message
* JVET-AK2006: Updates for SPTI SEI message
* JVET-AK0330: Fixes to OMI SEI message
* JVET-AK0333: Nested sub-chains in SPO SEI
* Work-around compile-problem with gcc 13/14
* JVET-AK0238: Bug fixes and codes cleanup for GFV SEI message
* Set DeblockingFilterOffsetInPPS to 1 for RA configs
* Modify semantics of IntraPeriod to enable autosetting based on frame rate
* JVET-AL0207: On matching target bitrate for subjective quality evaluation
* JVET-AL0055: Alternative configurations with reduced encoder runtime

VTM 23.10 was tagged on May 7, 2025. Changes only include removal of macros from previous meeting cycles.

VTM 23.11 is expected to be tagged during the 39th JVET meeting. Changes are expected to include:

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

***CTC Performance***

VTM 23.9 shows identical performance compared to VTM 23.7 in SDR CTC for AI and LD configurations. There is a minor change in RA:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | |
|  | **Over [vtm][vtm][VTM-23.7][b0c3ff99][ip1s][t0]** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -0.02% | -0.02% | -0.02% | 99% | 99% |
| Class A2 | -0.02% | -0.03% | -0.01% | 100% | 100% |
| Class B | -0.05% | -0.05% | -0.05% | 100% | 100% |
| Class C | -0.11% | -0.11% | -0.10% | 100% | 101% |
| Class E |  |  |  |  |  |
| **Overall** | -0.05% | -0.06% | -0.05% | 99% | 100% |
| Class D | -0.31% | -0.31% | -0.31% | 99% | 100% |
| Class F | -0.13% | -0.13% | -0.13% | 100% | 102% |

The current master branch (to be tagged as 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 23.10** | | | | | | | |
|  | Y | U | V | VMAF | VMAF-NEG | EncT | DecT | mPeakR |
| Class A1 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 95.9% | 98.6% | 69% |
| Class A2 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 97.7% | 98.9% | 69% |
| Class B | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 98.3% | 97.1% | 80% |
| Class C | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 99.3% | 96.9% | 93% |
| Class E | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 97.1% | 99.3% | 87% |
| **Overall** | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 97.8% | 98.0% | 80% |
| Class D | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 97.9% | 90.6% | 98% |
| Class F | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 99.0% | 97.5% | 90% |
| Class TGM | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 98.0% | 95.5% | 96% |
| Class M | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 99.2% | 97.0% | 86% |
|  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | |
|  | **Over VTM 23.10** | | | | | | | |
|  | Y | U | V | VMAF | VMAF-NEG | EncT | DecT | mPeakR |
| Class A1 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 97.0% | 99.1% | 88% |
| Class A2 | -0.01% | -0.01% | -0.01% | -0.01% | -0.01% | 96.6% | 99.1% | 88% |
| Class B | -0.01% | -0.01% | -0.01% | -0.01% | -0.01% | 96.8% | 98.3% | 90% |
| Class C | -0.02% | -0.02% | -0.02% | -0.04% | -0.03% | 97.0% | 95.7% | 96% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | -0.01% | -0.01% | -0.01% | -0.02% | -0.02% | 96.9% | 97.9% | 91% |
| Class D | -0.06% | -0.07% | -0.07% | -0.10% | -0.09% | 98.1% | 96.2% | 98% |
| Class F | -0.03% | -0.03% | -0.03% | -0.04% | -0.04% | 96.2% | 95.0% | 97% |
| Class TGM | -0.01% | -0.01% | -0.01% | -0.02% | -0.02% | 98.5% | 98.5% | 99% |
| Class M | -0.02% | -0.02% | -0.02% | -0.03% | -0.03% | 97.0% | 98.0% | 98% |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **Over VTM 23.10** | | | | | | | |
|  | Y | U | V | VMAF | VMAF-NEG | EncT | DecT | mPeakR |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -0.01% | -0.01% | -0.01% | -0.01% | -0.01% | 97.5% | 101.8% | 76% |
| Class C | -0.02% | -0.02% | -0.02% | -0.03% | -0.02% | 97.2% | 96.1% | 94% |
| Class E | -0.11% | -0.11% | -0.10% | -0.13% | -0.13% | 94.5% | 94.5% | 90% |
| **Overall (Ref)** | -0.04% | -0.04% | -0.04% | -0.05% | -0.05% | 96.7% | 98.0% | 85% |
| Class D | -0.06% | -0.05% | -0.05% | -0.08% | -0.08% | 97.8% | 109.7% | 98% |
| Class F | -0.04% | -0.04% | -0.04% | -0.05% | -0.05% | 94.9% | 95.4% | 94% |
| Class TGM | -0.01% | -0.01% | -0.01% | -0.02% | -0.02% | 96.6% | 94.9% | 99% |
| Class M | -0.03% | -0.03% | -0.03% | -0.04% | -0.04% | 93.9% | 97.2% | 98% |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | |
|  | **Over VTM 23.10** | | | | | | | |
|  | Y | U | V | VMAF | VMAF-NEG | EncT | DecT | mPeakR |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -0.01% | -0.01% | -0.01% | -0.01% | -0.01% | 96.2% | 97.3% | 79% |
| Class C | -0.01% | -0.01% | -0.01% | -0.01% | -0.01% | 96.8% | 94.5% | 93% |
| Class E | -0.09% | -0.09% | -0.08% | -0.11% | -0.10% | 94.8% | 98.2% | 90% |
| **Overall (Ref)** | -0.03% | -0.03% | -0.03% | -0.04% | -0.03% | 96.1% | 96.6% | 86% |
| Class D | -0.04% | -0.03% | -0.03% | -0.06% | -0.06% | 96.4% | 94.2% | 98% |
| Class F | -0.02% | -0.03% | -0.03% | -0.04% | -0.03% | 96.2% | 98.4% | 96% |
| Class TGM | -0.01% | -0.01% | -0.01% | -0.01% | -0.01% | 95.8% | 94.3% | 99% |
| Class M | -0.02% | -0.02% | -0.02% | -0.03% | -0.03% | 92.5% | 97.3% | 97% |

For the HDR CTCs, coding performance of VTM 23.10 compared to VTM 23.8 are reported in table below. Slight variations are observed in RA. Encoding/decoding run times are very close.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access** | | | | | | | | | |
|  | **Over VTM23.8** | | | | | | | | | |
|  |  |  | **wPSNR** |  |  | **PSNR** |  |  |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -0.10% | -0.10% | -0.10% | -0.10% | -0.11% | -0.10% | -0.10% | -0.11% | 100% | 102% |
| Class H2 |  |  |  |  |  | -0.03% | -0.03% | -0.03% | 100% | 100% |
| **Overall** | -0.10% | -0.10% | -0.10% | -0.10% | -0.11% | -0.07% | -0.07% | -0.08% | 100% | 102% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **All Intra** | | | | | | | | | |
|  | **Over VTM23.8** | | | | | | | | | |
|  |  |  | **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% | 101% | 101% |
| Class H2 |  |  |  |  |  | 0.00% | 0.00% | 0.00% | 100% | 99% |
| **Overall** | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 101% | 100% |

For the high bit depth CTCs, VTM 23.10 also shows no changes in coding performance compared to VTM 23.8 except for random access simulations where there is a slight improvement. This is assumed to be due to the changes introduced in MR2840.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access High Bit Depth Standard QP Range** | | | | | | | | | |
|  | **Over VTM23.8** | | | | | | | | | |
|  |  |  | **wPSNR** |  |  | **PSNR** |  |  |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -0.09% | -0.08% | -0.08% | -0.08% | -0.09% | -0.08% | -0.08% | -0.09% | 102% | 101% |
| Class H2 |  |  |  |  |  | -0.10% | -0.12% | -0.12% | 102% | 101% |
| **Overall** | -0.09% | -0.08% | -0.08% | -0.08% | -0.09% | -0.09% | -0.10% | -0.10% | 102% | 101% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access High Bit Depth Low QP Range** | | | | | | | |
|  | **Over VTM23.8** | | | | | | | |
|  | wPsnrY | wPsnrU | wPsnrV | psnrY | psnrU | psnrV | EncT | DecT |
| PQ444 | -0.001% | -0.001% | -0.001% | -0.001% | -0.001% | -0.001% | 99% | 99% |
| PQ422 | -0.001% | -0.001% | -0.001% | -0.001% | -0.001% | -0.001% | 100% | 100% |
| **Overall** | -0.001% | -0.001% | -0.001% | -0.001% | -0.001% | -0.001% | 99% | 100% |
|  |  |  |  |  |  |  |  |  |
| **Overall PQ** | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 100% | 100% |

Performance of high-performance conditions is reported for VTM 23.10 as follows:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access Main 10** | | | | | | | | |
|  | **Over VTM 23.10** | | | | | | | | |
|  | Y | U | V | VMAF | VMAF-NEG | EncT | DecT | mPeakR | mHWMR |
| Class A1 | -0.28% | -2.13% | -3.07% | 0.12% | -0.08% | 164.1% | 100.4% | 100% | 103% |
| Class A2 | -1.54% | -3.90% | -3.30% | -0.49% | -0.43% | 180.0% | 100.7% | 100% | 101% |
| Class B | -1.51% | -5.21% | -5.54% | -1.00% | -0.96% | 183.2% | 100.7% | 100% | 102% |
| Class C | -1.71% | -5.11% | -4.81% | -0.38% | -0.23% | 195.8% | 101.4% | 100% | 103% |
| Class E |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | -1.32% | -4.31% | -4.40% | -0.51% | -0.49% | 181.8% | 100.8% | 100% | 102% |
| Class D | -1.22% | -5.55% | -5.62% | -0.01% | 0.09% | 184.8% | 102.0% | 100% | 104% |
| Class F | -2.60% | -3.64% | -3.57% | -0.91% | -1.20% | 183.6% | 102.8% | 100% | 100% |
| Class TGM | -1.66% | -2.47% | -2.31% | -1.95% | -1.62% | 184.2% | 98.1% | 100% | 100% |
| Class M | -4.09% | -4.80% | -4.29% | -2.51% | -3.32% | 176.8% | 101.5% | 100% | 100% |
|  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | | |
|  | **Over VTM 23.10** | | | | | | | | |
|  | Y | U | V | VMAF | VMAF-NEG | EncT | DecT | mPeakR | mHWMR |
| Class A1 |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |
| Class B | -1.66% | -1.62% | -1.27% | -1.41% | -1.43% | 200.5% | 96.8% | 100% | 100% |
| Class C | -1.38% | -1.15% | -1.69% | -1.44% | -1.31% | 208.0% | 101.2% | 100% | 101% |
| Class E | -1.30% | -2.15% | -1.73% | -0.38% | -1.24% | 176.2% | 106.7% | 100% | 101% |
| **Overall (Ref)** | -1.48% | -1.60% | -1.52% | -1.16% | -1.34% | 196.5% | 100.6% | 100% | 100% |
| Class D | -1.40% | -1.02% | -1.05% | -0.78% | -0.85% | 195.3% | 91.0% | 100% | 101% |
| Class F | -1.70% | -1.88% | -2.06% | -1.74% | -1.65% | 173.2% | 103.3% | 100% | 101% |
| Class TGM | -1.75% | -1.68% | -1.64% | -1.42% | -1.69% | 180.1% | 101.5% | 100% | 100% |
| Class M | -1.84% | -2.14% | -2.30% | -1.43% | -1.60% | 168.9% | 101.4% | 100% | 100% |
|  |  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | | |
|  | **Over VTM 23.10** | | | | | | | | |
|  | Y | U | V | VMAF | VMAF-NEG | EncT | DecT | mPeakR | mHWMR |
| Class A1 |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |
| Class B | -1.01% | -0.49% | -0.17% | -0.86% | -0.91% | 170.5% | 100.4% | 100% | 100% |
| Class C | -0.91% | -0.40% | -0.79% | -0.95% | -0.92% | 173.5% | 102.7% | 100% | 101% |
| Class E | -1.04% | -1.59% | -0.96% | -0.58% | -1.21% | 145.3% | 101.4% | 100% | 100% |
| **Overall (Ref)** | -0.98% | -0.73% | -0.57% | -0.82% | -0.99% | 164.8% | 101.4% | 100% | 100% |
| Class D | -0.96% | -0.77% | 0.29% | -0.80% | -0.89% | 163.5% | 102.9% | 100% | 101% |
| Class F | -1.01% | -1.25% | -1.01% | -0.86% | -0.93% | 147.0% | 100.0% | 101% | 101% |
| Class TGM | -1.31% | -1.42% | -1.45% | -1.25% | -1.50% | 159.0% | 100.6% | 101% | 101% |
| Class M | -1.40% | -1.48% | -1.98% | -1.41% | -1.50% | 145.7% | 100.8% | 100% | 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 39th JVET meeting.

The following changes were merged into the TuC branch:

* Fix build on macos arm
* JVET-AK0153: Photosensitive content SEI messages
* Remove Packed Regions SEI (moved to VTM)
* JVET-AJ0245: Multi-layer support for Constituent Rectangles SEI

The following merge requests were submitted and are pending:

* JVET-AK0142: "AHG9: Display Rectangles SEI"
* FGR SEI code from JVET\_AG0328
* 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 39th JVET meeting.

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

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

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

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

Help to address these tickets would be appreciated.

1. **360Lib related activities**

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

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

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

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

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

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

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

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

1. **SCM related activities**

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

1. **SHM related activities**

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

1. **HTM related activities**

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

One merge request is was merged:

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

The next release will also include the following changes:

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

1. **HDRTools related activities**

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

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

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

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

The following MRs are pending [with status indicated]:

* JVET-AK0107: Modality Information SEI (pending review)
* JVET-AK2006: NNPFC and NNPFA SEI message (pending review)
* JVET-AL0062: AI usage restrictions SEI message (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. **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.

[JVET-AM0004](https://jvet-experts.org/doc_end_user/current_document.php?id=15898) 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. **Activities**
2. ***Testing of video coding technology beyond conditions of exploration experiments***

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

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. It is suggested to update the password for the site after each meeting with the Zoom password for that meeting.

1. **Related contributions**

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

|  |  |  |
| --- | --- | --- |
| [JVET-AM0004](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15898) | 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) |
| [JVET-AM0041](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15688) | AHG17: AhG meeting notes | [M. Wien](mailto:wien@lfb.rwth-aachen.de) |
| [JVET-AM0045](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15692) | AHG17: Generated VTM anchor bitstreams using LambdaScaleTowardsNextQP | [K. Andersson](mailto:kenneth.r.andersson@ericsson.com), [P. Wennersten (Ericsson)](mailto:per.wennersten@ericsson.com) |
| [JVET-AM0049](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15696) | [AHG17] Suggested results reporting template for constrained encoder complexity category | [E. Alshina](mailto:elena.alshina@huawei.com), [J. Sauer](mailto:johannes.sauer@huawei.com), [T. Solovyev](mailto:solovyev.timofey@huawei.com), [M. Lobo (Huawei)](mailto:merlin.andriana.lobo@huawei.com) |
| [JVET-AM0078](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15725) | AHG17: Suggestion to enable DMVR encoder control for VTM anchor | [K. Andersson (Ericsson)](mailto:kenneth.r.andersson@ericsson.com) |
| [JVET-AM0142](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15789) | AHG15: Analysis of Test Sequences for Game Content in the CfE Document | X. Liang, [K. Choi (KHU)](mailto:aikiho@khu.ac.kr), C. W. Ryu (Kaon Group) |
| [JVET-AM0223](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15870) | AHG4: proposed updates for VVC multi-layer verification test plan | [P. de Lagrange (InterDigital)](mailto:philippe.delagrange@interdigital.com) |
| [JVET-AM0234](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15881) | [AHG17] Overview of the 3GPP codec testing in TR 26.955 | [R. Mekuria](mailto:rufael.mekuria@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AM0269](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15936) | AHG17 ECM/VTM performance under CfE requirement | [K. Naser](mailto:karam.naser@interdigital.com), E. François, F. LeLéannec, F. Galpin, T. Poirier (InterDigital) |

1. **Recommendations**

The AHG recommends:

* To progress the work in AHG17 towards finalizing the draft test set for a Joint Call for Evidence on video compression with capability beyond VVC.
* To conduct subjective tests assessing the proposed rate points and coding conditions in the draft CfE.
* To continue to discuss and to update the non-finalized categories of the verification test plan for multilayer VVC and the subjective quality test plan for FGC, including those which have not been addressed yet.
* To collect volunteers to conduct further verification tests and subjective quality tests.
* To collect volunteers to actively contribute to the verification test development.
* To review the set of available test sequences for the verification tests as well as subjective quality tests and potentially collect more test sequences with a variety of content.
* To continue to collect new test sequences available for JVET with licensing statement.

Review of JVET-AM0223 next week together with AG 5. It was commented that no progress so far in acquiring 10-bit stereo material for multi-view VVC/HEVC testing.

[JVET-AM0005](https://jvet-experts.org/doc_end_user/current_document.php?id=15899) 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. **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

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
  + Three streams have been re-generated
  + No changes between 38th and 39th meeting.
* conformance bitstreams for VVC operation range extensions:
  + 57 bitstream categories have been identified
  + 1 bitstream of 1 identified category has been re-generated
  + 128 bitstreams of 57 identified categories have been cross-checked and uploaded.
  + 14 bitstreams have been re-generated between the 38th and 39th 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 38th and 39th 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 38th and 39th meeting
  + 2 HEVC Multiview Extended bitstreams have been provided, cross-checked, and made available, no changes between 38th and 39th meeting
  + 2 HEVC Multiview Main 10 bitstreams have been cross-checked.

1. **Activities and Discussion**

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

VVC activities:

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

VVC operation range extensions activities:

While testing the conformance streams with the latest VTM (VTM-23.10) it has been observed that these 14 packages

16b400P16\_A\_2

16b400P16\_B\_2

16b400P16\_C\_2

16b400P16\_D\_2

16b400P16\_E\_2

16b420P16\_B\_2

16b420P16\_C\_2

16b420P16\_D\_2

16b420P16\_E\_2

16b422P16\_B\_2

16b422P16\_C\_2

16b422P16\_D\_2

16b422P16\_E\_2

16b444etsrc\_A\_2

need to be re-generated because the VTM MR <https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/-/merge_requests/2743> has fixed an issue in the SIMD code, and such fix has caused a change in the decoded output.

The streams in these packages contain md5 checksums in SEI messages that are now incorrect, and the yuv.md5 and opl files need to be updated as well to reflect the change in decoded output.

The 14 packages have been re-generated and have been uploaded to <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVC2ndEd_regenerated/under_test/VTM-23.10>. No change in the remaining 2nd edition bitstreams and/or packages available at <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVC2ndEd/>

VVC Multilayer activities:

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

HEVC Multiview supporting extended bit depth activities:

As far as the new HEVC Multiview Main 10 profile in JVET-AJ0213 added at the 36th meeting and in output document AJ1006, two bitstreams previously generated have been cross-checked (MVHEVC\_N\_APPLE\_1 and MVHEVC\_O\_APPLE\_1).

No change in bitstreams and/or packages for the 2 HEVC Multiview Extended 10 and the 2 HEVC Multiview Extended bitstreams. The 6 packages are available at <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/HEVCMultiview/>.

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

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

The AHG5 chairs and JVET chairs can be reached at [jvet-conformance@lists.rwth-aachen.de](mailto:jvet-conformance@lists.rwth-aachen.de). Participants should not subscribe to this list but may send emails to it.

1. **Contributions**

No contributions.

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.
* Continue the generation, cross-checking, and documentation of the conformance streams for the HEVC Multiview profiles supporting extended bit depth and the new HEVC Multiview Main 10 profile, and update AL1008 to include the new 2 HEVC Multiview Main 10 streams.
* Study CD of VVC conformance 3rd edition and suggest improvements to JVET-AK2028, as appropriate.

[JVET-AM0006](https://jvet-experts.org/doc_end_user/current_document.php?id=15900) JVET AHG report: ECM software development (AHG6) [V. Seregin (chair), J. Chen, R. Chernyak, F. Le Léannec, K. Zhang (vice-chairs)]

1. **Software development**

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

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

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

The following changes were integrated into ECM-17.0:

JVET-AL0135: Cross-chroma input for CC-ALF (Test 5.3b) [MR 896]

JVET-AL0153: ALF-CCCM (Test 5.1) [MR 894]

JVET-AL0160: Subblock-based spatial MVP (Test 3.1) [MR 893]

JVET-AL0161: On interpolation filter for template matching (Test 3.7) [MR 899]

JVET-AL0114: On intra mode selection [MR 901]

JVET-AL0142: CCSAO with reused CTU control (Test 5.2) [MR 897]

JVET-AL0125: Improvement on MPM (Test 2.6) [MR 891]

JVET-AL0108: Block vector guided DIMD (Test 2.7) [MR 903]

JVET-AL0247: Fix for MaxTbSize [MR 905]

JVET-AL0157: Additional merge candidates (Test 3.3e) [MR 904]

JVET-AL0182: TALF reference picture extensions [MR 907]

JVET-AL0181: Advanced SBT with direction and position inference (Test 4.1) [MR 890]

JVET-AL0215: NSPT set for IntraNN and NSPT kernel retraining (Test 4.4c) [MR 902]

JVET-AL0191: CCP constraints with intra chroma encoder optimization (Test 2.2d) [MR 900]

JVET-AL0214: Mv refinement for TMVP (Test 3.6) [MR 895]

JVET-AL0206: Combination of BVEIP and EIP filter shapes (Test 2.9) [MR 909]

JVET-AL0126: CCP merge mode with adjustment (Test 2.3) [MR 910]

JVET-AL0079: Per-pixel based Affine MC regardless of OBMC flag (Test 3.5) [MR 906]

JVET-AL0228: Two NNLF interfaces (off by default) [MR 911]

JVET-AL0143: Chroma partition prediction in separate tree condition (Test 1.1c) [MR 914]

JVET-AL0081: Extended BDOF usage for MV refinement (Test 3.9) [MR 908]

JVET-AL0188: Flip-aware BV prediction in SGPM (Test 2.5) [MR 915]

JVET-AL0162: CMVP extension for constructed affine merge candidates (Test 3.8a) [MR 913]

JVET-AL0134: Joint reordering of GPM split modes and partition indices (Test 3.4a) [MR 916]

Fixes:

Fix isChromaFusion for AC0119 [MR 929]

Fix clang 19 compiling issues [MR 919]

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

Fix VTM11-ECM16 clang compiling issues [MR 889]

ECM-17.0 and VTM-11.0ecm17.0 were tagged on May 12, 2025.

***CTC Performance***

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

ECM-17.0 performance over ECM-16.1 anchor is summarized in the tables below.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | |
|  | **Over ECM-16.1** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -0.20% | -1.15% | -1.25% | 97.2% | 101.2% | 100.8% | 99.5% |
| Class A2 | -0.18% | -1.56% | -1.21% | 94.5% | 100.8% | 100.8% | 99.4% |
| Class B | -0.21% | -1.16% | -1.12% | 100.1% | 102.6% | 100.1% | 100.1% |
| Class C | -0.20% | -0.21% | -0.14% | 98.0% | 100.8% | 102.1% | 101.4% |
| Class E | -0.29% | -0.98% | -0.95% | 100.5% | 99.9% | 104.7% | 100.7% |
| **Overall** | -0.21% | -0.99% | -0.91% | 98.3% | 101.2% | 101.5% | 100.3% |
| Class D | -0.15% | 0.04% | 0.33% | 96.7% | 102.5% | 102.4% | 101.6% |
| Class F | -0.20% | -0.59% | -0.46% | 94.7% | 94.5% | 101.6% | 100.8% |
| Class TGM | -0.19% | -0.40% | -0.44% | 88.5% | 85.0% | 101.1% | 100.2% |
|  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | |
|  | **Over ECM-16.1** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -0.18% | -1.64% | -2.20% | 98.3% | 105.1% | 102.7% | 101.9% |
| Class A2 | -0.22% | -1.69% | -1.95% | 97.1% | 102.4% | 103.9% | 101.6% |
| Class B | -0.29% | -2.64% | -2.18% | 101.5% | 105.0% | 102.2% | 101.5% |
| Class C | -0.41% | -1.94% | -1.97% | 103.4% | 109.0% | 102.3% | 101.8% |
| Class E |  |  |  |  |  |  |  |
| **Overall** | -0.29% | -2.06% | -2.08% | 100.4% | 105.5% | 102.7% | 101.7% |
| Class D | -0.39% | -1.17% | -0.89% | 103.0% | 108.7% | 102.2% | 101.6% |
| Class F | -0.20% | -1.28% | -1.85% | 95.8% | 100.2% | 102.4% | 101.3% |
| Class TGM | -0.33% | -1.35% | -1.47% | 92.5% | 102.1% | 101.9% | 101.0% |
|  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | |
|  | **Over ECM-16.1** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -0.54% | -6.85% | -5.05% | 104.2% | 111.8% | 102.9% | 101.3% |
| Class C | -0.56% | -3.85% | -4.89% | 105.1% | 112.0% | 102.7% | 101.7% |
| Class E | -1.03% | -4.86% | -3.43% | 102.7% | 111.4% | 102.7% | 101.1% |
| **Overall** | -0.67% | -5.36% | -4.59% | 104.1% | 111.8% | 102.8% | 101.4% |
| Class D | -1.01% | -4.12% | -5.71% | 105.3% | 110.4% | 102.5% | 101.7% |
| Class F | -0.37% | -3.83% | -4.67% | 101.7% | 103.0% | 102.8% | 101.7% |
| Class TGM | -0.27% | -1.87% | -1.73% | 92.1% | 106.3% | 102.0% | 101.1% |
|  |  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | | |
|  | **Over ECM-16.1** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -0.59% | -6.68% | -4.02% | 104.2% | 114.8% | 102.2% | 101.4% |
| Class C | -0.71% | -4.46% | -4.63% | 103.0% | 109.3% | 102.5% | 101.7% |
| Class E | -0.59% | -4.37% | -2.83% | 101.0% | 106.2% | 102.3% | 101.6% |
| **Overall** | -0.63% | -5.36% | -3.93% | 103.0% | 110.7% | 102.3% | 101.6% |
| Class D | -0.73% | -3.87% | -4.02% | 102.8% | 107.8% | 102.5% | 101.7% |
| Class F | -0.80% | -4.08% | -4.92% | 98.6% | 106.5% | 101.4% | 101.7% |
| Class TGM | -0.53% | -1.79% | -2.16% | 91.1% | 98.3% | 101.7% | 101.1% |

The below tables show ECM-17.0 performance comparing to VTM-11.0ecm17.0 anchor.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | |
|  | **Over VTM-11.0ecm17.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -14.76% | -16.60% | -27.65% | 1163.7% | 533.8% | #DIV/0! | #DIV/0! |
| Class A2 | -21.25% | -24.93% | -29.15% | 1110.6% | 580.9% | #DIV/0! | #DIV/0! |
| Class B | -14.89% | -23.18% | -21.23% | 1115.9% | 639.0% | #DIV/0! | #DIV/0! |
| Class C | -15.02% | -11.99% | -13.11% | 1029.4% | 590.8% | #DIV/0! | #DIV/0! |
| Class E | -19.41% | -23.10% | -21.32% | 1038.6% | 648.7% | #DIV/0! | #DIV/0! |
| **Overall** | -16.71% | -19.87% | -21.83% | 1089.8% | 601.3% | #DIV/0! | #DIV/0! |
| Class D | -12.84% | -8.91% | -9.58% | 993.2% | 640.7% | #DIV/0! | #DIV/0! |
| Class F | -30.41% | -34.26% | -34.39% | 681.6% | 620.2% | #DIV/0! | #DIV/0! |
| Class TGM | -43.37% | -49.07% | -48.36% | 480.9% | 529.3% | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | |
|  | **Over VTM-11.0ecm17.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -27.43% | -24.79% | -37.03% | 1184.4% | 1124.5% | #DIV/0! | #DIV/0! |
| Class A2 | -30.65% | -34.78% | -40.19% | 1128.9% | 1338.4% | #DIV/0! | #DIV/0! |
| Class B | -25.30% | -33.71% | -30.74% | 1014.4% | 1196.7% | #DIV/0! | #DIV/0! |
| Class C | -27.06% | -23.64% | -24.47% | 1088.8% | 1336.4% | #DIV/0! | #DIV/0! |
| Class E |  |  |  |  |  |  |  |
| **Overall** | -27.27% | -29.46% | -32.22% | 1089.3% | 1244.8% | #DIV/0! | #DIV/0! |
| Class D | -27.79% | -23.89% | -24.71% | 1024.9% | 1459.0% | #DIV/0! | #DIV/0! |
| Class F | -33.30% | -36.14% | -36.98% | 880.0% | 853.5% | #DIV/0! | #DIV/0! |
| Class TGM | -42.78% | -48.57% | -48.43% | 686.7% | 626.8% | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | |
|  | **Over VTM-11.0ecm17.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -22.53% | -40.00% | -35.36% | 1034.3% | 1051.6% | #DIV/0! | #DIV/0! |
| Class C | -24.92% | -27.76% | -30.13% | 983.6% | 1102.7% | #DIV/0! | #DIV/0! |
| Class E | -22.55% | -30.05% | -28.45% | 978.3% | 694.5% | #DIV/0! | #DIV/0! |
| **Overall** | -23.33% | -33.43% | -31.89% | 1003.1% | 963.1% | #DIV/0! | #DIV/0! |
| Class D | -26.61% | -28.84% | -30.92% | 999.8% | 1258.8% | #DIV/0! | #DIV/0! |
| Class F | -30.88% | -41.04% | -41.18% | 861.6% | 771.2% | #DIV/0! | #DIV/0! |
| Class TGM | -41.07% | -51.05% | -50.93% | 679.1% | 584.7% | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | | |
|  | **Over VTM-11.0ecm17.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -20.44% | -48.22% | -43.93% | 904.2% | 1048.2% | #DIV/0! | #DIV/0! |
| Class C | -23.06% | -36.80% | -38.35% | 841.6% | 1075.7% | #DIV/0! | #DIV/0! |
| Class E | -20.93% | -37.70% | -37.05% | 878.0% | 672.8% | #DIV/0! | #DIV/0! |
| **Overall** | -21.43% | -41.78% | -40.35% | 876.3% | 946.3% | #DIV/0! | #DIV/0! |
| Class D | -25.80% | -39.87% | -40.34% | 822.1% | 1144.5% | #DIV/0! | #DIV/0! |
| Class F | -29.15% | -46.07% | -46.57% | 825.9% | 787.7% | #DIV/0! | #DIV/0! |
| Class TGM | -39.37% | -53.58% | -53.11% | 706.8% | 589.8% | #DIV/0! | #DIV/0! |

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-AM0007](https://jvet-experts.org/doc_end_user/current_document.php?id=15901) 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. **Group off tests**
2. ***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-17.0 was used in the AHG7 tool off tests. The cfg files used are included in the ECM software package.

1. ***Group 1 off***

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



1. ***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.



1. ***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.



1. ***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.



1. ***Group 5 off***

Group 5 includes tools which need large memory access.

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



1. ***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.



1. ***Summary***

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

1. **Issues**
2. ***Resolved issues***

* #109, [Current master tip (7fee7e00d) has decoding mismatch with AHG7 group1-5 off](https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/issues/109)
* #107, Current master tip (06c21da0) decoding mismatch with AHG7 group2 off
* #106, Current master tip (06c21da0) fails MD5sum check at decoding with AHG7 group1 off
* #105, Current master tip (06c21da0) has encoding crash with AHG7 group1 off
* #104, Current master tip (d3a1301a) has encoding crash with AHG7 group1-5 off

1. ***Open issues***

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

1. **Input contributions**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| [JVET-AM0042](https://jvet-experts.org/doc_end_user/current_document.php?id=15689) | m72844 | 2025-04-22 18:52:59 | 2025-04-22 19:28:04 | 2025-05-20 02:43:45 | Report of AHG7 conference call on Assessment Perspectives of Codec/Coding Tools | [X. Li](mailto:xlxiangli@google.com) |
| [JVET-AM0044](https://jvet-experts.org/doc_end_user/current_document.php?id=15691) | m72866 | 2025-05-20 18:41:53 | 2025-05-20 18:45:18 | 2025-05-20 18:45:18 | AHG7: Summary on the Tool Analysis in Earlier Proposals/Reports | [X. Li (Google)](mailto:xlxiangli@google.com) |
| [JVET-AM0134](https://jvet-experts.org/doc_end_user/current_document.php?id=15781) | m73044 | 2025-06-19 11:56:43 | 2025-06-19 14:19:37 | 2025-06-19 14:19:37 | AHG7: ECM tool combination | [R. Ishimoto](mailto:ishimoto.ryo@mail.sharp), [Z. Fan](mailto:fan.zheming@mail.sharp), [T. Chujoh](mailto:chujoh.takeshi@mail.sharp), [T. Ikai (Sharp)](mailto:ikai.tomohiro@mail.sharp) |
| [JVET-AM0194](https://jvet-experts.org/doc_end_user/current_document.php?id=15841) | m73108 | 2025-06-19 17:50:35 | 2025-06-19 17:56:52 | 2025-06-19 17:56:52 | On Analyzing and Reporting Encoding and Decoding Complexity | [A. Stein](mailto:alan.stein@v-nova.com), [S. Ferrara (V-Nova)](mailto:simone.ferrara@v-nova.com) |
| [JVET-AM0221](https://jvet-experts.org/doc_end_user/current_document.php?id=15868) | m73137 | 2025-06-19 22:17:19 | 2025-06-19 23:23:08 | 2025-06-19 23:23:08 | AHG7: TMRL Tool-Off Bug Fix | [Z. Xiang](mailto:alanzxiang@global.tencent.com), [R. Chernyak](mailto:chernyak@global.tencent.com), [B. Wang](mailto:biaowwang@global.tencent.com), [S. Liu (Tencent)](mailto:shanl@global.tencent.com) |
| [JVET-AM0227](https://jvet-experts.org/doc_end_user/current_document.php?id=15874) | m73143 | 2025-06-19 22:53:02 | 2025-06-23 20:11:35 | 2025-06-23 20:11:35 | 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-AM0295](https://jvet-experts.org/doc_end_user/current_document.php?id=15963) | m73624 | 2025-06-25 06:18:58 | 2025-06-25 06:25:43 | 2025-06-25 06:25:43 | [AHG7] External memory bandwidth evaluation | [Y. Kim](mailto:yearly.kim@samsung.com), [L. Li](mailto:lingl.li@samsung.com), [M. W. Park](mailto:m.w.park@samsung.com), [M. Park](mailto:mss.park@samsung.com), [M. Budagavi](mailto:m.budagavi@samsung.com), [K. P. Choi (Samsung)](mailto:kp5.choi@samsung.com) |

1. **Recommendations**

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

It was commented that newly integrated tools should report a mandatory tool-off test together with the merge request (could be more relevant for future developments rather than ECM).

BoG later in the meeting on methodology for complexity assessment of tools.

It was suggested to investigate whether the case groups 1-5 off could be combined with ECM5x used in CfE dry-run, to potentially generate another lower-complexity ECM version in the CfE part on faster encoding.

[JVET-AM0008](https://jvet-experts.org/doc_end_user/current_document.php?id=15902) JVET AHG report: Optimization of encoders and receiving systems for machine analysis of coded video content (AHG8) [S. Liu, J. Ström, S. Wang, M. Zhou (AHG chairs)]

***Software and Common Test Conditions***

AHG 8 related software and documents can be accessed at <https://vcgit.hhi.fraunhofer.de/jvet-ahg-ofm>. This repository contains two projects: common test conditions, reporting templates with anchor results, evaluation scripts and task networks are available in <https://vcgit.hhi.fraunhofer.de/jvet-ahg-ofm/ofm-ctc>, and software implementation examples are hosted in <https://vcgit.hhi.fraunhofer.de/jvet-ahg-ofm/vtm-ofm>. For this meeting cycle, common test conditions remain unchanged as described in output document JVET-AI2031.

***Technical Report***

The 9th draft of the technical report (TR) JVET-AL2030 “Optimization of encoders and receiving systems for machine analysis of coded video content (draft 9)” was produced and uploaded to JVET document system on 2025-04-30, including the following additions on top of draft 8:

* Updated to address comments in m72107
* Tool combination example (to Annex B) JVET-AL0152

The following combined tool examples have been included in the submitted DTR, besides single tool implementation examples.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Technology 1 | Technology 2 | Technology 3 | Technology 4 | Technology 5 |
| Adaptive QP (8.1 and A.1) | Temporal layer QP offset (8.2) |  |  |  |
| De-noising filter (7.5) | Temporal layer QP offset (8.2) |  |  |  |
| Pre-processing (7.2 and A.2) | NNPF (9.3 and A.3) |  |  |  |
| 4:4:4 coding (8) | Reduced resolution (Clauses 7.4 and 9.2) |  |  |  |
| Pre-processing (7.2 and A.2) | NNPF (9.3 and A.3) | Adaptive QP (8.1 and A.1) |  |  |
| NNPF (9.3 and A.3) | Adaptive QP (8.1 and A.1) |  |  |  |
| NNPF (9.3 and A.3) | Reduced resolution (Clauses 7.4 and 9.2) |  |  |  |
| Pre-processing (7.2 and A.2) | NNPF (9.3 and A.3) | Adaptive QP (8.1 and A.1) | Temporal layer QP offset (8.2) |  |
| Pre-processing (7.2 and A.2) | NNPF (9.3 and A.3) | Adaptive QP (8.1 and A.1) | Temporal resampling (9.1 and A.4) |  |
| Pre-processing (7.2 and A.2) | NNPF (9.3 and A.3) | Adaptive QP (8.1 and A.1) | Temporal resampling (9.1 and A.4) | Temporal layer QP offset (8.2) |

1. **Input contributions**

There is no input contributions related to AHG 8 mandates (by the time this report is uploaded) except this report.

1. **Recommendations**

The AHG recommends to:

* Continue improving the on-going TR document based on feedback.
* Discuss plan and timeline for finalization of TR (version 1).
* Continue investigating non-normative technologies and their uses for machine vision applications and machine consumptions.

[JVET-AM0009](https://jvet-experts.org/doc_end_user/current_document.php?id=15903) 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)]

1. **Related contributions**

A total of 68 contributions are identified relating to the mandates of AHG9. Some contributions relate to more than one mandate and/or SEI message. Some contributions also relate to the work of AHG13.

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

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

[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 [J. Boyce, M. M. Hannuksela (Nokia)]

[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 [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AM0162](https://jvet-experts.org/doc_end_user/current_document.php?id=15809) AHG9: Software implementation of attenuation map information metadata in the Green Metadata SEI message [C-H. Demarty, F. Urban, E. François, F. Aumont (InterDigital)]

*JVET- AM0162 also relates to software for 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 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AM0189 also relates to the study of JVET-AL2006 VSEI*

1. ***Study JVET-AL1006 HEVC (1)***

[JVET-AM0048](https://jvet-experts.org/doc_end_user/current_document.php?id=15695) AHG9/AHG2: Miscellaneous changes for HEVC [Y.-K. Wang, J. Xu (Bytedance)]

1. ***Study JVET-AL1017 AVC (0)***
2. ***Study JVET-AL2005 VVC (1)***

[JVET-AM0174](https://jvet-experts.org/doc_end_user/current_document.php?id=15821) AHG9: On general SEI payload constraints [Y. Sanchez, R. Skupin, T. M. Borges, K. Suehring, C. Hellge, T. Schierl (Fraunhofer HHI)]

1. ***Study JVET-AL2006 VSEI (25)***

**Editorial *(3)***

[JVET-AM0047](https://jvet-experts.org/doc_end_user/current_document.php?id=15694) AHG9: Miscellaneous changes for VSEI [Y.-K. Wang, J. Xu (Bytedance)]

*JVET- AM0047 also relates to modality information, digital signed content, and NNPFC SEI messages*

[JVET-AM0052](https://jvet-experts.org/doc_end_user/current_document.php?id=15699) AHG9: Editorial changes for VSEI [Y. He, S. Zhao, L. Kerofsky, M. Karczewicz (Qualcomm)]

[JVET-AM0191](https://jvet-experts.org/doc_end_user/current_document.php?id=15838) AHG9: Editorial updates for VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

**NNPF SEI messages *(2)***

[JVET-AM0047](https://jvet-experts.org/doc_end_user/current_document.php?id=15694) AHG9: Miscellaneous changes for VSEI [Y.-K. Wang, J. Xu (Bytedance)]

*JVET- AM0047 also relates to editorial changes in VSEI and the modality information and digital signed content SEI messages*

[JVET-AM0113](https://jvet-experts.org/doc_end_user/current_document.php?id=15760) AHG9: Supporting pre-processing aware post processing in the NNPFC SEI message [M. Damghanian, M. Pettersson, R. Sjöberg (Ericsson)]

**SEI processing order and processing order nesting SEI messages (*6*)**

[JVET-AM0080](https://jvet-experts.org/doc_end_user/current_document.php?id=15727) AHG9: On the PON SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AM0081](https://jvet-experts.org/doc_end_user/current_document.php?id=15728) AHG9: On the PON dependency constraint [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AM0082](https://jvet-experts.org/doc_end_user/current_document.php?id=15729) AHG9: On the PON nested FGC SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AM0121](https://jvet-experts.org/doc_end_user/current_document.php?id=15768) AHG9: On the SEI processing order SEI message [M. M. Hannuksela, J. Boyce, F. Cricri (Nokia)]

[JVET-AM0166](https://jvet-experts.org/doc_end_user/current_document.php?id=15813) AHG9: Miscellaneous aspects in VSEI v4 [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

*JVET- AM0166 also relates to the MI and PRI SEI messages*

[JVET-AM0206](https://jvet-experts.org/doc_end_user/current_document.php?id=15853) AHG9: On signalling of sei payload type in SEI processing order SEI message [H. Tan, C. Kim, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[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 ] [Y.-K. Wang (Bytedance)]

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

[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 [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

*JVET- AM0165 also relates to the SPTI, MI, TDI, and IFM SEI messages*

**Source picture timing information SEI message *(2)***

[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 [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

*JVET- AM0165 also relates to the EOI, MI, TDI, and IFM 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 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AM0189 also relates to the MI, TDI, DSCV, and AUR SEI messages and to the study of SEI messages in VSEI, VCC, HEVC, and AVC*

**Modality information SEI message *(4)***

[JVET-AM0047](https://jvet-experts.org/doc_end_user/current_document.php?id=15694) AHG9: Miscellaneous changes for VSEI [Y.-K. Wang, J. Xu (Bytedance)]

*JVET- AM0047 also relates to editorial changes in VSEI and the digital signed content and NNPFC SEI messages*

[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 [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

*JVET- AM0165 also relates to the EOI, SPTI, TDI, and IFM SEI messages*

[JVET-AM0166](https://jvet-experts.org/doc_end_user/current_document.php?id=15813) AHG9: Miscellaneous aspects in VSEI v4 [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

*JVET- AM0166 also relates to the SPO and PRI 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 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AM0189 also relates to the SPTI, TDI, DSCV, and AUR SEI messages and to the study of SEI messages in VSEI, VCC, HEVC, and AVC*

**Text description information SEI message *(3)***

[JVET-AM0098](https://jvet-experts.org/doc_end_user/current_document.php?id=15745) AHG9: On the TDI SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[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 [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

*JVET- AM0047 also relates to the EOI, SPTI, MI, and IFM 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 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AM0189 also relates to the SPTI, MI, DSCV, and AUR SEI messages and to the study of SEI messages in VSEI, VCC, HEVC, and AVC*

**Generative face video SEI messages *(1)***

[JVET-AM0091](https://jvet-experts.org/doc_end_user/current_document.php?id=15738) AHG9: On GFV SEI chroma key [J. Boyce, M. M. Hannuksela (Nokia)]

**Digitally signed content messages *(8)***

[JVET-AM0047](https://jvet-experts.org/doc_end_user/current_document.php?id=15694) AHG9: Miscellaneous changes for VSEI [Y.-K. Wang, J. Xu (Bytedance)]

*JVET- AAM0047 also relates to editorial changes in VSEI and the modality information and NNPFC SEI messages*

[JVET-AM0118](https://jvet-experts.org/doc_end_user/current_document.php?id=15765) AHG9: Digital signing of selected SEI messages [M. M. Hannuksela, J. Boyce (Nokia)]

[JVET-AM0119](https://jvet-experts.org/doc_end_user/current_document.php?id=15766) AHG9: On start and end flags of digitally signed content [M. M. Hannuksela, J. Boyce (Nokia)]

[JVET-AM0164](https://jvet-experts.org/doc_end_user/current_document.php?id=15811) AHG9: On DSC SEI [K. Suehring, T. Hinz, Y. Sanchez, J. Pfaff, H. Schwarz, D. Marpe, T. Wiegand (Fraunhofer HHI)]

[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 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AM0189 also relates to the SPTI, MI, TDI, and AUR SEI messages and to the study of SEI messages in VSEI, VCC, HEVC, and AVC*

[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 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AM0208](https://jvet-experts.org/doc_end_user/current_document.php?id=15855) AHG9: On aspects related to verification period in digitally-signed content SEI messages in VSEI v4 draft [H. Tan, J. Lee, J. Nam, C. Kim, J. Lim, S. Kim (LGE)]

[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 [H. Tan, J. Lee, J. Nam, C. Kim, J. Lim, S. Kim (LGE)]

**AI usage restrictions SEI message *(4)***

[JVET-AM0112](https://jvet-experts.org/doc_end_user/current_document.php?id=15759) AHG9: On AI usage restrictions SEI message [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

[JVET-AM0117](https://jvet-experts.org/doc_end_user/current_document.php?id=15764) AHG9: On the AI usage restrictions SEI message [M. M. Hannuksela, F. Cricri (Nokia)]

[JVET-AM0152](https://jvet-experts.org/doc_end_user/current_document.php?id=15799) AHG9: AI usage restrictions for entities other than decoded pictures [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[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 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*JVET- AM0189 also relates to the SPTI, MI, TDI, and DSCV SEI messages and to the study of SEI messages in VSEI, VCC, HEVC, and AVC*

**Packed regions information SEI message *(3)***

[JVET-AM0075](https://jvet-experts.org/doc_end_user/current_document.php?id=15722) AHG9: On packed regions information SEI message [T. Chujoh, Z. Fan, R. Ishimoto, T. Ikai (Sharp)]

[JVET-AM0166](https://jvet-experts.org/doc_end_user/current_document.php?id=15813) AHG9: Miscellaneous aspects in VSEI v4 [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

*JVET- AM0166 also relates to the SPO and MI SEI messages*

[JVET-AM0211](https://jvet-experts.org/doc_end_user/current_document.php?id=15858) AHG9: On the packed regions information SEI message [J. Xu, Y.-K. Wang (Bytedance)]

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

[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 [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

*JVET- AM0165 also relates to the EOI, SPTI, MI, and TDI SEI messages*

1. ***Study JVET-AL2032 TuC for VSEI (32)***

**NNPF SEI messages *(1)***

[JVET-AM0087](https://jvet-experts.org/doc_end_user/current_document.php?id=15734) AHG9: Comments on VSEI TuC [S. Deshpande (Sharp)]

[JVET-AM0173](https://jvet-experts.org/doc_end_user/current_document.php?id=15820) AHG9: NNPFA SEI message extension for multi-purpose NNPFs [C-H. Demarty, E. François, A. Ak (InterDigital), M. Hannuskela, F. Cricri (Nokia)]

**SEI processing order and processing order nesting SEI messages (*2*)**

[JVET-AM0079](https://jvet-experts.org/doc_end_user/current_document.php?id=15726) AHG9: On the SPO SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AM0155](https://jvet-experts.org/doc_end_user/current_document.php?id=15802) AHG9: On the SPO SEI message complexity signaling [Y. Gao, P. Wu, S. Xie, Y. Bai, C. Huang (ZTE)]

**Encoder optimization information SEI message *(2)***

[JVET-AM0126](https://jvet-experts.org/doc_end_user/current_document.php?id=15773) AHG9: Temporal quality indication for EOI SEI message [J. Chen, Y. Ye, B. Chen (Alibaba)]

[JVET-AM0179](https://jvet-experts.org/doc_end_user/current_document.php?id=15826) AHG9: Depth-aware optimization for Encoder optimization information SEI message [G. Teniou, S. Wenger, A. Hinds (Tencent)]

**Digitally signed content messages *(4)***

[JVET-AM0156](https://jvet-experts.org/doc_end_user/current_document.php?id=15803) AHG9: On Digitally Signing a SEI message [Y. Gao, P. Wu, Y. Bai, S. Xie, C. Huang (ZTE)]

[JVET-AM0160](https://jvet-experts.org/doc_end_user/current_document.php?id=15807) AHG9: On including SEI messages in the digitally signed content [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[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 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

[JVET-AM0205](https://jvet-experts.org/doc_end_user/current_document.php?id=15852) AHG9: Digitally signed content: use of Picture ID for overlay area exclusion [I. Sodagar, C. Fersch, S. McCarthy (Dolby Labs)]

**Film grain regions characteristics SEI message *(4)***

[JVET-AM0085](https://jvet-experts.org/doc_end_user/current_document.php?id=15732) AHG9/AHG13: On Film Grain Regions Characteristics SEI message [S. Deshpande, J. Samuelsson-Allendes (Sharp)]

[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 [S. Xie, W. Niu, P. Wu, Y. Gao, C. Huang (ZTE)]

*JVET- AM0124 also relates to software for SEI messages*

[JVET-AM0168](https://jvet-experts.org/doc_end_user/current_document.php?id=15815) [AHG9/AHG13] Implementation in VTM TuC of the film grain regions characteristics SEI message [F. Urban, E. François, P. de Lagrange (InterDigital), G. Teniou (Tencent)]

*JVET- AM0168 also relates to software for SEI messages*

[JVET-AM0230](https://jvet-experts.org/doc_end_user/current_document.php?id=15877) AHG9/AHG13: Reference picture resolution for the FGR SEI message [E. François, P. de Lagrange, F. Urban (InterDigital)]

**Constituent rectangles SEI messages (*2)***

[JVET-AM0092](https://jvet-experts.org/doc_end_user/current_document.php?id=15739) AHG9: Editorial changes on the CR SEI message [Y. He, S. Zhao, L. Kerofsky, M. Karczewicz (Qualcomm)]

[JVET-AM0093](https://jvet-experts.org/doc_end_user/current_document.php?id=15740) AHG9: On the CR SEI message [Y. He, S. Zhao, L. Kerofsky, M. Karczewicz (Qualcomm)]

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

[JVET-AM0096](https://jvet-experts.org/doc_end_user/current_document.php?id=15743) AHG9: On the QM SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

**Lens optical correction SEI message *(2)***

[JVET-AM0101](https://jvet-experts.org/doc_end_user/current_document.php?id=15748) AHG9: On Lens Optical Correction SEI message [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AM0102](https://jvet-experts.org/doc_end_user/current_document.php?id=15749) AHG9: Additional models for the LOC SEI message [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

**Display overlays information SEI message *(3)***

[JVET-AM0094](https://jvet-experts.org/doc_end_user/current_document.php?id=15741) AHG9: On the DOI SEI message [Y. He, S. Zhao, L. Kerofsky, M. Karczewicz (Qualcomm)]

[JVET-AM0147](https://jvet-experts.org/doc_end_user/current_document.php?id=15794) AHG9: On applying display overlays on display rectangles [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

[JVET-AM0180](https://jvet-experts.org/doc_end_user/current_document.php?id=15827) AHG9: Overlay purpose indicator for Display overlays information SEI message [G. Teniou, S. Wenger, A. Hinds (Tencent)]

**Bitdepth range information SEI message *(1)***

[JVET-AM0099](https://jvet-experts.org/doc_end_user/current_document.php?id=15746) AHG9: On the BRI SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

**Photosensitive content information SEI message *(1)***

[JVET-AM0086](https://jvet-experts.org/doc_end_user/current_document.php?id=15733) AHG9: On Photosensitive Content Information Signaling [S. Deshpande (Sharp)]

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

[JVET-AM0095](https://jvet-experts.org/doc_end_user/current_document.php?id=15742) AHG9: On the DR SEI message [Y. He, S. Zhao, L. Kerofsky, M. Karczewicz (Qualcomm)]

[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 [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

**Picture segment information SEI message *(2)***

[JVET-AM0097](https://jvet-experts.org/doc_end_user/current_document.php?id=15744) AHG9: On the PSI SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AM0192](https://jvet-experts.org/doc_end_user/current_document.php?id=15839) AHG9: On picture segmentation SEI message in TuC of VSEI [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

**Danmu information SEI message *(3)***

[JVET-AM0154](https://jvet-experts.org/doc_end_user/current_document.php?id=15801) AHG9: On danmu information SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AM0161](https://jvet-experts.org/doc_end_user/current_document.php?id=15808) AHG9: On display timing in the danmu information SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AM0182](https://jvet-experts.org/doc_end_user/current_document.php?id=15829) AHG9: On the Danmu SEI message [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

**Colour mapping information SEI message *(1)***

[JVET-AM0108](https://jvet-experts.org/doc_end_user/current_document.php?id=15755) AHG9: On colour mapping information SEI message [J. Samuelsson-Allendes, S. Deshpande (Sharp)]

1. ***Collect software and showcase information for SEI messages (4)***

**Film grain regions characteristics SEI message *(2)***

[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 [S. Xie, W. Niu, P. Wu, Y. Gao, C. Huang (ZTE)]

[JVET-AM0168](https://jvet-experts.org/doc_end_user/current_document.php?id=15815) [AHG9/AHG13] Implementation in VTM TuC of the film grain regions characteristics SEI message [F. Urban, E. François, P. de Lagrange (InterDigital), G. Teniou (Tencent)]

*JVET- AM0124 and JVET-AM0168 also relate to the film grain regions characteristics SEI message*

**Green metadata SEI message *(1)***

[JVET-AM0162](https://jvet-experts.org/doc_end_user/current_document.php?id=15809) AHG9: Software implementation of attenuation map information metadata in the Green Metadata SEI message [C-H. Demarty, F. Urban, E. François, F. Aumont (InterDigital)]

*JVET- AM0162 also relates to the study of SEI messages in VVC, HEVC, and AVC*

**Gaussian splatting information SEI message *(1)***

[JVET-AM0212](https://jvet-experts.org/doc_end_user/current_document.php?id=15859) AHG9: Gaussian splatting information SEI message [D. Wang, J. Xu, L. Zhang, Y.-K. Wang, S. Jiao (Bytedance)]

*JVET- AM0212 also relates to identifying potential needs for new SEI messages*

1. ***Identify potential needs for additional SEI messages, including study of AVC and HEVC SEI messages for use in VVC (6)***

[JVET-AM0083](https://jvet-experts.org/doc_end_user/current_document.php?id=15730) AHG9: Auxiliary sampling alignment and transformation information SEI [V. Zakharchenko, J. Boyce, D. Rusanovskyy, M. M. Hannuksela (Nokia)]

[JVET-AM0103](https://jvet-experts.org/doc_end_user/current_document.php?id=15750) AHG9: Camera Extinsic Information SEI message [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

[JVET-AM0153](https://jvet-experts.org/doc_end_user/current_document.php?id=15800) AHG9: Loss recovery information SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

[JVET-AM0181](https://jvet-experts.org/doc_end_user/current_document.php?id=15828) AHG9: Proposed new SEI message on 3d model reconstruction information [G. Teniou, S. Wenger, A. Hinds, J. Ricard (Tencent)]

[JVET-AM0184](https://jvet-experts.org/doc_end_user/current_document.php?id=15831) AHG9: Picture Reference Degree SEI Message [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

[JVET-AM0212](https://jvet-experts.org/doc_end_user/current_document.php?id=15859) AHG9: Gaussian splatting information SEI message [D. Wang, J. Xu, L. Zhang, Y.-K. Wang, S. Jiao (Bytedance)]

*JVET- AM0212 also relates to software for SEI messages*

1. **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.

1. **Recommendations**

The AHG recommends to:

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

[JVET-AM0010](https://jvet-experts.org/doc_end_user/current_document.php?id=15904) JVET AHG report: Encoding algorithm optimization (AHG10) [K. Andersson, P. de Lagrange, A. Duenas (co-chairs), T. Ikai, T. Solovyev, A. Tourapis (vice chairs)]

1. **Related contributions**

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

1. ***JVET-AM0045: AHG17 Generated VTM anchor bitstreams using LambdaScaleTowardsNextQP***

This document is a follow up the approach of scaling lambda to control target bitrate as suggested in JVET-AL0207 with the current approach for target bitrate matching where QP is increased by 1 at a selected frame and used for the remaining length of the video sequence. The document reports results of rate matching using VTM-23.9 where the QP closest to the target bitrate is selected and the lambda is scaled to increase or decrease the bitrate using the configuration parameter LambdaScaleTowardsNextQP. The sequences and target bitrates follow AHG17 (configurations of draft CfE).

In v2 the document added BDR comparisons with QP + 1 approach and fixed QP (QP closest to target bitrate) are included. The lambda scaling approach has more similar BDR compared to using fixed QP than to the QP + 1 rate matching approach.

1. ***JVET-AM0078: AHG17 Suggestion to enable DMVR encoder control for VTM anchor***

This document is about the configuration parameter DMVREncMvSelect in VTM which will penalize the usage of DMVR when it is a risk that the tool produces visual artifacts. This typically occurs at lower bitrates when DMVR has more troubles to find the correct motion for all subblocks. In this contribution DMVREncMvSelect has been tested on the AHG17 test sequences and target bitrate’s and it is asserted that its enabling can improve visual quality in some cases. It is therefore suggested to enable DMVREncMvSelect for the VTM anchor in the context of subjective related tests, such as in the scope of AHG17. For rate matching the configuration parameter LambdaScaleTowardsNextQP has been used.

In v2 the document added BDR in comparisons with QP +1 rate matching and lambda scaling rate matching approach as in JVET-AM0045 are included. The BDR loss per class varies between -0.2% to 1.6% in comparison to the QP + 1 rate matching approach and between 0.7% to 1.4% in comparison to the lambda scaling rate matching approach.

1. ***JVET-AM0125: AHG17 Analysis on encoding time and mode cost test for draft CfE sequences***

This document reports experimental results that show that runtime ratio of VTM high performance and ECM JVET-AL0245 are roughly 1.9x to 1.3x and 5.3x to 10.4x for R1 to R4, and encoding runtime and RDO count are correlated, and they vary greatly depending on sequences. For SDR\_RA\_HD, EncT per RDO count is 0.085, 0.080 msec/count in VTM 23.9 under default and high performance configurations respectively. On the other hand, it is 1.034 msec/count in ECM under JVET-AL0245 configuration, which is 13 times larger than that of VTM and it may reflect to 12x EncT in ECM.

1. ***JVET-AM0187: On Intra Period of Random Access Test Case for HD and below Content***

This document reports that in today’s streaming applications, intra period is reportedly much larger than 1 second used in our CTC, especially when the adaptive intra picture inserting by rate control is excluded. It is proposed to use larger intra period of 2 seconds for content with resolution at or below HD, in random access test cases of CfP and future CTC to better align with practical applications while keeping a reasonable testing runtime. The benefit for UGC content in AHG17 is about 5% with 2s intra period.

1. ***JVET-AM0200: AHG17: Getting VTM to run five times faster***

The document reports that the reduced runtime VTM encoder configuration #3 adopted at the 38th meeting doesn’t quite achieve the target of 0.2x encoder runtime under CfE test conditions. This contribution reports on software improvements that were recently made to VTM and proposes new encoder configurations to get closer to the target.

The document proposes to modify the encoder configuration variants for reduced runtime 2 (30%) and 3 (20%) present in VTM as follows:

* Reduced runtime configuration 2:

UseNonLinearAlfLuma : 0

SplitPredictAdaptMode : 2

MergeRdCandQuotaGpm : 5

ContentBasedFastQtbt : 1

AdaptBypassAffineMe : 1

MaxMTTHierarchyDepth : 2

MaxMTTHierarchyDepthISliceL : 2

MTS : 4

MTSIntraMaxCand : 3

MaxNumMergeCand : 5

AllowDisFracMMVD : 0

MaxMergeRdCandNumTotal : 5

* Reduced runtime configuration 3:

UseNonLinearAlfLuma : 0

SplitPredictAdaptMode : 2

MergeRdCandQuotaGpm : 4

MaxTTNonISlice : 32

MaxBTNonISlice : 64

ContentBasedFastQtbt : 1

AdaptBypassAffineMe : 1

CTUSize : 64

MaxMTTHierarchyDepth : 1

MaxMTTHierarchyDepthISliceL : 2

MaxMTTHierarchyDepthISliceC : 1

MTS : 4

MTSIntraMaxCand : 3

MaxNumMergeCand : 5

AllowDisFracMMVD : 0

AffineAmvr : 0

ISPFast : 1

FastMIP : 1

MaxMergeRdCandNumTotal : 4

AffineAmvrEncOpt : 0

1. ***JVET-AM0225: [AHG17] Encoder runtime for the constrained complexity configurations under the CfE draft test conditions***

This document presents simulation results with the reliable encoder runtime for the constrained complexity encoder configurations of VTM 23.9 under the test conditions from the CfE draft. The simulation results show encoder runtime 65%, 53%, 25% with luma bd-rate 0.9%, 2.8%, 17.6% for the reduced runtime 1, 2 and 3 configurations correspondingly, relatively to the default RA configuration of VTM 23.9. HM-18.0 tested under the similar test conditions, shows 42% encoder runtime with 65.6% luma bd-rate relatively to the default configuration of VTM 23.9.

1. ***JVET-AM0237: On constrained encoding and decoding experiments***

This document explores the trade-offs between coding efficiency and computational complexity for both encoder and decoder. During the previous meeting, multiple trade-off points were presented by changing ECM configurations. While certain configurations demonstrated encoder complexity levels approximately twice that of the VTM encoder, the corresponding decoder complexity failed to achieve a desired two times of VTM decoder. It was suggested that further modifications are necessary to effectively reduce decoder complexity alongside encoder complexity.

In the context of constrained encoding, specific configurations achieved encoder complexity levels approximately twice that of the VTM encoder while maintaining comparable BD-rate gains. However, the decoding time exhibited significant variations, ranging from x2, x4, to even x6 the decoding time of the VTM decoder.

This contribution emphasizes the importance of illustrating both encoding and decoding times to provide a comprehensive understanding of trade-offs within the constrained encoding category. It is suggested that decoding time information be discussed jointly with encoding time, and this is beneficial for CfE response and practical implementation of the next generation of video coding standard.

1. ***JVET-AM0238: Suggestion of GOP Size Setting of Random Access Configuration for Live-streaming Applications***

This document states that latency is critical for live streaming applications, and a larger GOP size will lead to higher delay. Therefore, the GOP size in practical live streaming applications generally is much smaller than the value of 32 as specified in the current Common Test Conditions (CTC). To better reflect the use case, it is proposed to add one additional test configuration, setting the GOP size to be 4 in random access test cases of CfP and future CTC, ensuring better alignment with practical live streaming scenarios. In addition, the intra period is also adjusted to be 2 seconds instead of 1 second to better match typical live streaming settings in real applications.

1. **Recommendation**

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

[JVET-AM0011](https://jvet-experts.org/doc_end_user/current_document.php?id=15905) JVET AHG report: Neural network-based video coding (AHG11) [E. Alshina, F. Galpin, S. Liu, A. Segall (co-chairs), J. Li, Y. Li, R.-L. Liao, M. Santamaria, T. Shao, M. Wien, P. Wu (vice chairs)]

1. ***Common Test Conditions***
2. **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-13-VTM\_vs\_NNVC-13.xlsm

also distributed by AhG14 in JVET-AM0014 and intermediate report JVET-AM0043

1. ***Complexity, quality metrics, training sets***

Beside AhG11 recommended training data sets (BVI-DVB, TVD, DIV2K) proponents use Vimeo 90 K triple (for training NN-Intra). For learnable Intra frame coding additionally UVG, CLIC2021, LSDIR and JPEG AI training sets were used in one contribution.

In one contribution the compression performance of models trained using MSE loss and combined MSE and MS-SSIM loss evaluated in seven quality metrics (additionally to PSNR).

One contribution studies relationship between CPU and GPU run time for different neural networks architecture, trying to improve complexity evaluation for NNVC.

Bit-exact reconstruction was discussed only via e-mails in context of EE1 tests implementation and NN model quantizing. If there is mathematical proof of no overflow 32 bits overflow during model quantization (like in JPEG AI) then bit-exact behaviour can be guaranteed. Otherwise handling of overflow shall be specified. For complex models (such as NN-Inter) drop of 0.5% was reported after float point model was converted to int 16.

1. ***Interaction with ECM***

Different NN-based in-loop filters, as they were designed in AhG11/EE1 were tested using interface available in ECM. In random access configuration NN-based in-loop filter provides roughly 1%, 2% and 5% BD-rate gain on top of ECM with moderate CPU encoding run-time increment for VLOP, LOP and HOP versions of filter correspondently. BD-rate gain NN filters show on top of ECM is roughly 5% lower than on top of VTM.

|  |  |  |
| --- | --- | --- |
| [JVET-AM0176](https://jvet-experts.org/doc_end_user/current_document.php?id=15823) | EE2-related: ECM NNLF evaluation using AhG11 trained model | [T. Poirier](mailto:tangi.poirier@interdigital.com), F. Galpin (InterDigital) |

1. ***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-AM0023](https://jvet-experts.org/doc_end_user/current_document.php?id=15913) | 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) |

1. ***Teleconferences***

The AHG conducted two joint teleconferences with AHG14 and EE1 during the interim period. The teleconferences were held on April 25 and May 23, 2025. In those teleconferences, the following topics were discussed:

* NNVC13.0 software integration status and anchor performance.
* Hybrid plus E2E AI video codec framework development
* New VTM rebasing and NNVC SW integration status up-date
* EE1 tests final design

In particular it was agreed to re-implement NNVC to be based on VTM-23.9, remove dead code. Corresponding work was conducted by AhG14.

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

1. ***Performance Evaluation***

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

In NNVC-13 default configuration only LOP6 filter was modified (number of sequential convolutions decreased), but the most of speed up comes due to the speed-up of SADL.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test vs NNVC (configured as VTM)** | **Random Access cfg** | | | | | **kMAC/pxl** | | | | **Param (Mprm)** | | | |
| **Y** | U | V | Enc | Dec | **Total** | Filter | Intra | SR | **Total** | Filter | Intra | SR |
| NN-Intra & LOP filter (2 tools) | | | | | | | | | | | | | |
| NNVC-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** | 0.21 | 1.3 | 0 |
| NNVC-10.0 (LOP3) | **-7.4%** | -13.6% | -11.6% | 1.2 | 33 | **21.7** | 16.9 | 4.8 | 0 | **1.5** | 0.21 | 1.3 | 0 |
| NNVC-9.1(LOP3) | **-7.3%** | -13.1% | -11.3% | 1.2 | 81 | **24.8** | 16.9 | 7.9 | 0 | **1.7** | 0.21 | 1.5 | 0 |
| NNVC-8.0(LOP2) | **-6.9%** | -13.2% | -12.1% | 1.2 | 73 | **25.0** | 17.1 | 7.9 | 0 | **1.6** | 0.05 | 1.5 | 0 |
| NNVC-7.1(LOP2) | **-6.9%** | -13.2% | -12.1% | 1.3 | 86 | **25.0** | 17.1 | 7.9 | 0 | **1.6** | 0.05 | 1.5 | 0 |
| NNVC-9.1(LOP2CA) | **-8.2%** | -16.5% | -15.5% | 2.5 | 69 | **25.5** | 17.6 | 7.9 | 0 | **1.6** | 0.05 | 1.5 | 0 |
| NN-Intra & HOP filter (2 tools) | | | | | | | | | | | | | |
| NNVC-10.0 (HOP5) | **-14.2%** | -19.5% | -19.9% | 2.6 | 1135 | **471** | 466 | 4.8 | 0 | **2.7** | 1.4 | 1.3 | 0 |
| NNVC-9.1(HOP4) | **-14.1%** | -19.2% | -19.6% | 2.9 | 1447 | **484** | 476 | 7.9 | 0 | **3.0** | 1.44 | 1.5 | 0 |
| NNVC-8.0(HOP3) | **-13.7%** | -13.9% | -14.5% | 2.5 | 1092 | **474** | 466 | 7.9 | 0 | **2.9** | 1.40 | 1.5 | 0 |
| NNVC-7.0(HOP2) | **-13.6%** | -12.5% | -14.2% | 4.1 | 2071 | **485** | 477 | 7.9 | 0 | **3.0** | 1.50 | 1.5 | 0 |
| NN-Intra & VLOP filter (2 tools) | | | | | | | | | | | | | |
| NNVC-11.0 (VLOP3) | **-5.8%** | -6.6% | -5.7% | 1.2 | 7 | **9.9** | 5.10 | 4.8 | 0 | **1.3** | 0.07 | 1.3 | 0 |
| NNVC-10.0 (VLOP2) | **-5.6%** | -7.6% | -6.4% | 1.1 | 15 | **10** | 5.16 | 4.8 | 0 | **1.3** | 0.06 | 1.3 | 0 |
| NNVC-9.1(VLOP) | **-5.3%** | -5.4% | -5.2% | 1.2 | 40 | **13** | 5.12 | 7.9 | 0 | **1.5** | 0.02 | 1.5 | 0 |
| NN-Intra & LOP filter content adaptive (2 tools) | | | | | | | | | | | | | |
| NNVC-10.0 caLOP4 | **-8.5%** | -18.0% | -17.1% | 2.3 | 36 | **21.8** | 16.9 | 4.8 | 0 | **1.5** | 0.21 | 1.3 | 0 |
| NN-Intra & LOP filter & adaptive resolution coding (3 tools) | | | | | | | | | | | | | |
| NNVC-11.0 NNSR | **-8.5%** | -12.2% | -10.9% |  |  | **26.3** | 16.8 | 4.8 | 4.7 | **1.4** | 0.05 | 1.3 | 0.05 |
| NNVC-8.0 RPR | **-7.5%** | -10.9% | -9.7% |  |  | **25.0** | 17.1 | 7.9 | 0 | **1.6** | 0.05 | 1.5 | 0 |
| NNVC-8.0 NNSR | **-7.8%** | -11.8% | -10.5% |  |  | **45.3** | 17.1 | 7.9 | 20.3 | **1.8** | 0.21 | 1.5 | 0.1 |

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

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

Following proposals from 36th, 37th and 38th meetings several companies propose framework for E2E AI coded reference picture insertion. Promising gain reported for this approach (4% and 1% in all intra and random-access configuration correspondingly). First attempt to integrate interface of E2E AI coded reference picture insertion for further experiments with different neural networks was done in coordination with AhG14. Partial integration in one frame test provides results similar those reported previously. More details of SW work can be given in AhG14 report. Some aspects of integration (such as harmonization with LMCS, for example) need to be discusses and agreed during JVET meeting.

1. **Input contributions**

There are 31 input contributions related to the AHG mandates. The list of input contributions is provided below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Reporting (**2**) | | | | | | |
| [JVET-AM0023](https://jvet-experts.org/doc_end_user/current_document.php?id=15913) | 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) | | | |  |
| [JVET-AM0043](https://jvet-experts.org/doc_end_user/current_document.php?id=15690) | [AHG11] [AHG14] Teleconference on NNVC | | [E. Alshina](mailto:elena.alshina@huawei.com), [F. Galpin](mailto:franck.galpin@interdigital.com) | | | |
| Combination of End-to-end AI coding and conventional codec (**3**) | | | | | | |
| [JVET-AM0050](https://jvet-experts.org/doc_end_user/current_document.php?id=15697) | AHG 14: Work on NN-coded Base Layer in VTM / NNVC | | [F. Brand](mailto:fabian.brand@huawei.com), [T. Solovyev](mailto:solovyev.timofey@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com), F. Urban, F. Galpin (Interdigital) | | | |
| [JVET-AM0057](https://jvet-experts.org/doc_end_user/current_document.php?id=15704) | AHG11: A Hybrid Framework Integrating End-to-End Learned Image Codec with Conventional Codec | | [N. Zou](mailto:nannan.zou@nokia.com), [A. Hallapuro](mailto:antti.hallapuro@nokia.com), [F. Cricri](mailto:francesco.cricri@nokia.com), [H. Zhang](mailto:honglei.1.zhang@nokia.com), [A. B. Koyuncu](mailto:burakhan.koyuncu@nokia.com), [J. Ahonen](mailto:jukka.1.ahonen@nokia.com), [M. M. Hannuksela (Nokia)](mailto:miska.hannuksela@nokia.com) | | | |
| [JVET-AM0214](https://jvet-experts.org/doc_end_user/current_document.php?id=15861) | AHG 11: Motion Vector Restriction in Multi-Layer Hybrid NN-based and Conventional Coding | | F. Brand, T. Solovyev, E. Alshina (Huawei) | | | |
| NNVC complexity assessment (**1**) | | | | | | |
| [JVET-AM0073](https://jvet-experts.org/doc_end_user/current_document.php?id=15720) | [AHG11] Comparison of execution time of NN on different devices | | [A. Karabutov](mailto:karabutov.alexander@huawei.com), [E. Alshina](mailto:elena.alshina@huawei.com), [F. Brand (Huawei)](mailto:fabian.brand@huawei.com) | | | |
| Interaction with ECM (**1**) | | | | | | |
| [JVET-AL0043](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0043-v1.zip) | [AHG11] [AHG14] Teleconference on NNVC | | E. Alshina, F. Galpin | | | |
| EE1 contributions (**7**) | | | | | | |
| [JVET-AM0053](https://jvet-experts.org/doc_end_user/current_document.php?id=15700) | EE1-2.2: Conditional loop-filter | M. Santamaria, F. Cricri, N. Le (Nokia) | | | |
| [JVET-AM0114](https://jvet-experts.org/doc_end_user/current_document.php?id=15761) | EE1-3.1: RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding [Q. Qin, C. Jung (Xidian Univ.)] | A. Suneja, [J. N. Shingala](mailto:jay.shingala@ittiam.com), [A. Shyam](mailto:ajayshyam@ittiam.com), S. P. Badya (Ittiam), [T. Shao](mailto:tong.shao@dolby.com), [P. Yin](mailto:pyin@dolby.com), S. McCarthy (Dolby) | | | |
| [JVET-AM0120](https://jvet-experts.org/doc_end_user/current_document.php?id=15767) | EE1-1.2: Over-Parameterized LOP In-Loop Filter | J. Han, C. Jung, Q. Qin (Xidian Univ.) | | | |
| [JVET-AM0122](https://jvet-experts.org/doc_end_user/current_document.php?id=15769) | EE1-1.3: Backbone Block Enhancement of LOP In-Loop Filter with Over-Parameterized Training and Variable Channels | J. Han, C. Jung, Q. Qin (Xidian Univ.) | | | |
| [JVET-AM0123](https://jvet-experts.org/doc_end_user/current_document.php?id=15770) | EE1-1.1: Sample-based adaptive blending weight selection for NN-based in-loop filter | H. Kwon, H. Ko (Hanyang Univ.) | | | |
| [JVET-AM0135](https://jvet-experts.org/doc_end_user/current_document.php?id=15782) | EE1-2.1: Improved VLOP Attention with SIMD acceleration | Y. Li, M. Coban, M. Karczewicz, L. Kerofsky | | | |
| [JVET-AM0175](https://jvet-experts.org/doc_end_user/current_document.php?id=15822) | EE1-3.2: Deep Reference Frame Generation for Inter Prediction Enhancement | X. Chen, N. Fu, W. Zhang, J. Zhang, D. Ding, W. Ma, Z. Chen (Wuhan Univ.) | | | |
| New NNVC tools in AhG11 or EE1 related contributions (**10**) | | | | | | |
| [JVET-AM0115](https://jvet-experts.org/doc_end_user/current_document.php?id=15762) | EE1-related: URFS Performance Comparison on NNVC-4.0 and NNVC-9.0 Training Sets | | | Q. Qin, C. Jung (Xidian Univ.) | | |
| [JVET-AM0116](https://jvet-experts.org/doc_end_user/current_document.php?id=15763) | EE1-related: Comparative Analysis of URFS in AJ0099, AK0077, and AL0105 | | | Q. Qin, C. Jung (Xidian Univ.) | | |
| [JVET-AM0131](https://jvet-experts.org/doc_end_user/current_document.php?id=15778) | AHG11: LOP with Overlapped Feature Integration | | | J. Chi, A. Li, Y. Du, Ce Zhu, L. Luo, H.Guo (UESTC), Y. Huo, Y. Liu (Transsion) | | |
| [JVET-AM0143](https://jvet-experts.org/doc_end_user/current_document.php?id=15790) | AHG11: Feature Fusion-Based Post-Filter for Efficient Video Enhancement | | | T. Das, K. Choi (KHU), B.-S. Kim, I. Cho, S. Hahm (KBS) | | |
| [JVET-AM0144](https://jvet-experts.org/doc_end_user/current_document.php?id=15791) | AHG11: GAN-Based Post-Filter for Quality Enhancement of VVC Compressed Video | | | T. Das, K. Choi (KHU), B.-S. Kim, I. Cho, S. Hahm (KBS) | | |
| [JVET-AM0177](https://jvet-experts.org/doc_end_user/current_document.php?id=15824) | AHG11: Deep Reference Frame Generation for Inter Prediction Enhancement with Structural Re-parameterization | | | W. Zhang, C. Gui, N. Fu, X. Chen, W. Ma, Z. Chen (Wuhan Univ.) | | |
| [JVET-AM0185](https://jvet-experts.org/doc_end_user/current_document.php?id=15832) | AhG11: Decomposed Content-Adaptive VLOP | | | Z. Xu, J. Konieczny, A. Filippov, C. Hollmann, V. Rufitskiy, T. Dong, H. Qin (TCL) | | |
| [JVET-AM0186](https://jvet-experts.org/doc_end_user/current_document.php?id=15833) | AhG11: Content-Adaptive Neural Network-based Super Resolution | | | Z. Xu, J. Konieczny, A. Filippov (TCL) | | |
| [JVET-AM0199](https://jvet-experts.org/doc_end_user/current_document.php?id=15846) | AHG11: NNSR with consistent backbone block | | | H. Cho, S. Bahk, H. Y. Kim (KHU), D. Kim, S.-C. Lim (ETRI) | | |
| [JVET-AM0224](https://jvet-experts.org/doc_end_user/current_document.php?id=15871) | AHG11: Multi-scale LOP backbone blocks with cross-scale interactions | | | L. Murn, M. Santamaria, F. Cricri (Nokia) | | |
| Cross-checks (**7** some not yet uploaded at the time report was prepared) | | | | | | |
| [JVET-AM0267](https://jvet-experts.org/doc_end_user/current_document.php?id=15934) | Crosscheck of JVET-AM0175 (EE1-3.2: Deep Reference Frame Generation for Inter Prediction Enhancement) | | | | [N. Bhaskar (Huawei)](mailto:nisha.bhaskar@h-partners.com) | |
| [JVET-AM0272](https://jvet-experts.org/doc_end_user/current_document.php?id=15939) | Crosscheck of JVET-AM0135 (EE1-2.1: Improved VLOP Attention with SIMD acceleration) | | | | [M. Santamaria (Nokia)](mailto:maria.santamaria_gomez@nokia.com) | |
| [JVET-AM0275](https://jvet-experts.org/doc_end_user/current_document.php?id=15942) | Crosscheck of JVET-AM0257 (EE1-4.1: Cross-component enhanced NNSR) | | | | [J. Han](mailto:jiang16h@163.com), [C. Jung](mailto:zhengzk@xidian.edu.cn), [Q. Qin (Xidian Univ.)](mailto:kippqin@163.com) | |
| [JVET-AM0282](https://jvet-experts.org/doc_end_user/current_document.php?id=15949) | Crosscheck of JVET-AM0114 (EE1-3.1: RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding) | | | | N. Bhaskar (Huawei) | |
| [JVET-AM0283](https://jvet-experts.org/doc_end_user/current_document.php?id=15950) | crosscheck of JVET-AM0175 (EE1-3.2: Deep Reference Frame Generation for Inter Prediction Enhancement) | | | | [Z. Xie (OPPO)](mailto:xiezhihuang@oppo.com) | |
| [JVET-AM0293](https://jvet-experts.org/doc_end_user/current_document.php?id=15961) | Crosscheck of JVET-AM0120 (EE1-1.2: Over-Parameterized LOP In-Loop Filter) | | | | [T. Yang](mailto:y_tian@hust.edu.cn), [W.-X. He](mailto:wxhe@hust.edu.cn), [Y.-Q. Zhu](mailto:yiqingzhu@hust.edu.cn), [J.-D. Ye](mailto:ye_jd@hust.edu.cn), [X.-T. Xie](mailto:xiatian_xie@hust.edu.cn), [J.-S. Gong](mailto:jsgong@hust.edu.cn), [Q. Liu (HUST)](mailto:q.liu@hust.edu.cn), [Z.-Y. Lv (vivo)](mailto:zhuoyi.lv@vivo.com) | |
| [JVET-AM0294](https://jvet-experts.org/doc_end_user/current_document.php?id=15962) | Crosscheck of JVET-AM0122 (EE1-1.3: Backbone Block Enhancement of LOP In-Loop Filter with Over-Parameterized Training and Variable Channels | | | | [T. Yang](mailto:y_tian@hust.edu.cn), [W.-X. He](mailto:wxhe@hust.edu.cn), [Y.-Q. Zhu](mailto:yiqingzhu@hust.edu.cn), [J.-D. Ye](mailto:ye_jd@hust.edu.cn), [X.-T. Xie](mailto:xiatian_xie@hust.edu.cn), [J.-S. Gong](mailto:jsgong@hust.edu.cn), [Q. Liu (HUST)](mailto:q.liu@hust.edu.cn), [Z.-Y. Lv (vivo)](mailto:zhuoyi.lv@vivo.com) | |

1. **Recommendations**

The AHG recommends:

* Review all input contributions.
* Continue investigating neural network-based video coding tools, including coding performance and complexity.
* Continue collecting training materials for neural network-based video coding tool development and investigate training stability.
* Discuss and agree on details of end-to-end AI coded refPicture integration (potential BoG)
* Recommend promising technologies for next EE1 round

[JVET-AM0012](https://jvet-experts.org/doc_end_user/current_document.php?id=15906) JVET AHG report: Enhanced compression beyond VVC capability (AHG12) [M. Karczewicz, Y. Ye, L. Zhang (co-chairs), B. Bross, R. Chernyak, X. Li, K. Naser, Y. Yu (vice-chairs)]

The primary activity of the AHG was the “Exploration experiment on enhanced compression beyond VVC capability” (JVET-AL2024). The combined improvements of the ECM-17.1 over VTM-11.0ecm17.0 anchorfor AI, RA and LB configurations are:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | All Intra Main10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -14.76% | -16.60% | -27.65% | 1163.7% | 533.8% |
| Class A2 | -21.25% | -24.93% | -29.15% | 1110.6% | 580.9% |
| Class B | -14.89% | -23.18% | -21.23% | 1115.9% | 639.0% |
| Class C | -15.02% | -11.99% | -13.11% | 1029.4% | 590.8% |
| Class E | -19.41% | -23.10% | -21.32% | 1038.6% | 648.7% |
| Overall | -16.71% | -19.87% | -21.83% | 1089.8% | 601.3% |
| Class D | -12.84% | -8.91% | -9.58% | 993.2% | 640.7% |
| Class F | -30.41% | -34.26% | -34.39% | 681.6% | 620.2% |
| Class TGM | -43.37% | -49.07% | -48.36% | 480.9% | 529.3% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Random Access Main 10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -27.43% | -24.79% | -37.03% | 1184.4% | 1124.5% |
| Class A2 | -30.65% | -34.78% | -40.19% | 1128.9% | 1338.4% |
| Class B | -25.30% | -33.71% | -30.74% | 1014.4% | 1196.7% |
| Class C | -27.06% | -23.64% | -24.47% | 1088.8% | 1336.4% |
| Class E |  |  |  |  |  |
| Overall | -27.27% | -29.46% | -32.22% | 1089.3% | 1244.8% |
| Class D | -27.79% | -23.89% | -24.71% | 1024.9% | 1459.0% |
| Class F | -33.30% | -36.14% | -36.98% | 880.0% | 853.5% |
| Class TGM | -42.78% | -48.57% | -48.43% | 686.7% | 626.8% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Low Delay B Main 10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -22.53% | -40.00% | -35.36% | 1034.3% | 1051.6% |
| Class C | -24.92% | -27.76% | -30.13% | 983.6% | 1102.7% |
| Class E | -22.55% | -30.05% | -28.45% | 978.3% | 694.5% |
| Overall | -23.33% | -33.43% | -31.89% | 1003.1% | 963.1% |
| Class D | -26.61% | -28.84% | -30.92% | 999.8% | 1258.8% |
| Class F | -30.88% | -41.04% | -41.18% | 861.6% | 771.2% |
| Class TGM | -41.07% | -51.05% | -50.93% | 679.1% | 584.7% |

The rate reduction for natural sequences over VTM in RA configuration for {Y, U, V} increased from ECM-16.1’s {-27.06%, -28.00%, -30.80%} to ECM-17.0’s {-27.27%, -29.46%, -32.22%}. For SCC sequences (class TGM) the rate reduction for RA configuration increased from ECM-16.1’s { -42.58%, -47.84%, -47.66%} to ECM-17.0’s { -42.78%, -48.57%, -48.43%}.

1. **Contributions**

In addition to 25 EE2 contributions, 41 (comparing to 30 last meeting) EE2-related and AHG12-related contributions were received. The EE2-related and AHG12-related contributions can be subdivided as follows:

***Intra (9)***

JVET-AM0104, "EE2-related: On reference sample filtering for TIMD", V. Rufitskiy, A. Filippov, T. Dong (TCL)

JVET-AM0105, "EE2-related: Candidate replacement in MPM list", Hao Tian, Yanbo Gao, Shuai Li, Jianjun Lei, Bin Li, Fang Xing, Pengfei Han

JVET-AM0140, "Non-EE2: Modifications of the unwrapping and interpolation filtering processes for angular modes", V. Rufitskiy, A. Filippov, T. Dong (TCL)

JVET-AM0141, "Non-EE2: Adaptive Planar Weight for DIMD", J.-H. Lee, K. Choi (KHU), C. W. Ryu (Kaon Group)

JVET-AM0145, "AHG12: TMRL blend", S. Blasi, G. Kulupana, D. Bugdayci Sansli, J. Lainema (Nokia)

JVET-AM0149, "Non-EE2: On filtering for angular modes", T. Dong, V. Rufitskiy, A. Filippov (TCL)

JVET-AM0150, "Non-EE2: Extension of reconstructed area types for EIP", W. Niu, S. Xie, M. Jia, Y. Bai, C. Huang (ZTE)

JVET-AM0167, "Non-EE2: On long-tap interpolation filtering for angular modes", T. Dong, V. Rufitskiy, A. Filippov (TCL)

JVET-AM0301, "AHG12: IntraTMP with DMVR", K. Naser, F. Le Léannec, P. Bordes, P. Le Guyadec (InterDigital)

***Inter (9)***

JVET-AM0065, "Non-EE2: Joint reordering of GPM with intra prediction", Z. Sun, Y. Yu, L. Zhang, H. Yu, D. Wang (OPPO)

JVET-AM0066, "Non-EE2: Joint reordering of GPM with affine prediction", L. Zhang, Y. Yu, Z. Sun, H. Yu, D. Wang (OPPO)

JVET-AM0072, "Non-EE2: Diversity reordering for ARMC pairwise candidates", C. Wang, Y. Yu, L. Zhang, Z. Xie, H. Yu, D. Wang (OPPO)

JVET-AM0107, "AHG12: Generated Merge Candidates", D. Bugdayci Sansli, J. Lainema (Nokia)

JVET-AM0132, "AHG12: Amvp temporal candidates derived from temporal collocated picture", Z. Li, X. Zeng, M. Jia, C. Huang (ZTE)

JVET-AM0139, "EE2-related: On Chained Motion Vector Prediction", X. Zeng, M. Jia, Z. Li, C. Huang (ZTE)

JVET-AM0129, "Non-EE2: binarization improvement of GPM", X. Wang, J. Chen, Ce Zhu, L. Luo, H. Guo (UESTC), Y. Huo, Y. Liu (Transsion)

JVET-AM0217, "EE2-related: Simplification of TMVP Refinement", T.M. Bae, S.Deshpande (Sharp Corporation)

JVET-AM0247, "Non-EE2: Extension of AMVP MVP Index Range", T. M. Bae, S. Deshpende (Sharp Corporation)

***Cross Component Prediction (5)***

JVET-AM0067, "Non-EE2: Enhanced CCP merge mode with BVG-CCCM model", H. Zhang, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AM0076, "Non-EE2: Enhanced DD-CCP and CCP-Merge Fusion", P. Bordes, T. Dumas, F. Galpin, Y. Chen (InterDigital)

JVET-AM0148, "Non-EE2: Multi-template selection for inter CCP merge mode with zero luma CBF", J. Huo, J. Liu, Y. Ma, F. Yang (Xidian Univ.)

JVET-AM0169, "Non-EE2: Reducing Candidate Modes in DDCCP", Shuai Wan, Yujie Yin, Zhiwei Zhu (NWPU), Shaowei Xie, Xing Zeng, Cheng Huang (ZTE)

JVET-AM0196, "Non-EE2: Adaptive subsampling filter selection for CCLM/CCCM", Y. Kidani, H. Kato, K. Kawamura (KDDI)

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

JVET-AM0064, "EE2-related: Updated multi-models' usage strategy for ALF-CCCM", N. Song, L. Xu, Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AM0070, "Non-EE2: On regularization of ALF-CCCM", Z. Xie, N. Song, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AM0071, "AHG12: Extensions on ALF-CCCM", L. Xu, N. Song, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AM0110, "AHG12: Weighted averaging for bi-directional samples of TALF", K. Takada, S. Deshpande (Sharp)

JVET-AM0159, "Non-EE2: On ALF coefficient coding", I. Jumakulyyev, D. Bugdayci Sansli, J. Lainema (Nokia)

JVET-AM0171, "AHG12: On ALF-CCCM Model", F. Wang, N. Song, Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AM0176, "EE2-related: ECM NNL evaluation using AhG11 trained models", T. Poirier, F. Galpin (Interdigital)

JVET-AM0183, "Non-EE2: Look-up table based loop filtering for ECM", Y. Du, J. Chen, A. Li, J. Liu, C. Zhu, L. Luo, H. Guo (UESTC), Y. Huo, Y. Liu (Transsion)

JVET-AM0285, "AHG12: Reuse of TALF control information", Y. Bai, M. Jia, W. Niu, S. Xie, C. Huang(ZTE)

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

JVET-AM0055, "EE2-3.6 related: On Context Budget Control for Transform Skip Residual Coding", T. N. Canh, P. Yin, S. McCarthy (Dolby)

JVET-AM0068, "AHG12: On Shifting Quantization Center", Y. Yu, H. Yu, J. Gan, L. Xu, H. Huang, F. Wang, Z. Xie, D. Wang (OPPO)

JVET-AM0069, "Non-EE2: On Sign Prediction", Y. Zhang, L. Xu, Y. Yu, J. Gan, H. Yu, D. Wang (OPPO)

JVET-AM0111, "AHG12: On Residual Sign Prediction", C. Hollmann, A. Filippov (TCL)

JVET-AM0127, "EE2-3.6 related: Advanced Budget Control for TSRC", R. Xu, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang, W. Song (Hisense)

JVET-AM0311, "AHG12: On Shifting Quantization Center for simple quantization (DQ and RDOQ disabled) (JVET-AM0068 related)", M. Le Pendu, M. Balcilar, F. Le Léannec, K. Naser (InterDigital)

***Entropy Coding (1)***

JVET-AM0220, "AHG12: Fix on cabac\_init\_flag and Temporal Cabac Inheritance", B. Wang, R. Chernyak, Z. Xiang, S. Liu (Tencent)

***Partitioning (1)***

JVET-AM0130, "Non-EE2: On partitioning optimization", G. Wang, C. Zhou, Z. Lv (vivo)

***Other (1)***

JVET-AM0216, "AHG12: Fixes for 12-bit internal bit depth in ECM", R. Yu, V. Seregin, M. Karczewicz (Qualcomm)

1. Recommendations

The AHG recommends:

* To review all the related contributions.

[JVET-AM0013](https://jvet-experts.org/doc_end_user/current_document.php?id=15907) 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-AM0013 JVET AHG report: Film grain technologies (AHG13)
* Five other contributions were uploaded at the time of the report drafting:
  + JVET-AM0085 AHG9/AHG13: On Film Grain Regions Characteristics SEI message
  + JVET-AM0124 AHG9/AHG13: On typo fix and interface software contribution to the FGRC SEI message
  + JVET-AM0168 AHG9/AHG13: Implementation in VTM TuC of the film grain regions characteristics SEI message
  + JVET-AM0230 AHG9/AHG13: Reference picture resolution for the FGR SEI message
  + [JVET-AM0288](https://jvet-experts.org/doc_end_user/current_document.php?id=15955) Neural network-based film grain analysis

***Contributions***

There were five contributions registered other than the AHG report. Four were uploaded as of 06/23/25.

**JVET-AM0085 AHG9/AHG13: On Film Grain Regions Characteristics SEI message**

This contribution relates to the film grain regions characteristics (FGRC) SEI message, which is included in the Technologies under consideration for future extensions of VSEI. It is proposed to signal width and height of the picture that the parameters in the FGRC SEI message apply to.

Contributions JVET-AL0086, JVET-AL0204, and JVET-AL0339 proposed adding signalling of width and height in an extension of the Film Grain Characteristics (FGC) SEI message. JVET-AL0339 was adopted in VSEI V4.

It is proposed to signal width and height of the picture that the parameters in the film grain regions characteristics (FGRC) SEI message apply to. Currently the width and height information is obtained via the variables PicWidthInLumaSamples and PicHeightInLumaSamples which are passed to the FGRC SEI. It is asserted that under certain situations, such as when reference picture resampling is used together with FGRC SEI, there may not be enough clarity regarding the width and the height that the parameters in FGRC apply to.

**JVET-AM0124 AHG9/AHG13: On typo fix and interface software contribution to the FGRC SEI message**

The document of “Technologies under consideration for future extensions of VSEI (version 7)” (JVET-AK2032) has been finalized in March 2025. In the document, the Film Grain Regions Characteristics (FGRC) SEI message design has been stabilized and the texts, relating to the FGRC SEI message, have been fully integrated. During our FGRC SEI message software implementation process, one typo in the document of JVET-AK2032 was identified. In this meeting contribution, the authors propose to correct this identified typo, and would like to request a merge process on FGRC SEI message interface software integration.

**JVET-AM0168 AHG9/AHG13: Implementation in VTM TuC of the film grain regions characteristics SEI message**

This contribution provides a status of the VTM software implementation of the Film Grain Regions Characteristics (FGRC) SEI message, defined in the VSEI TuC. It states that the single model version (one model per picture), aligned with the TuC specification JVET-AG2032, is available in a branch of the VTM TuC git repository. It also states that the interest of the FGRC SEI message, in single model version, has been demonstrated by showcases in JVET-AH0212. It is proposed to include the FGRC SEI message in the WD of the next VSEI specification version (v5), when this version is initiated.

**JVET-AM0230 AHG9/AHG13: Reference picture resolution for the FGR SEI message**

This contribution proposes to add a reference picture resolution to the FGR SEI message (included in the technologies under consideration for future extensions of VSEI), consistent with the decision to add this information to the FGC SEI message during the previous meeting.

The reasons to indicate the intended picture resolution for the interpretation of the FGC SEI message were explained and showcased in JVET-AL0288, based on a potential mismatch caused by reduced-resolution coding, and the solution adopted was to add this information as an extension to the FGC SEI message as proposed in JVET-AL0339.

The same reasons apply to the FGRC SEI message proposed in the TuC, without the need for an extension, though.

**JVET-AM0288 Neural network-based film grain analysis**

Not yet uploaded.

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.

JVET-AL2020 is planned to be delivered before the end of this meeting. Likely, no new version from the current meeting.

[JVET-AM0014](https://jvet-experts.org/doc_end_user/current_document.php?id=15908) JVET AHG report: NNVC software development (AHG14) [F. Galpin (chair), R. Chang, Yue Li, Yun Li, M. Santamaria, J. N. Shingala, Z. Xie (vice chairs)]

1. **Software development**

***Location***

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

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

NNVC-13.0 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:

|  |  |  |
| --- | --- | --- |
| **Contribution** | **MR** | **Description** |
| AL0084 | MR 303 | LOP6 |
| AL0169 | MR 304 | ALOP |
|  | MR 302 | Various cleaning and fixes |
| AL0265 | MR 306 | Sadl v13 |

In SADL v13, the following changes were integrated:

|  |  |  |
| --- | --- | --- |
| **Contribution** | **MR** | **description** |
|  | MR 152 | Optimization for multi-output models |
|  | MR 151 | Extend broadcasting for add layer |
| AL0100 | MR 150 | Tile feature |
| AL0100 | MR 149 | SIMD optimization for 2x2 deconvolution |

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> )

***Software overview***

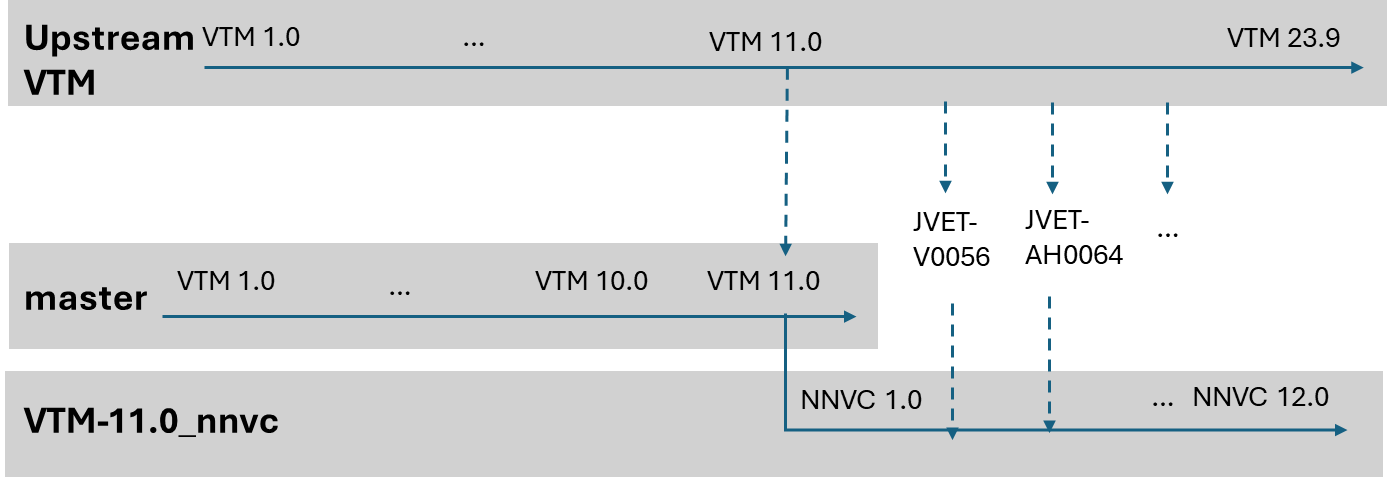
Between the 2 meetings, a joint effort was made to support new features such as hybrid end-to-end coding and also to rebase the NNVC software on the newest VTM 23.9.

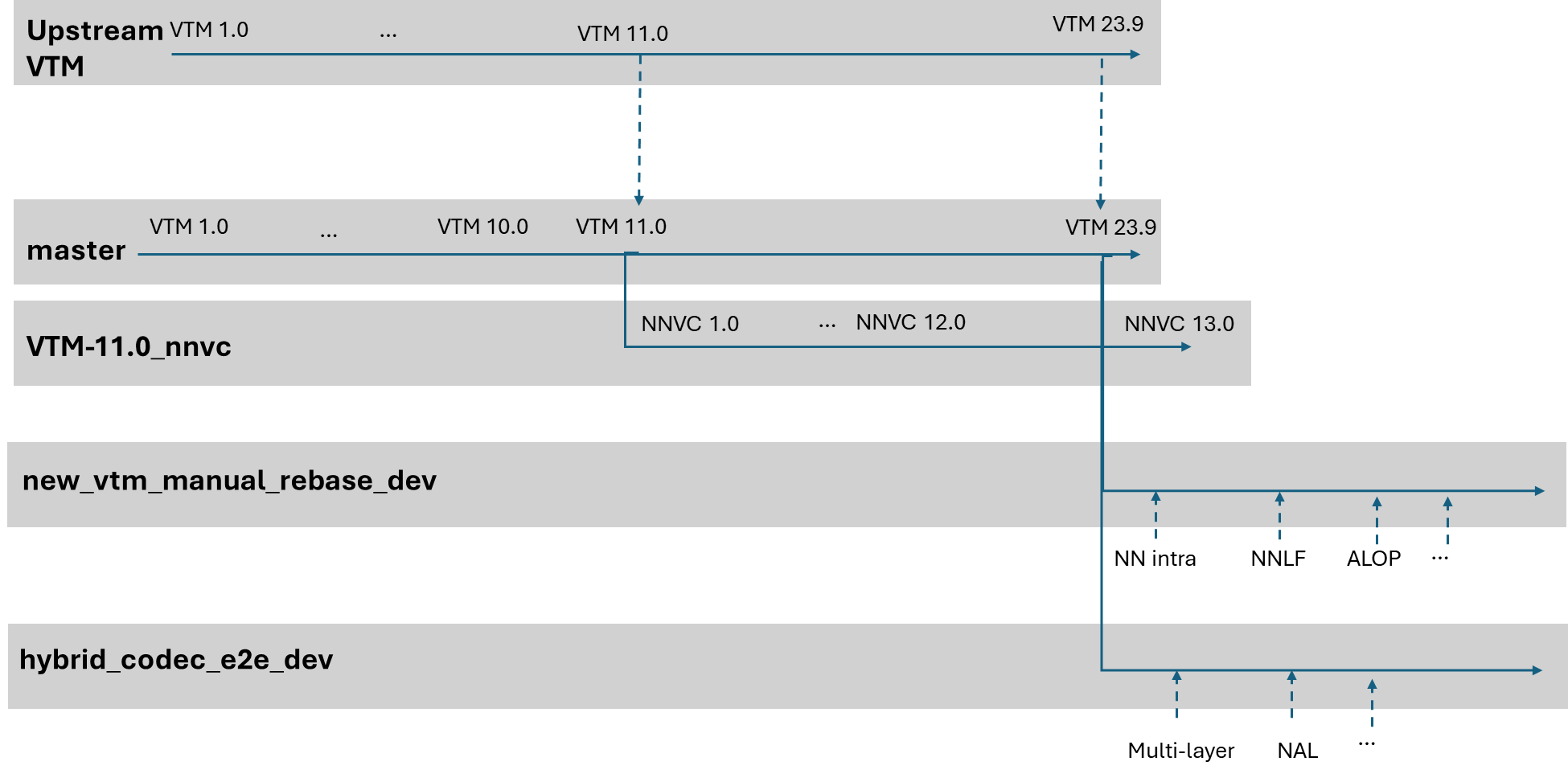
Because the divergence between NNVC basis and VTM was too large, it was decided to port NNVC tools back to the new VTM-23.9 manually.

For the development of the hybrid codec, it was decided to start directly from the VTM 23.9 version.

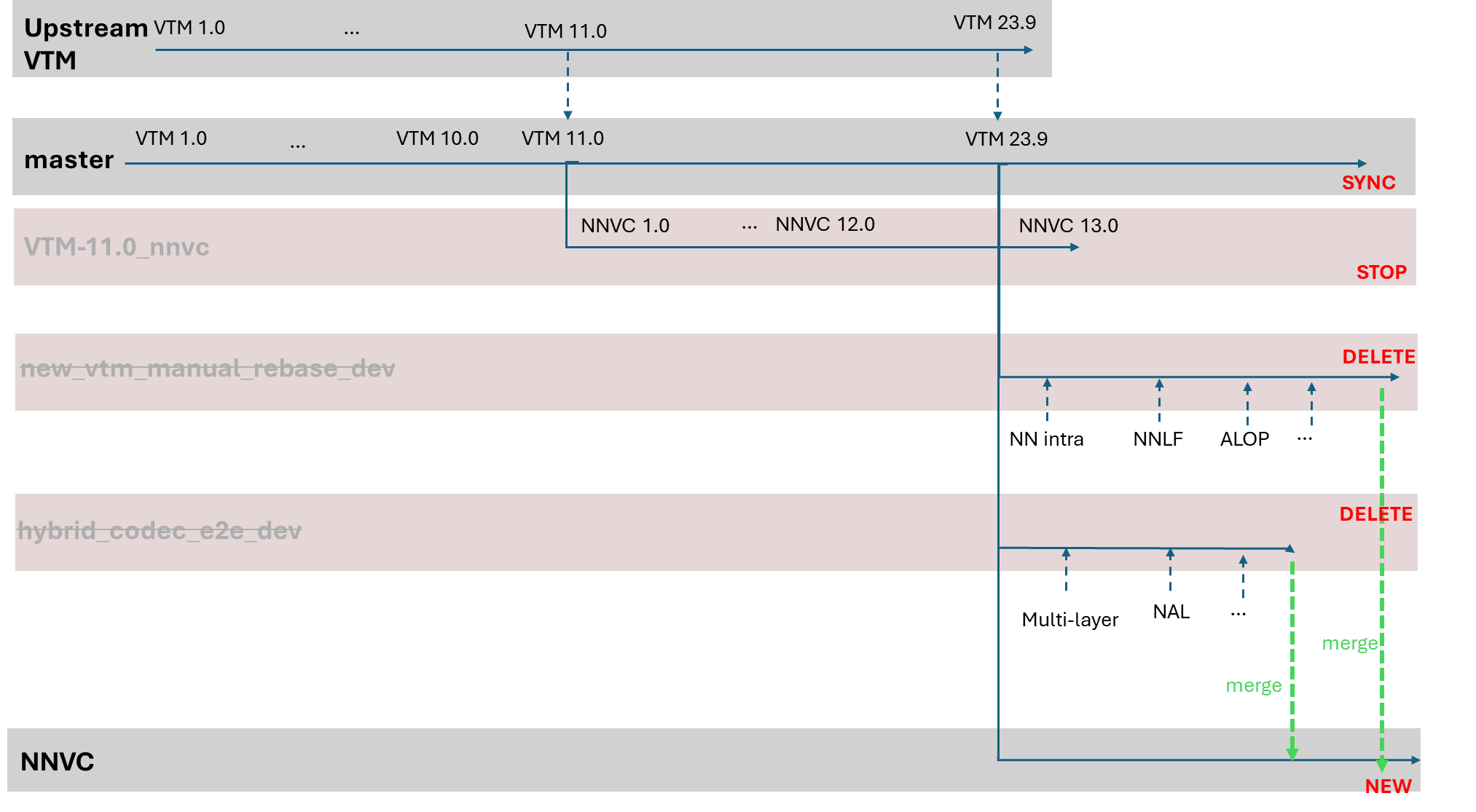
In order to keep the repository consistent with the upstream repository (VTM), the master branch is now synchronized again with the VTM repository.

**Status of the repository**

The following diagram shows the status of the repository just after the 38th meeting.

The following diagram shows the repository at the beginning of the 39th meeting:

The following diagram shows a possible output after the 39th meeting:



**Hybrid end-to-end**

|  |  |
| --- | --- |
| **MR** | **Description** |
| MR 305/MR312 | Base structure for hybrid codec support using multi-layer |
| MR 313/MR324 | Add new NAL unit and bitstream and bitstream embedding |
| MR 327 | Extend/fix usage to external base/slice, single/multi layer |

Basic framework capabilities is complete. One open issue remains for AI configuration. Additional features are expected on top of the current basis.

The new software has the following features:

* Encoding/decoding on the fly using an external codec (via a script execution).
* Possible embedding of the external codec bitstream in the bitstream using a new NAL unit type.
* Possible use of multilayer coding where the base layer used an external codec and the enhancement layer is fully compatible with the VTM multi-layer specifications.
* Possible use of an external YUV file containing the externally coded frames and optionally additional information for debugging purposes.

**Rebased NNVC software**

|  |  |
| --- | --- |
| **MR** | **Description** |
| MR 309 | Base structure for NNVC |
| MR 308/MR316 | NN intra |
| MR 311/MR315 | NNLF |
| MR 314 | Adaptive NNLF APS and syntax |
| MR 322 | Adaptive NNLF models |
| MR 317 | Macros and code cleaning |
| MR 323 | Adaptive NNLF inference |
| MR 319 | Deprecated code cleaning |
| MR 325/326 | | NNPF models and training scripts |

Work in progress:

* MR 321: adaptive NNLF training scripts: cleaning is in progress.
* NNSR: MR in progress
* Post-filter: MR in progress

***NNVC-13.0***

***Software version***

NNVC-13 was tagged April 28th, 2025

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**

See configurations section for naming convention.

***Comparison to VTM***

**NNVC-12.0 VTM vs NNVC-13.0 VTM**

VTM configuration of NNVC is not changed between version 10.0 and 13.0.

**NNVC-13.0 VTM vs NNVC-13.0 anchor**

The NNVC-13.0 anchor includes LOP.6 filter and Intra Prediction tools activated.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-13.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -9.31% | -13.81% | -15.30% | -9.40% | -15.83% | -17.44% | 113% | 2284% |
| Class A2 | -8.39% | -14.89% | -9.43% | -8.59% | -15.43% | -9.51% | 112% | 2232% |
| Class B | -7.91% | -16.02% | -14.70% | -8.17% | -18.23% | -17.49% | 114% | 3160% |
| Class C | -7.62% | -14.33% | -13.63% | -8.08% | -14.96% | -14.98% | 112% | 3380% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -8.21% | -14.90% | -13.48% | -8.48% | -16.32% | -15.21% | 113% | 2813% |
| Class D | -8.20% | -13.60% | -12.47% | -7.13% | -15.27% | -13.55% | 108% | 3395% |
| Class F | -4.42% | -8.60% | -7.17% | -5.43% | -11.44% | -11.10% | 119% | 1676% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-13.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | -6.04% | -10.67% | -10.51% | -6.51% | -10.24% | -12.46% | 107% | 2875% |
| Class C | -6.11% | -11.98% | -10.17% | -6.99% | -10.66% | -8.35% | 102% | 3207% |
| Class E | -6.83% | -4.61% | -7.76% | -8.31% | -4.25% | -6.06% | 110% | 3059% |
| **Overall** | -6.26% | -9.59% | -9.71% | -7.12% | -8.88% | -9.49% | 106% | 3028% |
| Class D | -6.96% | -9.83% | -7.37% | -6.88% | -7.24% | -2.92% | 100% | 3076% |
| Class F | -3.69% | -6.24% | -5.48% | -5.75% | -7.37% | -9.18% | 110% | 1771% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | |
|  | **BD-rate Over NNVC-13.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | -6.60% | -13.26% | -12.55% | -6.88% | -13.83% | -15.77% | 111% | 2870% |
| Class C | -6.50% | -14.70% | -12.48% | -7.11% | -14.27% | -12.97% | 105% | 3152% |
| Class E | -7.51% | -6.22% | -9.50% | -9.01% | -7.01% | -9.87% | 116% | 3340% |
| **Overall** | -6.80% | -11.98% | -11.76% | -7.49% | -12.27% | -13.36% | 110% | 3075% |
| Class D | -7.34% | -11.59% | -10.14% | -7.19% | -8.95% | -8.51% | 101% | 3220% |
| Class F | -3.91% | -7.84% | -6.35% | -5.90% | -10.64% | -12.73% | 114% | 1790% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-13.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -9.92% | -16.24% | -16.92% | -9.67% | -19.53% | -19.05% | 159% | 2693% |
| Class A2 | -8.35% | -15.90% | -11.98% | -8.84% | -16.46% | -11.95% | 160% | 2252% |
| Class B | -8.36% | -15.62% | -16.31% | -8.67% | -18.08% | -18.64% | 159% | 2307% |
| Class C | -8.32% | -14.13% | -14.08% | -8.97% | -17.41% | -17.64% | 150% | 1846% |
| Class E | -11.82% | -17.08% | -18.09% | -12.34% | -17.40% | -19.52% | 157% | 2644% |
| **Overall** | -9.19% | -15.68% | -15.49% | -9.54% | -17.79% | -17.52% | 157% | 2296% |
| Class D | -8.24% | -12.33% | -12.77% | -8.31% | -16.79% | -17.22% | 144% | 1737% |
| Class F | -5.83% | -10.33% | -9.48% | -6.30% | -13.32% | -13.48% | 133% | 1970% |

Note: Results from Interdigital, crosschecked by OPPO.

**NNVC-13.0 VTM mode vs NNVC-13.0 HOP.5**

The NNVC-13.0 did not change the HOP5 model. Performance is the same as NNVC-11.0 with a slight decoding time increase.

**NNVC-13.0 VTM mode vs NNVC-13.0 VLOP**

The NNVC-13.0 did not change the VLOP3 model. Performance is the same as NNVC-11.0 with a slight decoding time decrease.

**NNVC-13.0 VTM vs NNVC-13.0 NNSR**

The NNVC-13.0 did not change the NNSR model. Performance is the same as NNVC-11.

***Comparison to NNVC-13.0 anchor***

**NNVC-12 anchor vs NNVC-13.0 anchor**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-12.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | 0.15% | 0.11% | -0.30% | 0.30% | 0.60% | 0.39% | 95% | 93% |
| Class A2 | 0.04% | 0.64% | 0.43% | 0.17% | 0.78% | 0.55% | 98% | 96% |
| Class B | -0.08% | 0.25% | 0.00% | -0.01% | 0.42% | -0.01% | 100% | 97% |
| Class C | 0.01% | 0.55% | -0.03% | -0.05% | 0.91% | 0.38% | 102% | 100% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | 0.01% | 0.38% | 0.02% | 0.07% | 0.66% | 0.29% | 99% | 97% |
| Class D | -0.09% | 0.19% | 0.07% | 0.25% | 0.08% | 0.17% | 100% | 101% |
| Class F | 0.02% | 0.23% | 0.42% | 0.13% | 0.92% | 0.57% | 100% | 104% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-12.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | -0.04% | 1.08% | 0.25% | 0.07% | 1.39% | 0.64% | 97% | 101% |
| Class C | 0.01% | 0.90% | 0.13% | -0.01% | 1.63% | 0.33% | 99% | 96% |
| Class E | -0.22% | 3.62% | -2.16% | -0.36% | 2.65% | 0.04% | 99% | 103% |
| **Overall** | -0.07% | 1.66% | -0.39% | -0.06% | 1.78% | 0.39% | 98% | 99% |
| Class D | 0.01% | 0.34% | -0.70% | 0.30% | 1.12% | 1.83% | 97% | 94% |
| Class F | -0.12% | -0.40% | -0.31% | 0.04% | -0.77% | -0.69% | 97% | 104% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | |
|  | **BD-rate Over NNVC-12.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | -0.01% | 0.69% | 0.23% | -0.03% | 1.15% | 0.18% | 98% | 97% |
| Class C | 0.09% | 0.47% | 0.11% | -0.05% | 0.79% | 0.36% | 95% | 94% |
| Class E | 0.12% | 3.53% | -2.50% | 0.20% | 2.64% | -0.80% | 90% | 89% |
| **Overall** | 0.06% | 1.33% | -0.49% | 0.02% | 1.40% | 0.00% | 94% | 94% |
| Class D | 0.07% | 0.18% | -0.58% | 0.37% | 1.18% | 0.35% | 98% | 96% |
| Class F | 0.08% | -0.47% | 0.32% | 0.02% | -1.16% | -0.41% | 98% | 102% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-12.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | 0.13% | -0.45% | -1.20% | 0.25% | -0.74% | -0.39% | 101% | 99% |
| Class A2 | 0.05% | 0.04% | 0.36% | 0.14% | 0.10% | 0.25% | 98% | 97% |
| Class B | -0.02% | 0.40% | 0.09% | 0.03% | 0.47% | 0.13% | 97% | 96% |
| Class C | -0.02% | 0.07% | 0.14% | 0.01% | 0.17% | 0.27% | 98% | 96% |
| Class E | 0.03% | 0.56% | 0.37% | 0.14% | 0.46% | 0.54% | 99% | 97% |
| **Overall** | 0.02% | 0.15% | -0.02% | 0.10% | 0.14% | 0.16% | 99% | 97% |
| Class D | -0.04% | -0.42% | 0.02% | 0.04% | 0.13% | 0.50% | 101% | 101% |
| Class F | -0.06% | 0.40% | 0.62% | -0.10% | 0.61% | 0.47% | 97% | 94% |

Note: Results from InterDigital, crosschecked by OPPO.

***Performance of new NNVC development branch***

The new version benefits from VTM improvement between version 11.0 and 23.9.

**NNVC-13.0 VTM vs NNVC-new VTM**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-13.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -0.12% | 0.18% | 0.03% | -0.38% | 0.17% | -0.07% | 68% | 90% |
| Class A2 | 0.03% | 0.25% | 0.49% | -0.19% | 0.04% | 0.36% | 71% | 91% |
| Class B | -0.02% | 0.13% | 0.14% | -0.28% | 0.18% | 0.23% | 71% | 93% |
| Class C | -0.31% | 0.18% | 0.22% | -0.34% | 0.39% | 0.28% | 73% | 94% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -0.10% | 0.18% | 0.21% | -0.30% | 0.21% | 0.21% | 71% | 92% |
| Class D | -0.63% | -0.19% | 0.04% | -0.26% | 0.74% | 1.24% | 78% | 100% |
| Class F | 0.42% | 0.53% | 0.88% | 0.34% | 0.47% | 0.75% | 73% | 97% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-13.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | -0.02% | 0.31% | -0.26% | -0.38% | 0.32% | -0.64% | 71% | 89% |
| Class C | -0.09% | 0.02% | 0.36% | -0.25% | 0.04% | 1.67% | 74% | 92% |
| Class E | -0.30% | 0.37% | 0.73% | -0.72% | 0.77% | -0.03% | 73% | 91% |
| **Overall** | -0.11% | 0.23% | 0.19% | -0.42% | 0.34% | 0.28% | 72% | 90% |
| Class D | -0.13% | 0.20% | -0.44% | -0.30% | 0.23% | -0.41% | 79% | 94% |
| Class F | 0.40% | 0.55% | 0.45% | 0.10% | 0.96% | 0.28% | 72% | 91% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | |
|  | **BD-rate Over NNVC-13.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class C | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class E | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| **Overall** | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class D | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class F | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-13.0 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% | 82% | 95% |
| Class A2 | -0.60% | -0.50% | -0.50% | -0.58% | -0.42% | -0.40% | 84% | 95% |
| Class B | -0.69% | -0.41% | -0.35% | -0.85% | -0.19% | -0.20% | 86% | 98% |
| Class C | -0.43% | -0.63% | -0.53% | -0.83% | -0.26% | -0.26% | 88% | 97% |
| Class E | -0.36% | 0.12% | 0.38% | -0.60% | 0.27% | 0.30% | 84% | 96% |
| **Overall** | -0.55% | -0.43% | -0.17% | -0.72% | -0.20% | 0.00% | 85% | 96% |
| Class D | -0.40% | -0.47% | -0.17% | -0.98% | -0.41% | 0.35% | 90% | 105% |
| Class F | -0.12% | -0.69% | -1.05% | -0.08% | -0.39% | -0.25% | 84% | 96% |

Note: Results from InterDigital, crosschecked by xxx.

New VTM base is both faster and has slight bdrate improvement.

**VTM 23.9 vs NNVC-new VTM**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **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 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 101% | 171% |
| Class A2 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 101% | 173% |
| Class B | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 102% | 136% |
| Class C | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 102% | 126% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 101% | 146% |
| Class D | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 102% | 121% |
| Class F | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 102% | 146% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **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 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 105% | 120% |
| Class A2 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 105% | 120% |
| Class B | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 106% | 118% |
| Class C | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 105% | 116% |
| Class E | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 105% | 123% |
| **Overall** | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 105% | 119% |
| Class D | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 105% | 112% |
| Class F | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 103% | 117% |

Note: Results from InterDigital, crosschecked by xxx.

Note: very small bdrate gains change can be observed due to the added signaling at SPS level.

Note: some unnecessary processing is done by default in NNVC, increasing the decoding runtime. Further investigation is needed.

**NNVC-13.0 vs NNVC-new**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-13.0 VTM** | | | | | | | |
|  | 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% | 71% | 97% |
| Class A2 | 0.11% | 0.19% | 0.34% | -0.04% | 0.13% | 0.29% | 73% | 97% |
| Class B | 0.16% | 0.23% | 0.10% | 0.07% | 0.30% | 0.07% | 74% | 97% |
| Class C | -0.17% | 0.12% | 0.01% | 0.08% | 0.46% | -0.09% | 74% | 98% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | 0.07% | 0.18% | 0.12% | 0.08% | 0.24% | 0.03% | 73% | 97% |
| Class D | -0.50% | -0.41% | -0.20% | -0.15% | 0.53% | 0.59% | 78% | 98% |
| Class F | 0.44% | 0.52% | 0.58% | 0.31% | 0.76% | 0.29% | 75% | 98% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-13.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | 0.10% | 0.10% | 0.31% | -0.04% | -0.22% | -0.16% | 72% | 98% |
| Class C | -0.05% | 0.03% | 0.53% | -0.04% | 0.05% | 1.07% | 75% | 99% |
| Class E | -0.08% | -0.07% | -0.09% | -0.23% | 0.16% | -0.46% | 76% | 96% |
| **Overall** | 0.00% | 0.04% | 0.29% | -0.09% | -0.04% | 0.17% | 74% | 98% |
| Class D | -0.06% | -0.26% | 0.24% | 0.09% | 1.21% | -0.67% | 80% | 99% |
| Class F | 0.42% | 0.66% | 0.76% | 0.21% | 1.19% | 0.93% | 74% | 98% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main10** | | | | | | | |
|  | **BD-rate Over NNVC-13.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class C | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class E | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| **Overall** | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class D | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class F | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-13.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -0.03% | -0.29% | -0.09% | 0.00% | -0.28% | -0.10% | 84% | 98% |
| Class A2 | 0.01% | -0.01% | 0.13% | 0.01% | -0.11% | 0.09% | 86% | 98% |
| Class B | 0.02% | 0.06% | 0.16% | 0.03% | 0.13% | 0.08% | 86% | 99% |
| Class C | 0.11% | 0.13% | 0.22% | 0.19% | 0.24% | 0.33% | 89% | 99% |
| Class E | 0.18% | 0.23% | 0.04% | 0.24% | 0.12% | 0.00% | 85% | 99% |
| **Overall** | 0.06% | 0.03% | 0.11% | 0.09% | 0.05% | 0.09% | 86% | 98% |
| Class D | 0.20% | 0.25% | 0.29% | 0.30% | 0.25% | 0.90% | 89% | 101% |
| Class F | 0.17% | 0.23% | 0.12% | 0.22% | 0.42% | 0.52% | 85% | 99% |

Note: Results from InterDigital, crosschecked by xxx.

**NNVC-new vs NNVC-new-VLOP**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-new** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | 2.10% | 9.95% | 11.46% | 1.54% | 11.54% | 13.77% | 97% | 49% |
| Class A2 | 2.75% | 10.71% | 5.90% | 2.26% | 10.84% | 6.09% | 97% | 46% |
| Class B | 2.66% | 10.52% | 9.71% | 1.99% | 12.90% | 12.58% | 97% | 46% |
| Class C | 2.90% | 9.40% | 9.18% | 2.18% | 9.32% | 10.55% | 99% | 46% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | 2.63% | 10.14% | 9.16% | 2.01% | 11.26% | 10.98% | 98% | 47% |
| Class D | 3.68% | 9.83% | 8.62% | 1.85% | 10.78% | 8.70% | 101% | 43% |
| Class F | 1.61% | 5.78% | 4.33% | 1.88% | 6.97% | 7.93% | 95% | 46% |

Note: Results from InterDigital, crosschecked by xxx.

**NNVC-new vs NNVC-new-HOP**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-new** | | | | | | | |
|  | 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% | 326% | 4591% |
| Class A2 | -7.34% | -6.68% | -19.04% | -6.42% | -5.28% | -15.93% | 301% | 4191% |
| Class B | -5.66% | -10.48% | -3.42% | -4.14% | -6.02% | 0.88% | 308% | 4232% |
| Class C | -6.77% | -4.05% | -4.08% | -4.91% | 0.06% | 1.20% | 240% | 4084% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -6.60% | -5.97% | -7.57% | -5.80% | -3.92% | -4.14% | 290% | 4253% |
| Class D | -7.16% | -5.11% | -6.32% | -4.20% | 2.93% | 1.80% | 233% | 4102% |
| Class F | -4.89% | -3.06% | -3.57% | -4.03% | -1.03% | 0.65% | 424% | 4141% |

Note: Results from InterDigital, crosschecked by xxx.

**NNVC-new vs NNVC-new-NNPF**

xxx

**NNVC-new vs NNVC-new-NNSR**

xxx

1. **Contributions**

We have 4 contributions for AhG14 and 1 telco report.

|  |  |  |  |
| --- | --- | --- | --- |
| [JVET-AM0043](https://jvet-experts.org/doc_end_user/current_document.php?id=15690) | m72847 | [AHG11] [AHG14] Teleconference on NNVC | E. Alshina, F. Galpin |
| [JVET-AM0050](https://jvet-experts.org/doc_end_user/current_document.php?id=15697) | m72904 | AHG 14: Work on NN-coded Base Layer in VTM / NNVC | [F. Brand](mailto:fabian.brand@huawei.com), [T. Solovyev](mailto:solovyev.timofey@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AM0136](https://jvet-experts.org/doc_end_user/current_document.php?id=15783) | m73046 | AhG14: Improvement of SIMD implementation with expanded SIMD operators in SADL for LOP with Attention | Y. Li, M. Coban, M. Karczewicz (Qualcomm) |
| [JVET-AM0170](https://jvet-experts.org/doc_end_user/current_document.php?id=15817) | m73081 | AhG14: SADL update | [F. Galpin (InterDigital)](mailto:franck.galpin@interdigital.com) |
| [JVET-AM0178](https://jvet-experts.org/doc_end_user/current_document.php?id=15825) | m73089 | AHG14: The extension of SADL library | N. Fu, W. Ma, Z. Chen (Wuhan Univ.) |

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.3 | encoder\_xxx\_vtm.cfg + nn-based/vlop3.cfg |
| SR | Super-resolution | nn-based/nnsr.cfg + nn-based/nnsr\_classAx.cfg |
| PF | Adaptive post-filters | nn-based/nnpf/nnpf\_xxx.cfg |
| ALOP | Intra pred+adaptive LOP | encoder\_xxx\_vtm.cfg +nn-based/intra.cfg+xxx |

Deprecated options:

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

1. **Recommendations**

The AHG recommends to:

* Review all input contributions.
* Merge the different development branches into one branch and keep it in sync with upstream VTM
* Continue to port possible missing tools to the new branch.
* Continue to develop NNVC software.
* Improve the software documentation.
* Encourage people to report all (potential) bugs that they are finding using GitLab Issues functionality <https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/VVCSoftware_VTM/-/issues>
* Encourage people to submit merge requests fixing identified bugs.

It was commented that results could indicate that loop filters are not well optimized for the low delay configurations.

[JVET-AM0015](https://jvet-experts.org/doc_end_user/current_document.php?id=15909) 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 | -11.69% | -24.88% | -19.62% | 994.06% | 634.44% | #DIV/0! |
| Class G2 | -18.48% | -23.52% | -27.75% | 1016.13% | 711.41% | #DIV/0! |
| **Overall** | -14.71% | -24.28% | -23.23% | 1003.81% | 667.57% | #DIV/0! |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access Main 10** | | | | | |
|  | **Over VTM-11.0ecm17.0** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class G1 | -27.77% | -45.28% | -36.44% | 896.57% | 1842.95% | #DIV/0! |
| Class G2 | -25.11% | -36.10% | -36.87% | 978.26% | 1785.03% | #DIV/0! |
| **Overall** | -26.63% | -43.04% | -37.69% | 932.00% | 1821.02% | #DIV/0! |

\* ECM decoder crashed for BaoleiYard in RA. Results are averaged without BaoleiYard.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay B Main 10** | | | | | |
|  | **Over Anchor** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class G1 | -21.14% | -54.38% | -43.35% | 926.25% | 1701.45% | #DIV/0! |
| Class G2 | -18.51% | -50.07% | -48.55% | 1010.12% | 1594.77% | #DIV/0! |
| **Overall** | -20.15% | -52.77% | -45.30% | 956.85% | 1660.63% | #DIV/0! |
|  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | |
|  | **Over Anchor** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class G1 | -19.55% | -59.97% | -50.61% | 834.63% | 1424.30% | #DIV/0! |
| Class G2 | -16.33% | -56.91% | -56.11% | 929.08% | 1459.42% | #DIV/0! |
| **Overall** | -18.34% | -58.83% | -52.67% | 868.87% | 1437.37% | #DIV/0! |

Note: A slight deviation in results from cross-check was reported for Minecraft in LDP mainly in chroma component. This is suspected to be related to the different GCC versions used by the cross-check. Further investigation is being conducted.

**HDR**

HDR results are not yet available.

1. **Input contributions**

One contribution listed below is identified relating to the mandates of AHG15.

|  |  |  |
| --- | --- | --- |
| **Report** | | |
| [JVET-AM0142](https://jvet-experts.org/doc_end_user/current_document.php?id=15789) | AHG15: Analysis of Test Sequences for Game Content in the CfE Document | X. Liang, [K. Choi (KHU)](mailto:aikiho@khu.ac.kr), C. W. Ryu (Kaon Group) |

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

It was commented that the crash in Baolei Yard likely happens due to a memory overflow (4K sequence).

[JVET-AM0016](https://jvet-experts.org/doc_end_user/current_document.php?id=15910) 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>. During this AHG period, the updated parameter translators (as in JVET-AL0147) were integrated into the AHG16 software repository. 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, which are currently pending integration. At this meeting, one contribution on lightweight multi-resolution CFTE model and color calibration post-processing has been received.

Regarding coordination with AHG9 to develop the GFV and GFVE SEI messages, at this meeting, one contribution related to the chroma key feature in the GFV SEI message has been received.

1. **Related contributions**

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

* [JVET-AM0058](https://jvet-experts.org/doc_end_user/current_document.php?id=15705), AHG16: Lightweight Multi-resolution CFTE Model and Color Calibration Post-processing Algorithm for Generative Face Video Compression [Z. Zhang, S. Yin, 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 (GFV) and/or generative face video enhancement (GFVE) SEI messages:

* [JVET-AM0091](https://jvet-experts.org/doc_end_user/current_document.php?id=15738), AHG9: On GFV SEI chroma key [J. Boyce, M. M. Hannuksela (Nokia)]

1. **Recommendations**

The AHG recommends to:

* Review related contributions;
* Continue AHG16 to study GFVC-related topics.

[JVET-AM0017](https://jvet-experts.org/doc_end_user/current_document.php?id=15911) JVET AHG report: Testing of video coding technology beyond CTC (AHG17) [J.-R. Ohm, M. Wien (co-chairs), M. Abdoli, E. Alshina, V. Baroncini, J. Chen, R. Chernyak, Z. Deng, P. de Lagrange, L. Li, D. Rusanovskyy (vice chairs)]

1. **Activities**

The draft CfE document JVET-AL2026 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 2025-04-15, 205-05-06, 2025-06-04 and 2025-06-17, respectively. The reports of these meetings are available in JVET-AM0041.

1. ***Preparation of bitstreams according to the draft 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-AL2026. 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 5x**: ECM with a reduced runtime setting at about a factor of 5 of the runtime of the default VTM configuration.

The bitrates and indicative PSNR figures are provided in the accompanying Excel sheet.

1. **Related contributions**

|  |  |  |
| --- | --- | --- |
| [JVET-AM0017](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15911) | JVET AHG report: Testing of video coding technology beyond CTC (AHG17) | J.-R. Ohm, M. Wien (co-chairs), M. Abdoli, E. Alshina, V. Baroncini, J. Chen, R. Chernyak, Z. Deng, P. de Lagrange, L. Li, D. Rusanovskyy (vice chairs) |
| [JVET-AM0041](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15688) | AHG17: AhG meeting notes | [M. Wien](mailto:wien@lfb.rwth-aachen.de) |
| [JVET-AM0045](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15692) | AHG17: Generated VTM anchor bitstreams using LambdaScaleTowardsNextQP | [K. Andersson](mailto:kenneth.r.andersson@ericsson.com), [P. Wennersten (Ericsson)](mailto:per.wennersten@ericsson.com) |
| [JVET-AM0049](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15696) | [AHG17] Suggested results reporting template for constrained encoder complexity category | [E. Alshina](mailto:elena.alshina@huawei.com), [J. Sauer](mailto:johannes.sauer@huawei.com), [T. Solovyev](mailto:solovyev.timofey@huawei.com), [M. Lobo (Huawei)](mailto:merlin.andriana.lobo@huawei.com) |
| [JVET-AM0078](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15725) | AHG17: Suggestion to enable DMVR encoder control for VTM anchor | [K. Andersson (Ericsson)](mailto:kenneth.r.andersson@ericsson.com) |
| [JVET-AM0125](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15772) | AHG17: Analysis on encoding time and mode cost test for draft CfE sequences | [Y. Tokumo](mailto:tokumo.yasuaki@mail.sharp), [S. Hong](mailto:hong.sujun@mail.sharp), [T. Ikai (Sharp)](mailto:ikai.tomohiro@mail.sharp) |
| [JVET-AM0187](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15834) | On Intra Period of Random Access Test Case for HD and below Content | [X. Li (Google)](mailto:xlxiangli@google.com), [L. Zhang (ByteDance)](mailto:lizhang.idm@bytedance.com), [X. Wang (Kwai)](mailto:xianglinwang@kwai.com), [S. Liu (Tencent)](mailto:shanl@global.tencent.com), [A. Duenas (Warner Bros. Discovery)](mailto:alberto.duenas@wbd.com), [A. Norkin (Netflix)](mailto:anorkin@netflix.com), [W. Zhang (Disney)](mailto:Wenhao.Zhang2@disney.com), [Y. Ye (Alibaba)](mailto:yan.ye@alibaba-inc.com), [A. Segall (Amazon)](mailto:asegall@amazon.com) |
| [JVET-AM0194](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15841) | On Analyzing and Reporting Encoding and Decoding Complexity | [A. Stein](mailto:alan.stein@v-nova.com), [S. Ferrara (V-Nova)](mailto:simone.ferrara@v-nova.com) |
| [JVET-AM0200](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15847) | AHG17: Getting VTM to run five times faster | [F. Bossen](mailto:frank@bossentech.com) |
| [JVET-AM0225](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15872) | [AHG17] Encoder runtime for the constrained complexity configurations under the CfE draft test conditions | [T. Solovyev](mailto:solovyev.timofey@huawei.com), [J. Sauer](mailto:johannes.sauer@huawei.com), [M. A. Lobo](mailto:merlin.andriana.lobo@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AM0234](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15881) | [AHG17] Overview of the 3GPP codec testing in TR 26.955 | [R. Mekuria](mailto:rufael.mekuria@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AM0237](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15884) | On constrained encoding and decoding experiments | [L. Li](mailto:lingl.li@samsung.com), [M. W. Park](mailto:m.w.park@samsung.com), [M. Park](mailto:mss.park@samsung.com), [Y. Kim](mailto:yearly.kim@samsung.com), [M. Budagavi](mailto:m.budagavi@samsung.com), [K. P. Choi (Samsung)](mailto:kp5.choi@samsung.com) |
| [JVET-AM0238](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15885) | Suggestions on GOP Size Setting of Random Access Configuration for Live-streaming Applications | Y. Wu, [Y. He](mailto:yuwen.he@bytedance.com), K. Zhang, [L. Zhang (Bytedance)](mailto:lizhang.idm@bytedance.com), [X. Li (Google)](mailto:Xiang%20Li%20), [S. Liu (Tencent)](mailto:Shan%20Liu%20), [W. Zhang (Disney)](mailto:) |
| [JVET-AM0269](file:///D:\Sciebo\MwiMeetings\20250626_MPEG151_JVET-AM_AG5-20_Daejeon\JVET\current_document.php?id=15936) | AHG17 ECM/VTM performance under CfE requirement | [K. Naser](mailto:karam.naser@interdigital.com), E. François, F. LeLéannec, F. Galpin, T. Poirier (InterDigital) |
| [JVET-AM0287](https://jvet-experts.org/doc_end_user/current_document.php?id=15954) | [AHG17] On HDR coding and metrics | Dmytro Rusanovskyy (Nokia), Edouard Francois (InterDigital) |

1. **Recommendations**

The AHG recommends:

* To progress the work in AHG4 towards finalizing the draft test set for a Joint Call for Evidence on video compression with capability beyond VVC.
* To conduct subjective tests assessing the proposed rate points and coding conditions in the draft CfE.
* To consider inclusion of bitstreams of JVET-AM0045 and potentially also JVET-AM0078 in the subjective evaluation.
* To review the remaining input contributions related to AHG17 during the meeting.
* To finalize and publish the CfE document.

Potentially more ACR test cases possible from JVET-AM0045, JVET-AM0078 and JVET-AM0200. Mathias to clarify offline with proponents, and present plans Friday 0900 (first item 2nd day)

[JVET-AM0018](https://jvet-experts.org/doc_end_user/current_document.php?id=15912) 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)]

***Simulation software***

Adoptions of last JVET meeting (JVET-AL0201) were merged to ‘*ull-master*’ branch: <https://vcgit.hhi.fraunhofer.de/jvet-ahg-ull/VVCSoftware_VTM/-/tree/ull-master>.

***Teleconferences***

Two teleconferences were held on May 20th and June 11h, with 24 and 17 participants correspondingly.

The following topics were discussed:

* GDR and Temporal scalability transmission simulations.
* Comments and suggestions on ULL test conditions
* Dry-run of visual tests discussion
* Software modifications of JVET-AL0201 adopted last JVET meeting

The meeting minutes, presented materials and video demonstrations are available in [JVET-AM0046](https://jvet-experts.org/doc_end_user/current_document.php?id=15693) and [JVET-AM0051](https://jvet-experts.org/doc_end_user/current_document.php?id=15698).

1. **Related contributions**

A total of 16 contributions are identified relating to the mandates of AHG18. They are listed below. Some contributions also relate to the work of AHG9.

|  |  |  |
| --- | --- | --- |
| **Report** | | |
| [JVET-AM0018](https://jvet-experts.org/doc_end_user/current_document.php?id=15912) | 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-AM0046](https://jvet-experts.org/doc_end_user/current_document.php?id=15693) | 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) |
| [JVET-AM0051](https://jvet-experts.org/doc_end_user/current_document.php?id=15698) | AHG18: 2nd teleconference on ultra-low latency and packet loss resilience | [S. Ikonin](mailto:sergey.ikonin@huawei.com), [S. Wenger](mailto:swenger@global.tencent.com), V. Zakharchenko (co-chairs), S. Deshpande, J. Ström, X. Ma, C. Kim, S. Puri, S. Fößel (vice-chairs) |
| **Test condition and evaluation methodology** | | |
| [JVET-AM0109](https://jvet-experts.org/doc_end_user/current_document.php?id=15756) | AHG18: On Test Conditions for Ultra-Low Latency and Error Resilience | [S. Deshpande (Sharp)](mailto:sdeshpande@sharplabs.com) |
| [JVET-AM0204](https://jvet-experts.org/doc_end_user/current_document.php?id=15851) | AhG18: Multilayer coding with spatial scalability under ultra low latency test scenario | [V. Zakharchenko (Nokia)](mailto:vlad.zakharchenko@nokia.com) |
| [JVET-AM0222](https://jvet-experts.org/doc_end_user/current_document.php?id=15869) | AHG18: On test conditions for ultra-low latency and packet loss resilience | [S. Ikonin](mailto:sergey.ikonin@huawei.com), [I. Gribushin](mailto:gribushin.ivan@huawei.com), [M. Sychev](mailto:Sychev.Maxim@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| **Proposals** | | |
| [JVET-AM0153](https://jvet-experts.org/doc_end_user/current_document.php?id=15800) | AHG9: Loss recovery information SEI message | [C. Kim](mailto:chulkeun.kim@lge.com), [H. Tan](mailto:dr.hendry@lge.com), [J. Nam](mailto:junghak.nam@lge.com), [J. Lee](mailto:jangw.lee@lge.com), [J. Lim](mailto:jaehyun.lim@lge.com), [S. Kim (LGE)](mailto:seunghwan3.kim@lge.com) |
| [JVET-AM0184](https://jvet-experts.org/doc_end_user/current_document.php?id=15831) | AHG9: Picture Reference Degree SEI Message | [S. Zhao](mailto:shzhao@qti.qualcomm.com), [Y. He](mailto:yonghe@qti.qualcomm.com), [L. Kerofsky](mailto:kerofsky@qti.qualcomm.com), [M. Karczewicz (Qualcomm)](mailto:martak@qti.qualcomm.com) |
| [JVET-AM0195](https://jvet-experts.org/doc_end_user/current_document.php?id=15842) | AhG18: Gradual Decoding Refresh (GDR) under ultra low latency test scenario | [M. Sychev](mailto:%20Sychev.Maxim@huawei.com), [A. Dzugaev](mailto:dzugaev.akhsarbek@h-partners.com), [S. Ikonin (Huawei)](mailto:Sergey.Ikonin@huawei.com), [E. Alshina (Huawei)](mailto:Elena.Alshina@huawei.com) |
| [JVET-AM0198](https://jvet-experts.org/doc_end_user/current_document.php?id=15845) | AhG18: Temporal Scalability under ultra low latency test scenario | [Maxim Sychev](mailto:%20Sychev.Maxim@huawei.com), [Kirill Malyshev](mailto:Malyshev.Kirill@huawei-partners.com), [Sergey Ikonin](mailto:Sergey.Ikonin@huawei.com), [Elena Alshina (Huawei)](mailto:Elena.Alshina@huawei.com) |
| [JVET-AM0202](https://jvet-experts.org/doc_end_user/current_document.php?id=15849) | AhG18: On ultra low latency and packet loss resilience coding tools integration | [V. Zakharchenko (Nokia)](mailto:vlad.zakharchenko@nokia.com) |
| [JVET-AM0203](https://jvet-experts.org/doc_end_user/current_document.php?id=15850) | AHG18: Full VTM tool set in ultra-low latency test scenario | [V. Khamidullin](mailto:vyacheslav.khamidullin1@huawei.com), [I. Gribushin](mailto:gribushin.ivan@huawei.com), [S. Ikonin](mailto:sergey.ikonin@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AM0235](https://jvet-experts.org/doc_end_user/current_document.php?id=15882) | Implementation of error resilient transmission system for scalable services | [S. Iwamura](mailto:iwamura.s-gc@nhk.or.jp), S. Nemoto, Y. Kondo, A. Ichigaya (NHK) |
| **Informational** | | |
| [JVET-AM0188](https://jvet-experts.org/doc_end_user/current_document.php?id=15835) | AHG18: An introduction to the next generation media transport protocol—Media over QUIC(MoQ) | [W. Ding](mailto:dingweihang1@huawei.com), [X. Ma](mailto:maxiang6@huawei.com), [S. Ikonin](mailto:Sergey.Ikonin@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AM0201](https://jvet-experts.org/doc_end_user/current_document.php?id=15848) | AHG18: Overview of 3GPP features for Extended Reality (XR) and related high quality conversational services and related implications for ultra-low latency (ULL) coding | [R. Mekuria](mailto:rufael.mekuria@huawei.com), [Q. Pan](mailto:panqi8@huawei.com), [X. Ma](mailto:maxiang6@huawei.com), [S. Ikonin](mailto:Sergey.Ikonin@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |
| [JVET-AM0218](https://jvet-experts.org/doc_end_user/current_document.php?id=15865) | AHG18: Solution beyond scalable coding for 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), [X. Ma](mailto:maxiang6@huawei.com),  [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com) |

1. **Recommendations**

The AHG recommends:

* Review all input contributions.
* Discuss test conditions and evaluation methodology.
* Consider bypassing key important information over transmission channel as reasonable setup for dry-run subjective evaluation to avoid too much video stall
* 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 (34)

## AHG1: Development, deployment and advertisement of standards (0)

This section is kept as a template for future use.

## AHG2: Text development and errata reporting (0)

This section is kept as a template for future use.

See also 6.1 and 6.2.1.

## AHG3: Software development (1+1)

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

[JVET-AM0158](https://jvet-experts.org/doc_end_user/current_document.php?id=15805) [AHG3][AHG6] ECM software code quantity progress [T. Ikai (Sharp)]

See also 5.2.5

[JVET-AM0280](https://jvet-experts.org/doc_end_user/current_document.php?id=15947) AHG3: VTM decoder memory print [C. Hollmann, V. Rufitskiy, A. Filippov (TCL)] [late]

## AHG3: Test conditions (3)

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

[JVET-AM0187](https://jvet-experts.org/doc_end_user/current_document.php?id=15834) On Intra Period of Random Access Test Case for HD and below Content [X. Li (Google), L. Zhang (ByteDance), X. Wang (Kwai), S. Liu (Tencent), A. Duenas (Warner Bros. Discovery), A. Norkin (Netflix), W. Zhang (Disney), Y. Ye (Alibaba), A. Segall (Amazon)]

[JVET-AM0238](https://jvet-experts.org/doc_end_user/current_document.php?id=15885) Suggestions on GOP Size Setting of Random Access Configuration for Live-streaming Applications [Y. Wu, Y. He, K. Zhang, L. Zhang (Bytedance), X. Li (Google), S. Liu (Tencent), W. Zhang (Disney)] [late]

[JVET-AM0226](https://jvet-experts.org/doc_end_user/current_document.php?id=15873) Separate Luma and Chroma Plane Coding [X. Li (Google)]

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

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

[JVET-AM0223](https://jvet-experts.org/doc_end_user/current_document.php?id=15870) AHG4: proposed updates for VVC multi-layer verification test plan [P. de Lagrange (InterDigital)]

## AHG4: Test and training material (0)

This section is kept as a template for future use.

## AHG5: Conformance test development (0)

This section is kept as a template for future use.

## AHG7: ECM tool assessment (6+1)

Contributions in this area were discussed during 1400–1610 on Monday 30 June 2025 (chaired by JRO).

[JVET-AM0042](https://jvet-experts.org/doc_end_user/current_document.php?id=15689) Report of AHG7 conference call on Assessment Perspectives of Codec/Coding Tools [X. Li]

The following list of criteria relevant for analysis of tools is provided in the report:

***1.1 Quality perspective***

|  |  |  |
| --- | --- | --- |
| Index | Item | Measurement/study methodology |
| 1 | MOS | Subjective viewing, CCR, DCR, ACR |
| 2 | PSNR | Report by JVET reference software |
| 3 | HDR metrics | Report by JVET reference software or HDR tools |
| 4 | MS-SSIM | Report by JVET reference software |
| 5 | VMAF/VMAF-NEG | **If this metric is used**, VMAF/VMAF-NEG value should be reported by the open source tool by Netflix (<https://github.com/Netflix/vmaf>), the exact software version and calculation in parallel/sequential encoding need to be specified |
| 6 | Quality balancing between luma and chroma signal | To consider adding an indicator or combined YUV gain in the reporting template in the next meeting. No action for now. To further study the details based on sequence level calculation relative to anchor (based on PSNR). |

***1.2 Architecture perspective***

|  |  |  |
| --- | --- | --- |
| Index | Item | Measurement/study methodology |
| 1 | High level of parallel processing | Explicit description on max CTU size |
| 2 | Dependency and latency | Explicit description on whether spatial reconstructed samples are used to derive/refine inter information |

***1.3 Hardware perspective***

|  |  |  |
| --- | --- | --- |
| Index | Item | Measurement/study methodology |
| 1 | Buffer size of pipeline | Explicit description on max transform size vs coding gain, and whether any partition cross an VPDU |
| 2 | Interleaved intra and inter pipeline | Explicit description on whether inter block processing needs to wait for reconstructed spatial neighbors |
| 3 | Block matching (searching/ reordering) in intra pipeline | Block matching and related processing complexity (case by case details should be provided) vs coding gain |
| 4 | Intensive processing neighboring reconstructed samples | Processing complexity (case by case details should be provided, e.g. number of multiplication, division) vs coding gain |
| 5 | Block level sequential operation | Computational complexity (case by case details should be provided, e.g., the number of comparison, of the sequential operations vs coding gain) |
| 6 | Non-reference-sample storage in DPB | Buffer size and memory bandwidth increase vs coding gain |
| 7 | Line buffers | Buffer size vs coding gain |
| 8 | Internal memory storage (RAM) | Buffer size vs coding gain |
| 9 | Large look up tables (ROM) | Table size vs coding gain |
| 10 | Memory bandwidth in the worst case | Worst case fetching area analysis used in VVC and HEVC  Encourage to use JVET\_J0090\_MEMORY\_BANDWITH \_MEASURE (needs to check whether the tool works properly in the current software) and commercial tool for the analysis. |
| 11 | Operation number in the worst case | Worst case operation numbers (case by case details should be provided, e.g. number of multiplication, division) vs coding gain |
| 12 | Throughput analysis of entropy coding | More input is needed |

***1.4 Software perspective***

|  |  |  |
| --- | --- | --- |
| Index | Item | Measurement/study methodology |
| 1 | Runtime | Report by reference software, report GPU time (including GPU info) if applicable. |
| 2 | OS and compiler | Report by reference software |
| 3 | Overall memory usage | Report by reference software |
| 4 | Code changes | Report by Gitlab for CE/EE proposal, in terms of the number of lines of code changes relative to anchor |
| 5 | Sequence/QP/Resolution based optimization | Explicit description on any sequence/QP/resolution dependent parameter setting/optimization |
| 6 | SIMD optimization | Encourage to provide description on the speedup factor |
| 7 | Multithreading support | There are cons and pros. More discussion may be needed |

It was commented that for 1.2.2 (dependency and latency of architecture) more than usage of spatial neighborhood samples seems relevant (e.g. bit rate fluctuation, bitstream buffer needs).

It was commented that in software mechanisms for enabling/disabling of tools are also relevant (at least in software used in development).

[JVET-AM0044](https://jvet-experts.org/doc_end_user/current_document.php?id=15691) AHG7: Summary on the Tool Analysis in Earlier Proposals/Reports [X. Li (Google)]

During the AHG7 call on Assessment Perspectives of Codec/Coding Tools between 39th and 40th JVET meeting, it was requested to further check the tool analysis in earlier proposals and reports, such as AHG5 and AHG16 activities during VVC development, AHG12, AHG9 activities during HEVC development. In this contribution, the activities are summarized.

The contribution is a decent summary of methods used to assessment of tools complexity during HEVC and VVC standard development. It was commented that the VVC CfP H1002 and the proposal package description template JVET-H1003 also contained a lot of detailed aspects to be described about complexity of an algorithm and its tools, but there was no number criteria to be provided. It might be a good exercise to investigate how VVC could be quantitatively analysed by the criteria of the former CfP.

It was further commented that the previous CfP was too much focused on detailed building blocks of a classical hybrid codec. It appears more important to define more abstract criteria such as local memory, tables, dependencies at which granularity, capability for parallelization, etc., and some new criteria may need to be added e.g. for neural networks.

[JVET-AM0134](https://jvet-experts.org/doc_end_user/current_document.php?id=15781) AHG7: ECM tool combination [R. Ishimoto, Z. Fan, T. Chujoh, T. Ikai (Sharp)]

This contribution studies the optimal tool combinations by evaluating the performance improvements of tools in relation to encoding time and decoding time. Off-tests were conducted for each tool to measure their performance and runtime. A performance score was calculated representing gain relative to runtime (a.k.a. p-score in this contribution), which enables to create a series of tool combinations depending on the efficiency of the tools in terms of runtime. Finally, selected tool combinations configurations were evaluated in terms of performance and runtime. It is reported that the tool combinations configuration achieves a good gain relative to runtime.

Contribution for information – no action proposed.

[JVET-AM0221](https://jvet-experts.org/doc_end_user/current_document.php?id=15868) AHG7: TMRL Tool-Off Bug Fix [Z. Xiang, R. Chernyak, B. Wang, S. Liu (Tencent)]

This proposal fixes an encoder crash bug found in Template-based Multiple Reference Line (TMRL) tool-off test, which is caused by the interaction of Multiple Reference Line (MRL) mode and Most Probable Mode (MPM) changes introduced in ECM-16.0. It is proposed to accept the bug fix so that more tool-off combinations can be tested. The test results of TMRL tool-off based on different bug fix options are reported on top of ECM.

Decision(SW): Adopt JVET-AM0221 option 1 (encoder only, no change in CTC)

[JVET-AM0330](https://jvet-experts.org/doc_end_user/current_document.php?id=15998) Crosscheck of JVET-AM0221 (AHG7: TMRL Tool-Off Bug Fix) [[L. Xu (OPPO)](mailto:xuluhang@oppo.com)] [late]

[JVET-AM0227](https://jvet-experts.org/doc_end_user/current_document.php?id=15874) AhG7: On bin to bit ratio in ECM [T. N. Canh, P. Yin, S. McCarthy (Dolby), J. N. Shingala (Ittiam)] [late]

This contribution studies CABAC bin statistics across ECM 17.0, VTM 23.10, and HM 16.19 under CTC condition. The peak and average bin to bit ratio (bin2bit), weighted BD-binrate, and context coded ratio are examined. For weighted bin2bit calculation, bypass bins are weighted at 0.25. The results for AI/RA in CTC condition are as follows:

- ECM 17.0 shows 17.38%/16.40% (7.81%/6.62%) increase for peak weighted (unweighted) bin2bit ratio over VTM 23.10 and 41.31%/40.35% (22.11%/22.03%) over HM 16.19, while VTM 23.10 shows 20.39%/20.58% (13.52%/12.58%) increase for peak weighted (unweighted) bin2bit ratio over HM 16.19.

- ECM 17.0 shows weighted BD-binrate of -2.22%/-11.12% over VTM 23.10 and weighted BD-binrate of -11.70%/-40.97% over HM-16.19 for luma while VTM 23.10 shows weighted BD-binrate of -10.11%/-33.53% for luma over HM 16.19.

- The ratio of Y bitrate saving to Y binrate saving of ECM-17.0 over VTM-23.10 is 7.59x/2.43x, while the corresponding ratio of VTM23.10 over HM 16.19 is 2.53x/1.27x.

- ECM 17.0 has a context bin over total bin ratio of 86.98%/85.68% which represents an increase of 13.68%/13.72% from 76.51%/75.34% in VTM 23.10 and 24.62%/25.31% over HM 16.19 from 69.79%/68.37%.

- The number of contexts has increased by a factor of 4.5x from 379 contexts in VTM 23.10 to 1706 contexts in ECM 17.0. The storage for CABAC initialization and context models has increased by a factor of 22.5x and 10.8x in ECM 17.0 over VTM 23.10, respectively.

ECM requires higher throughput CABAC engine for real time decoding due to double digit increase in bin2bit ratio from VTM. The peak weighted bin2bit ratio has been increased from 1.1 (1.02 ~ 1.16) in VTM to 1.3 (1.20 ~ 1.54) in ECM. On the other hand, the binrate saving is much smaller in ECM over VTM compared to VTM over HM due to the significant increase in signaling bins from newly added. Meanwhile, most bins are context coded in ECM at nearly 86~87% of total bins. Additionally, the memory requirement for CABAC initialization and context models has been increased significantly in ECM 17.0 over VTM 23.10.

Reference is taken to JVET-N0049, where the bin-to­-bit ratio is introduced as a criterion for throughput. Number of context models is suggested as another relevant aspect, having impact on storage needs. Also the weighting factor comes from JVET-N0049.

It was commented that it is less relevant for an exploration item of ECM to have an excessive usage of context coded bins, but for a potential proposal towards a future standard it is highly important.

It is further proposed in the contribution to fix a bug in VTM (and ECM), which does not allow to analyse the bin to bit ratio at the current moment. It was suggested to submit a report of the bug and a merge request.

[JVET-AM0295](https://jvet-experts.org/doc_end_user/current_document.php?id=15963) [AHG7] External memory bandwidth evaluation [Y. Kim, L. Li, M. W. Park, M. Park, M. Budagavi, K. P. Choi (Samsung)] [late]

This contribution provides VTM and ECM evaluation results of external memory accesses on decoder with various cache configurations. The measurements were conducted using two different methods: Valgrind and JVET-J0090. Evaluation using Valgrind measures external memory accesses across the entire decoding process. JVET-J0090, on the other hand, measures external memory accesses during motion compensation module, specifically targeting the reference picture buffer.

When measured using Valgrind, ECM15.0 exhibited average 1580% and maximum 2066% more memory access than VTM23.9. Similarly, JVET-J0090 results indicated average 1325% and maximum 1833% increases in reference picture buffer access during motion compensation. It is suggested to continuously study measurement on external memory bandwidth in AHG7, and address memory bandwidth problem in future video coding standard.

It was commented that measuring the memory bandwidth (using tools such as Valgrind) would be highly beneficial in addition to the runtime as a criterion for evaluation. This would require running the decoder twice, as executing the tool makes the decoder faster.

It was further commented that some capability of analysis the worst case would also be desirable (or perhaps be more important). Worst case is important for hardware implementation.

Is it known which tools in ECM cause highest memory access?

Could it be made mandatory for a CfP submission to deliver numbers of memory access determined by a tool like Valgrind? For decoder or also for encoder? Kept for further discussion.

It was commented that the memory access reported by Valgrind is still an underestimate, and also the macro in VTM may not be considered by all recent implementations of tools.

Decision(SW): Adopt the implementation of the fix from JVET-J0090 to run memory analysis tools with ECM (already exists in VTM). This would allow further study in AHG7.

BoG (X. Li, E. Alshina, F. Bossen) to further discuss criteria and instruments to analyse complexity of tools, based on the ideas in JVET-AM0042, JVET-AM0044, JVET-AM0125, JVET-AM0227, and JVET-AM0295. In this context, it should also considered what aspects would need improvement compared to previous CFP documents.

[JVET-AM0332](https://jvet-experts.org/doc_end_user/current_document.php?id=16000) AHG17/AHG7 Test Results of AHG7 Group1-5 off with Smaller Partition Depth [X. Li (Google)] [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)

This section is kept as a template for future use.

## AHG13: Film grain synthesis (1+4)

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

[JVET-AM0085](https://jvet-experts.org/doc_end_user/current_document.php?id=15732) AHG9/AHG13: On Film Grain Regions Characteristics SEI message [S. Deshpande, J. Samuelsson-Allendes (Sharp)]

See 6.4.7

[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 [S. Xie, W. Niu, P. Wu, Y. Gao, C. Huang (ZTE)]

See 6.4.7

[JVET-AM0168](https://jvet-experts.org/doc_end_user/current_document.php?id=15815) [AHG9/AHG13] Implementation in VTM TuC of the film grain regions characteristics SEI message [F. Urban, E. François, P. de Lagrange (InterDigital), G. Teniou (Tencent)]

See 6.4.7

[JVET-AM0230](https://jvet-experts.org/doc_end_user/current_document.php?id=15877) AHG9/AHG13: Reference picture resolution for the FGR SEI message [E. François, P. de Lagrange, F. Urban (InterDigital)]

See 6.4.7

[JVET-AM0288](https://jvet-experts.org/doc_end_user/current_document.php?id=15955) Neural network-based film grain analysis [Z. Ameur, F. Lefevbre, P. De Lagrange, M. Radosavljević (InterDigital)] [late]

## Implementation studies (3)

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

[JVET-AM0239](https://jvet-experts.org/doc_end_user/current_document.php?id=15886) VVdeC with multi-layer decoding capability [S. Iwamura, S. Nemoto, Y. Kondo, A. Ichigaya (NHK)]

[JVET-AM0242](https://jvet-experts.org/doc_end_user/current_document.php?id=15889) VVC playback on Chromium browser [S. Iwamura, S. Nemoto, Y. Kondo, A. Ichigaya (NHK)] [late]

[JVET-AM0298](https://jvet-experts.org/doc_end_user/current_document.php?id=15966) Ultra-low latency demo: Ressource constraint VVC and HEVC software encoding up to 4K [M. Alvarez Mesa, B. Bross (HHI), C. C. Chi (Spin Digital Labs)] [late]

(include abstract)

No need for presentation – describes demo

## Profile/tier/level specification (0)

This section is kept as a template for future use.

## AHG15: Gaming content compression (0+1)

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

[JVET-AM0142](https://jvet-experts.org/doc_end_user/current_document.php?id=15789) AHG15: Analysis of Test Sequences for Game Content in the CfE Document [X. Liang, K. Choi (KHU), C. W. Ryu (Kaon Group)]

See also 4.16

## AHG16: Generative face video (1)

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

Also refer to section 6.1.4.

[JVET-AM0058](https://jvet-experts.org/doc_end_user/current_document.php?id=15705) AHG16: Lightweight Multi-resolution CFTE Model and Color Calibration Post-processing Algorithm for Generative Face Video Compression [Z. Zhang, S. Yin, S. Wang (CityUHK), B. Chen, R.-L. Liao, J. Chen, Y. Ye (Alibaba)]

## AHG17: CfE preparation (15)

Contributions in this area were discussed during 1610–1810 on Monday 30 June 2025 (chaired by JRO). & Tue 0910-1125 & Wedneday 1450-1555

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

[JVET-AM0041](https://jvet-experts.org/doc_end_user/current_document.php?id=15688) AHG17: AhG meeting notes [M. Wien]

No need to review.

[JVET-AM0045](https://jvet-experts.org/doc_end_user/current_document.php?id=15692) AHG17: Generated VTM anchor bitstreams using LambdaScaleTowardsNextQP [K. Andersson, P. Wennersten (Ericsson)]

At the JVET meeting in April it was suggested to compare the approach of scaling lambda to control target bitrate as suggested in JVET-AL0207 with the current approach for target bitrate matching where QP is increased by 1 at a selected frame and used for the remaining length of the video sequence. This document reports results of rate matching using VTM-23.9 where the QP closest to the target bitrate is selected and the lambda is scaled to increase or decrease the bitrate using the configuration parameter LambdaScaleTowardsNextQP. The sequences and target bitrates follow AHG17 (configurations of draft CfE).

In v2 BDR comparisons with QP + 1 approach and fixed QP (QP closest to target bitrate) are included. The lambda scaling approach has more similar BDR compared to using fixed QP than to the QP + 1 rate matching approach.

The lambda scale parameter is determined in several rounds of encoder runs (at most three). The value of lambda scale depends on the distance between the target rate and the closest QP rate.

See further notes under JVET-AM0323

[JVET-AM0314](https://jvet-experts.org/doc_end_user/current_document.php?id=15982) Cross-check of JVET-AM0045 (AHG17: Generated VTM anchor bitstreams using LambdaScaleTowardsNextQP) [C. Bartnik, A. Wieckowski (HHI)] [late]

[JVET-AM0049](https://jvet-experts.org/doc_end_user/current_document.php?id=15696) [AHG17] Suggested results reporting template for constrained encoder complexity category [E. Alshina, J. Sauer, T. Solovyev, M. Lobo (Huawei)]

This document proposes starting point for results reporting template, which can be used for multiple tests comparison and trade-off illustration.

The xls was generated by importing csv files witch data that would be delivered by proponents. Converting them for comparison into Excel data or Figures for a report would need to be done later.

[JVET-AM0078](https://jvet-experts.org/doc_end_user/current_document.php?id=15725) AHG17: Suggestion to enable DMVR encoder control for VTM anchor [K. Andersson (Ericsson)]

In VTM there is a configuration parameter DMVREncMvSelect which will penalize the usage of DMVR when it is a risk that the tool produces visual artifacts. This typically occurs at lower bitrates when DMVR has more troubles to find the correct motion for all subblocks. In this contribution DMVREncMvSelect has been tested on the AHG17 test sequences and target bitrate’s and it is asserted that its enabling can improve visual quality in some cases. It is therefore suggested to enable DMVREncMvSelect for the VTM anchor in the context of subjective related tests, such as in the scope of AHG17. For rate matching the configuration parameter LambdaScaleTowardsNextQP has been used.

In v2 BDR in comparisons with QP +1 rate matching and lambda scaling rate matching approach as in JVET-AM0045 are included. The BDR loss per class varies between -0.2% to 1.6% in comparison to the QP + 1 rate matching approach and between 0.7% to 1.4% in comparison to the lambda scaling rate matching approach.

No impact on encoder runtime.

It was commented that it would be desirable to have the VTM with best visual quality as anchors.

See further notes under JVET-AM0323.

[JVET-AM0315](https://jvet-experts.org/doc_end_user/current_document.php?id=15983) Cross-check of JVET-AM0078 (AHG17: Suggestion to enable DMVR encoder control for VTM anchor) [C. Bartnik, A. Wieckowski (HHI)] [late]

[JVET-AM0125](https://jvet-experts.org/doc_end_user/current_document.php?id=15772) AHG17: Analysis on encoding time and mode cost test for draft CfE sequences [Y. Tokumo, S. Hong, T. Ikai (Sharp)]

This contribution reports analysis on encoding time and mode cost test (the number of RDO search, RDO count) for draft CfE sequences. Experimental results show that runtime ratio of VTM high performance and ECM JVET-AL0245 are roughly 1.3x to 1.9x and 10.4x to 5.3x for R1 to R4, and encoding runtime and RDO count are correlated, and they vary greatly depending on sequences. For SDR\_RA\_HD, EncT per RDO count is 0.087, 0.082 msec/count in VTM 23.9 under default and high performance configurations respectively. On the other hand, it is 1.060 msec/count in ECM under JVET-AL0245 configuration, which is 13 times larger than that of VTM and it may reflect to 12x DecT in ECM to VTM.

v2 added/fixed experimental results and added the following proposal.

Considering ECM/VTM EncT ratio in CfE operation points are much higher than those of CTC. It is proposed to apply encoding times condition or plot to the highest rate point, R4.

One finding is that the runtime per RDO check is significantly higher in ECM, which may be due to the slower decoding process that needs to be conducted during RDO.

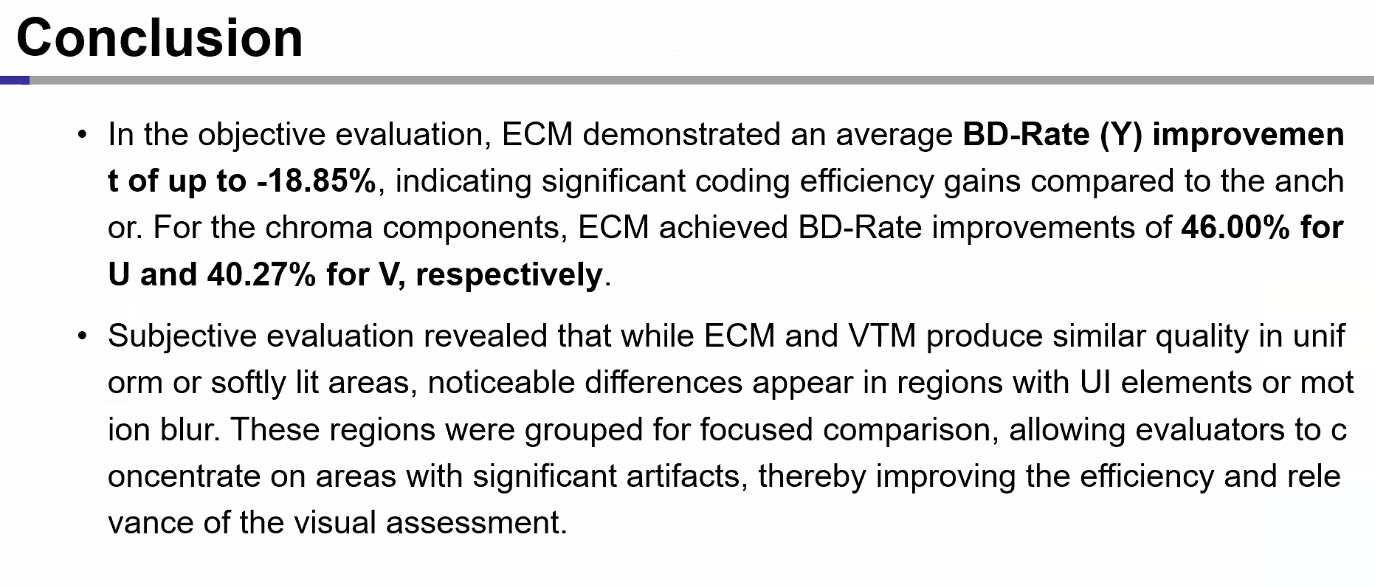
The number of RDO checks is lower in ECM than VTM, which according to the proponents’ analysis I likely due to the MTT depth reduction.

It was commented that RDO count in ECM may be incomplete, as the tracing functionality may not be implemented in all tools

It was commented that only analysing R4 in encoder complexity would not be appropriate. Further discussion is necessary on that, as the number of data is large, which could be done by analysing the CfE results.

[JVET-AM0142](https://jvet-experts.org/doc_end_user/current_document.php?id=15789) AHG15: Analysis of Test Sequences for Game Content in the CfE Document [X. Liang, K. Choi (KHU), C. W. Ryu (Kaon Group)]

This contribution presents a detailed comparative analysis of the Enhanced Compression Model (ECM) and the Versatile Video Coding Test Model (VTM) under low-delay scenarios. Low-delay experiments were conducted on representative gaming sequences using both ECM and VTM. The results are evaluated using objective metrics—such as BD-Rate and PSNR—as well as subjective visual assessments, providing a comprehensive understanding of the performance of both models. These findings serve as anchor references for performance evaluation on gaming content.



According to proponents, differences are more clearly visible in sequences with lower motion.

Visual comparison was mostly performed at low rates.

For information – no specific action proposed.

[JVET-AM0194](https://jvet-experts.org/doc_end_user/current_document.php?id=15841) On Analyzing and Reporting Encoding and Decoding Complexity [A. Stein, S. Ferrara (V-Nova)]

For BoG review.

[JVET-AM0200](https://jvet-experts.org/doc_end_user/current_document.php?id=15847) AHG17: Getting VTM to run five times faster [F. Bossen]

The reduced runtime VTM encoder configuration #3 adopted at the 38th meeting doesn’t quite achieve the target of 0.2x encoder runtime under CfE test conditions. This contribution reports on software improvements that were recently made to VTM and proposes new encoder configurations to get closer to the target.

In the contribution, also alternative methods for averaging runtimes are suggested (as the runtime reduction is not constant on a sequence basis. It will need to be further discussed whether it is anyway better to evaluate/plot graphs of distortion over runtime individually for each sequence/rate point, and make some averaging in “BD” fashion from the whole set.

Runtimes are generally lower and closer to the targeted runtimes points than for the other faster VTM encodings.

Use as VTM reduced runtime anchors in CfE

Decision(SW): Include in VTM

[JVET-AM0289](https://jvet-experts.org/doc_end_user/current_document.php?id=15956) Cross-check of JVET-AM0200 "AHG17: Getting VTM to run five times faster" [F. Le Léannec (InterDigital)] [late]

[JVET-AM0225](https://jvet-experts.org/doc_end_user/current_document.php?id=15872) [AHG17] Encoder runtime for the constrained complexity configurations under the CfE draft test conditions [T. Solovyev, J. Sauer, M. A. Lobo, E. Alshina (Huawei)]

This document presents simulation results with the reliable encoder runtime for the constrained complexity encoder configurations of VTM 23.9 under the test conditions from the CfE draft. The simulation results show encoder runtime 65%, 53%, 25% with luma bd-rate 0.9%, 2.8%, 17.6% for the reduced runtime 1, 2 and 3 configurations correspondingly, relatively to the default RA configuration of VTM 23.9. HM-18.0 tested under the similar test conditions, shows 42% encoder runtime with 65.6% luma bd-rate relatively to the default configuration of VTM 23.9.

The analysis indicates that the encoder run time savings are highly dependent on rate points.

For the comparison VTM vs. HM, it is commented that VTM includes much more code optimization for fast runtime than HM.

[JVET-AM0234](https://jvet-experts.org/doc_end_user/current_document.php?id=15881) [AHG17] Overview of the 3GPP codec testing in TR 26.955 [R. Mekuria, E. Alshina (Huawei), J. Lemotheux (Orange)]

This document provides a very brief overview of the 3GPP SA4 codec testing. This document targets assisting improvement of test conditions for potential next generation video codec development in JVET. This document just a very brief summary of materials made to the publicly available by 3GPP, deeper analysis is expected in a future.Presented Wed 2 July afternoon.

Services considered in TR 26.955 are

• 5G Media Streaming

o 5GMS Downlink Streaming

o 5GMS Uplink Streaming

o 5GMS Television

o 5GMS Downlink 360 Virtual Reality

• Multimedia Telephony Services over IMS

• Messaging Services

• Screen Content Coding

Codec support in 3GPP SA4 services is as follows:

a) HEVC/H.265 and AVC/H.264 have been recommended and supported in different services.

b) Also new codecs AV1, VVC and EVC were evaluated and considered for adoption (but none of them recommended).

The following quality metrics were used for in TR 26.955:

• SDR

o Per component PSNR: PSNR(Y), PSNR(U), PSNR(V) (if bitDepth is set to 10, then maxValue is set to 1020 – same as in JVET)

o Average PSNR over all colour components: PSNR = (6\*PSNR(Y) + PSNR(U) + PSNR(V))/ 8

o Multi-Scale Structural Similarity Metric - MS-SSIM (there is minor difference in implementation compared to one used in JVET)

o Video Multimethod Assessment Fusion - VMAF. For VMAF computation the associated software implementation [5] is used.

• HDR

o Per component PSNR: PSNR(Y), PSNR(U), PSNR(V) (if bitDepth is set to 10, then maxValue is set to 1020 – same as in JVET)

o Average PSNR over all colour components: PSNR = (6\*PSNR(Y) + PSNR(U) + PSNR(V))/ 8

o Per component weighted PSNR: wPSNR(Y), wPSNR(U), wPSNR(V)

o Average wPSNR over all colour components

o PSNRL100 (computed in 32-bit EXR)

o DE100 (computed in 32-bit EXR)

It was commented that it is valuable if different standardization bodies use different sets of test sequnces.

It was further commented that sequences used in CfE were selected to be appropriate for viewing, and it would be desirable to add more material for CTC.

The whole set of Netflix had been investigated in JVET, and selection was made by good reasons, e.g. not being complex enough.

It was commented that it rather looks as if 3GPP would have copied from JVET conditions, and that perhaps the test were conducted less rigidly than usually in JVET.

Interesting information, experts are encouraged to study the 3GPP report, at this moment no need is seen to change the test conditions in particular for CfE.

[JVET-AM0237](https://jvet-experts.org/doc_end_user/current_document.php?id=15884) On constrained encoding and decoding experiments [L. Li, M. W. Park, M. Park, Y. Kim, M. Budagavi, K. P. Choi (Samsung)]

This contribution explores the trade-offs between coding efficiency and computational complexity for both encoder and decoder. During the previous meeting, multiple trade-off points were presented by changing ECM configurations. While certain configurations demonstrated encoder complexity levels approximately twice that of the VTM encoder, the corresponding decoder complexity failed to achieve a desired two times of VTM decoder. It was suggested that further modifications are necessary to effectively reduce decoder complexity alongside encoder complexity.

In the context of constrained encoding, specific configurations achieved encoder complexity levels approximately twice that of the VTM encoder while maintaining comparable BD-rate gains. However, the decoding time exhibited significant variations, ranging from x2, x4, to even x6 the decoding time of the VTM decoder.

This contribution emphasizes the importance of illustrating both encoding and decoding times to provide a comprehensive understanding of trade-offs within the constrained encoding category. It is suggested that decoding time information be discussed jointly with encoding time, and this is beneficial for CfE response and practical implementation of the next generation of video coding standard.

It is proposed to also include an analysis of decoding runtime in the CfE part for fast encoding, as there is dependency of decoder and encoder runtime.

It was commented that in the analysis percentages of run time saving relative to anchor were averaged over the different rate points. It was suggested that an alternative could be averaging absolute run times (where the high rate points would usually require more, and saving is more relevant).

[JVET-AM0269](https://jvet-experts.org/doc_end_user/current_document.php?id=15936) AHG17 ECM/VTM performance under CfE requirement [K. Naser, E. François, F. Le Léannec, F. Galpin, T. Poirier (InterDigital)] [late]

During the discussion about CfE test conditions, it was agreed in JVET-AL0337 that the two complexity points of ~0.2x and ~5x VTM encoder time should be considered for evaluating CfE responses. This contribution studies the feasibility of achieving these points using ECM and VTM software with modified configurations parameters. It is concluded that the high complexity point (~5x EncT) can be easily achieved with ECM software with significant coding gain compared to VTM. However, ECM software within the lowest complexity point (~0.2x EncT) shows bad performance compared to VTM software. It is asserted that ECM requires high amount of code cleaning/simplification to meet VTM performance.

It is shown that ECM can still show reasonable performance at 2xVTM encoder run time, and gets similar performance at 1xVTM by switching off more tools. However, it gets worse at lower encoder run time.

It was commented that this is not surprising. ECM emerged from VTM, and was not targeting a faster encoding than VTM. Theoretically, by configuring it like 0.2xVTM, it should not become worse, but this may no longer be configurable with current software.

Proponents are asked to help AHG7 in fixing bugs when finding problems in disabling tools.

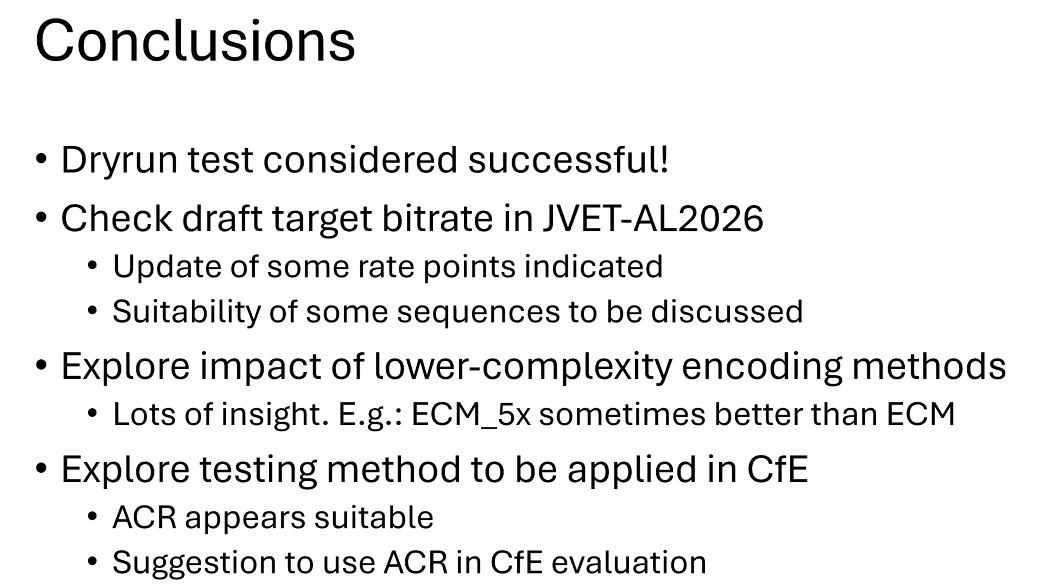
[JVET-AM0287](https://jvet-experts.org/doc_end_user/current_document.php?id=15954) [AHG17] On HDR coding and metrics [D. Rusanovskyy (Nokia), E. François (InterDigital)] [late]

To be discussed in BoG.

When HDR metrics would be defined differently, care should be taken that there is no divergence regarding the reference to JVET-AC2011.

[JVET-AM0323](https://jvet-experts.org/doc_end_user/current_document.php?id=15991) AHG17: Report on CfE dryrun testing [M. Wien, C. Lehmann, P. de Lagrange]

First presentation of some results in joint meeting with AG 5 Monday 30 June 1705-1810.



From the results shown

* DCR and ACR provide very similar results
* Rate ranges are OK in most cases
* Good percentage of non-overlapping confidence intervals ECM/VTM
* JVET-AM0200 at lowest rate usually equivalent to rt3

Specific observation on sequence basis

* Ducks take off has strong “knee” behaviour
* Beatriz: Lowest rate point may be too high
* Dota: Lowest rate point may be too high
* Camellia 2 highest rates saturating, lowest rate too high
* Nightlandscape 2 highest rates saturating
* Neptunfountain: R4 of ECM5 worse than R3

It was agreed to use JVET-AM0200 as reduced-runtime VTM anchor

For JVET-AM0045, report cases where one or the other (anchor with QP+1) was better. It was later reported that there were roughly equal number of cases where one or the other was better, or they were equal. There was only one case out of 120 where JVET-AM0045 was significantly better (non-overlapping confidence intervals). Not enough justification to change from the QP+1 method, which is also used in ECM and allowed/suggested for CfE proposals.

For JVET-AM0078, no conclusion is possible, as it was only tested in few cases which were not the same as for JVET-AM0045, such that it impossible to judge if improvement is due to rate matching or DMVR fix. Also some further viewing was conducted, which did not reveal any issue with the current CfE test cases.

Keep all sequences, but maybe not all will be used in visual testing in CfE (depending on number of submissions).

Offline activity (P. Nikitin, E. Francois, E. Alshina) to suggest rate point modifications

For lowest rate modifications, informal viewing should be conducted with closest fixed QP, to avoid that new rate becomes too low.

It was agreed to use ACR-HR (ref. ITU-T P.910) instead of DCR for the CfE. For ACR-HR, also originals are included for all test sequences (which was not the case for all sequences during the dry-run). This will help to identify which MOS value is the “saturation point” (which however may mean that an encoded version could be judged better and makes results better interpretable at high rate points.

[JVET-AM0332](https://jvet-experts.org/doc_end_user/current_document.php?id=16000) AHG17/AHG7 Test Results of AHG7 Group1-5 off with Smaller Partition Depth [X. Li (Google)] [late]

For BoG review.

BoG (F. Bossen) to discuss:

* Refine CfE in terms of which data to collect for the cases of improved compression (based on JVET-AM0049) and constrained runtime (based on 125, 200, 225, 237)
* Discuss how to combine and evaluate runtime data, and how to describe that in the CfE
* Discuss HDR metrics (related to first point)
* Discuss whether it makes sense to include ECM in reduced runtime test (considering information from 125, 269, 332)
* Update timelines in CfE

(not for BoG) For the CfE, it was ECM16.1 will be included for the case of improved compression testing, only regenerate re-defined rate points.

[JVET-AM0337](https://jvet-experts.org/doc_end_user/current_document.php?id=16005) Report of side activity on CfE bitrate allocation P. Nikitin (Qualcomm), E. Alshina (Huawei), E. François (Interdigital)

TBP

[JVET-AM0338](https://jvet-experts.org/doc_end_user/current_document.php?id=16006) Suggested text and figure on Call for Evidence document [L. Li, W. Choi, M. Budagavi, K. P. Choi (Samsung)] [late]

TBP

## AHG18 Ultra-low latency and packet loss resilience (12)

Contributions in this area were discussed during 1900–2030 on Monday 30 June 2025 and during 1415–1450 on Tuesday 1 July (chaired by JRO).

[JVET-AM0046](https://jvet-experts.org/doc_end_user/current_document.php?id=15693) 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)]

No need to review.

[JVET-AM0051](https://jvet-experts.org/doc_end_user/current_document.php?id=15698) AHG18: 2nd 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)]

No need to review.

[JVET-AM0109](https://jvet-experts.org/doc_end_user/current_document.php?id=15756) AHG18: On Test Conditions for Ultra-Low Latency and Error Resilience [S. Deshpande (Sharp)]

Comments and suggestions are provided for Ultra-Low Latency and Error Resilience Test Conditions. Following topics are discussed:

• Randomization of temporal starting point in packet traces for testing

• Using more diverse packet traces

• Multi-QP Evaluation

• Measuring temporal quality fluctuations

First aspect – agreed, but a way must be found how to implement, also in case where the video would be longer than the number of packets.

Second aspect – basically agreed, but it was commented that this would be desirable, but may be difficult as owners are often reluctant. 5G seems most realistic to get some. It was further commented that both downlink and uplink would be desirable (currently, only downlink is used in the simulator).

Third aspect – with higher QPs (37/42), in many cases VVC still provides good quality, somehow sequence dependent, but probably relevant for the given application scenarios. Some alignment between video bitrate and network throughput is necessary, anyway, and varying the QP may give more flexibility. Agreed – exact definition to be further studied in AHG.

Fourth aspect – requires further study. Fluctuation of errors is relevant, but restricting to freeze frames is likely not sufficient, as this is just one way to handle error concealment.

[JVET-AM0188](https://jvet-experts.org/doc_end_user/current_document.php?id=15835) AHG18: An introduction to the next generation media transport protocol – Media over QUIC (MoQ) [W. Ding, X. Ma, S. Ikonin, E. Alshina (Huawei)]

In this contribution, the progresses of the next generation media transport protocol, i.e., Media over QUIC(MoQ), are introduced. MoQ is designed by IETF to support a wide range of latency requirements ranging from seconds to tens of milliseconds. Its flexible priority mechanism, inherited from QUIC, ensures that critical information is transmitted preferentially, while less-critical data is dropped first during congestion—an attribute particularly advantageous for supporting Real-time Communication (RTC), especially for the ultra-low latency (ULL) application scenarios. Moreover, MoQ inherits from QUIC the capability to transmit both reliable streams and unreliable datagrams over a single connection. The abovementioned capability and MoQ’s unique hierarchical object data model bring new transmission features, and there is a new possibility to enable ULL applications if the video codec can better fit the new transmission features.

As an essence of the presentation, priority of certain parts of the stream would be matching with QUIC concepts, which is able to drop low-priority parts of the stream. Multiple levels of priority are possible, multiple streams.

[JVET-AM0195](https://jvet-experts.org/doc_end_user/current_document.php?id=15842) AhG18: Gradual Decoding Refresh (GDR) under ultra low latency test scenario [M. Sychev, A. Dzugaev, S. Ikonin, E. Alshina (Huawei)]

This informational proposal provides the results and analysis of Gradual Decoding Refresh technology under ultra-low latency (ULL) test scenario investigated by AhG18. The BD-PSNR results demonstrate a performance of this technique under ULL test conditions: 1.63 dB increase on average for classes A & B at same latency restrictions. Freezing time is decreased by 10% on average for classes A & B. As a supplementary result by request during AhG18 discussions the GDR combined with Scalable (SGDR) solution was evaluated demonstrating synergy effect of efficiency. SGDR further improves the quality under ULL scenario up to 4.44 dB of average performance increase in respect to single layer VTM and freezing time was decreased by 26%. Demo videos solution are provided in the same conditions.

Decision(SW/BF): Include bug fix in GDR encoder to AHG branch (not relevant for main VTM branch).

[JVET-AM0198](https://jvet-experts.org/doc_end_user/current_document.php?id=15845) AhG18: Temporal Scalability under ultra low latency test scenario [M. Sychev, K. Malyshev, S. Ikonin, E. Alshina (Huawei)]

This informational proposal provides the results and analysis of Temporal Scalability approach under ultra-low latency (ULL) test scenario investigated by AhG18. The BD-PSNR results demonstrate a performance of this technique under ULL test conditions: 0.74 dB increase on average for classes A & B at same latency restrictions for IPPI configuration (3dB for A1 class). Freezing time is decreased by 10% on average for class A1, but for other classes the improvements is not such obvious. Demo videos solution are provided in the same conditions.

No action – does not require modification of software.

[JVET-AM0201](https://jvet-experts.org/doc_end_user/current_document.php?id=15848) AHG18: Overview of 3GPP features for Extended Reality (XR) and related high quality conversational services and related implications for ultra-low latency (ULL) coding [R. Mekuria, Q. Pan, X. Ma, S. Ikonin, E. Alshina (Huawei)]

This contribution presents an overview of the features developed in the 3GPP network for Extended Reality (XR) and related high quality conversational video applications. This contribution proposes to develop test conditions related to the 3GPP network that results in losses of “groups of correlated packets” and different prioritization values to packets (1-15 in 3GPP network). Adopting test conditions corresponding to the 3GPP network can benefit both the codec design and potentially adoption in 3GPP network conditions.

It is commented that a mechanism for prioritizing packets as available in modern networks (described in this contribution and similar as described in JVET-AM0188 as well) would be highly desirable in the AHG18 network simulator software.

In this proposal, it is suggested by the proponent to include a test condition that mimics the 3GPP method. It is however suggested to start implementing more generic priority mechanisms for dedicated packets or groups of packets without sticking to some specific protocol. It is also commented that some mechanism of grouping packets is already present in the simulator (for Wifi).Agreed to further study and work on this in the AHG.

[JVET-AM0202](https://jvet-experts.org/doc_end_user/current_document.php?id=15849) AhG18: On ultra low latency and packet loss resilience coding tools integration [V. Zakharchenko (Nokia)]

This document provides a series of observations in scope of AhG 18 on the proposed software, test conditions, and quality metrics reporting for the ultra low latency and packet loss resilience video coding.

This contribution confirms the results reported in JVET-AM0046 for the IPPI configuration catch with the results of the proponent.

This contribution highlights the absence of essential coding tools in the evaluation such as SAO, ALF, temporal filtering, and cross component tools.

This contribution suggests following modifications to the coding conditions:

* Expand a set of tested bitrates to evaluate additional test points, suggested test points may correspond to fixed QPs of 22, 27, 32, 37.
* Report the quality as a set of BD-rate curves per latency restriction in addition to BD-PSNR curves as a function of latency.
* Enable coding tools that have significant influence on the visual quality of the decoded picture.

It had already been agreed in the context of JVET-AM0109 to use a range of 6 QP values, such that BD-PSNR curves can be computed. Though this requires some adaptation of the channel capacity in the network simulator (and generating trace files) per rate point, it is expected that there would be no dependency with the impact of the latency parameter.

Generally, the current results seem to indicate that relatively large PSNR gains are possible for algorithms providing better resilience, whereas BD-rate criteria are often used when the qualities are still relative close. It was agreed to conduct further study on interpreting BD metrics in the AHG, where it should also be investigated what the impact is when the RD graphs are no longer convex due to network errors.

It was agreed that the coding tools that are currently disabled (Deblock filter, cross-component coding tools, SAO, temporal filter coding tools, ALF, MRL) to be re-enabled, as the most recent simulation software is stable when they are set on (see also JVET-AM0203).

[JVET-AM0203](https://jvet-experts.org/doc_end_user/current_document.php?id=15850) AHG18: Full VTM tool set in ultra-low latency test scenario [V. Khamidullin, I. Gribushin, S. Ikonin, E. Alshina (Huawei)]

Ultra-low latency simulation software of AHG18 is currently using simplified encoding configuration with reduced coding tools set originally as it was originally proposed in contribution JVET-AK0193 for sake of VTM software stability on packet loss scenario and simulations speedup. This contribution proposes to enable back full set of VTM coding tools and reports its performance under ultra-low latency test scenario using fast encoding configuration VTM-Reduced-runtime-3 proposed in JVET-AL0055 and used in draft CfE Section 3 (fast encoding) of JVET-АМ0041.

A specific problem that is solved is the possible unavailability of APS.

It was commented that such a software change would no longer allow testing conformant decoder behaviour. It is however pointed out that in case of incomplete bitstreams no conformant behaviour is defined in VVC. There is no normative concealment, etc. Even frame freeze is not normative.

It was asked if the concept could be used together with multi-layer functionality. This should basically be possible, but has not been tested.

It was agreed that the software should be made available in a software branch for further study in AHG (not the main branch currently)

[JVET-AM0204](https://jvet-experts.org/doc_end_user/current_document.php?id=15851) AhG18: Multilayer coding with spatial scalability under ultra low latency test scenario [V. Zakharchenko (Nokia)]

This document provides suggestions related to AhG 18 test conditions and quality metrics reporting for the ultra low latency and packet loss resilience video coding for a multilayer spatial scalable test condition.

This contribution suggests:

* Aspect 1: Evaluating visual quality using any of the multilayer coding condition with an assumption of robust base layer transmission;
* Aspect 2: Evaluating multilayer coding condition using spatial scalability.

It was commented that aspect 1 (assumption of a zero-loss base layer) is not realistic in a low-latency scenario. This could at most be seen as an “optimum case”, but might not even justify investigating robustness of coding tools against data losses, or error concealment in the base layer. As a first step to a priority mechanism, it might be OK, or potentially with lower packet losses than for the enhancement.

The proponent explains that the amount of data in the base layer would be assumed to be low, e.g. 10-15%.

About aspect 2, it was commented that spatial scalability might indeed be needed to have a relatively low amount of rate in the base layer (potentially together with temporal scalability and quality scalability, e.g. using high QP in the base layer).

Further study should be conducted about realistic transmission priority mechanism in networks that foreseen for low-latency scenarios, before defining testing conditions.

[JVET-AM0218](https://jvet-experts.org/doc_end_user/current_document.php?id=15865) AHG18: Solution beyond scalable coding for ultra-low latency and packet loss resilience [S. Ikonin, V. Khamidullin, I. Gribushin, M. Sychev, X. Ma, E. Alshina (Huawei)]

This contribution describes the coding technology beyond scalable coding that can be used for ultra-low latency and packet loss resilient decoding scenarios. The described technology re-uses concept of data partitioning of H.263/4 which separates prediction and residual information into different sub-streams. Additionally, entropy coding of residual coefficients is performed using multiple independent entropy coded chunks. A lost aware NN-based loop filter is further applied to reduce subjective impact of lost residuals and propagation if these errors via inter frame prediction. A demo video files are provided with contribution.

Compared to and on top of a 2-layer SNR scalability with priority of base layer from JVET-AK0183 (vs. adding high priority DP part of the stream of the proposed approach, and the loss-aware loop filter). Gain is 2.2 dB on average.

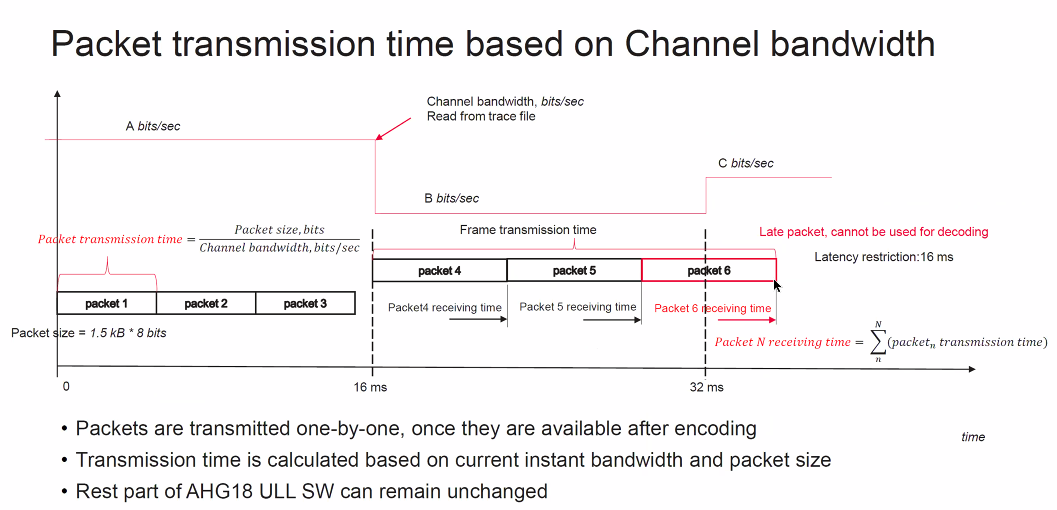
About 3% overhead for the multiple chunks.

The loss aware loop filter gets information which parts of the picture are lost. It was trained on VTM streams using BVI-DVC plus error patterns.

Contribution for information – no specific action proposed.

[JVET-AM0222](https://jvet-experts.org/doc_end_user/current_document.php?id=15869) AHG18: On test conditions for ultra-low latency and packet loss resilience [S. Ikonin, I. Gribushin, M. Sychev, E. Alshina (Huawei)]

This contribution proposes simplification of ultra-low latency test by replacing packet trace files by channel bandwidth traces, introduces single frame reconstruction test under various packet loss conditions, and optional configuration of bypassing portion of key important information suitable for scalable coding technologies.

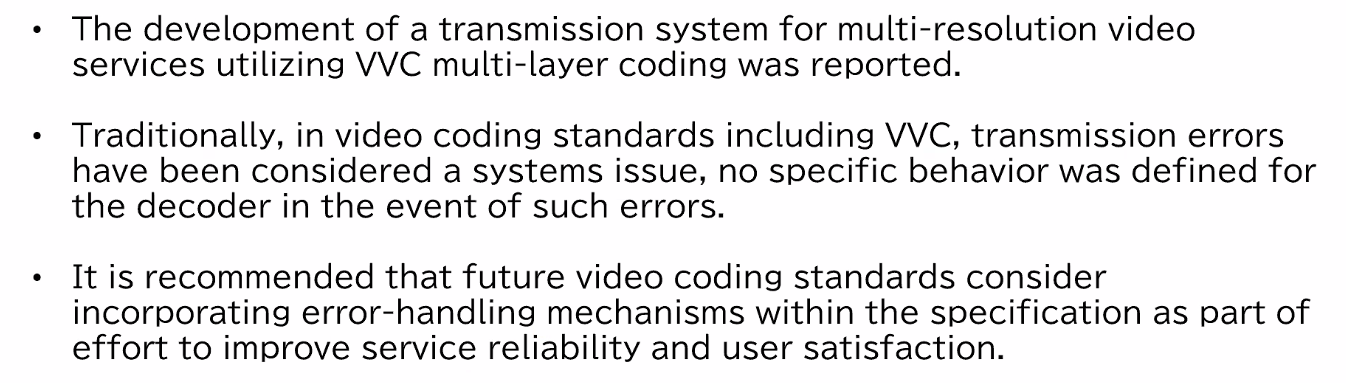


It was commented that the bypassing of high priority packets could also be extended by giving them priority in the queue, i.e. shifting them forward such that they will be lost with less probability. As a first step, bypassing would be appropriate.

Further study in AHG, is assessed to have advantages for simplifying simulations, and also introducing priority mechanisms.

[JVET-AM0235](https://jvet-experts.org/doc_end_user/current_document.php?id=15882) Implementation of error resilient transmission system for scalable services [S. Iwamura, S. Nemoto, Y. Kondo, A. Ichigaya (NHK)]

This contribution reports development of transmission system of multi-resolution video services using VVC multi-layer coding for providing videos with appropriate quality/resolution according to the reception environment. The developed transmission system assumes that different paths are used for the transmission of the base layer and the enhancement layer and introduces bitstream synthesis processing to reconstruct the original multi-layer bitstream from separately transmitted data while compensating for the transmission delay of each path. Furthermore, an error concealment function is incorporated to the system to maintain service quality when the transmission quality of the enhancement layer deteriorates.



It was commented that in a broadcast scenario packet losses do not occur by low latency effects, but rather by the fact that certain packets may not reach certain users, and no feedback.

An approach of “dummy data” is suggested that can be used for concealment in case of data losses.

No specific action for JVET.

[JVET-AM0325](https://jvet-experts.org/doc_end_user/current_document.php?id=15993) AHG18: BD-PSNR as alternative evaluation metric for ultra-low latency test scenario [M. Sychev, K. Malyshev, S Ikonin, E. Alshina (Huawei)] [late]

This informational proposal provides an example of usage Bjontegaard (BD-PSNR) metric for ultra-low latency (ULL) test scenario investigated by AhG18 and test conditions proposed in JVET-AL0176. The BD-PSNR results comply with observed quality improvement for results obtained in ULL evaluation. Documents demonstrate the behavior of BD-PSNR and BD-rate for some corner cases.

Some test successfully passing video through the channel without freezes which leads to horizontal curves with similar value which is critical for BD-Rate calculation due to vertical integration, but BD-PSNR succeed in all of such cases. This allows to avoid “#VALUE” in excel tables and to obtain average single number of obtained results.

For further study in AHG – see notes under JVET-AM0109 and JVET-AM0202.

## CICP (2)

Contributions in this area were discussed during 1815–1900 on Monday 30 June 2025, and during 1215–1300 and 1450-1520 on Wednesday 2 July 2025 (chaired by JRO).

[JVET-AM0089](https://jvet-experts.org/doc_end_user/current_document.php?id=15736) On CICP TuC for monochrome content [J. Boyce, M. M. Hannuksela (Nokia), A. Tourapis, D. Podborski (Apple)]

Several modifications are proposed to the CICP TuC in JVET-AH1005 related to monochrome content, as summarized below:

1. Add a ColourPrimaries codepoint table entry 128 for Monochrome unspecified, and renumber entries 128-129 to 129-130

2. Add a HasColourCoordinates variable to the interpretation of the ColourPrimaries codepoint value

3. Modify MatrixCoefficients codepoint table entries 19 and 20 so that the order of colour components is GBR/YZX rather than GRB/YXZ

4. Provide equations to derive Y, Cb, and Cr values for ColourPrimaries codepoint values 128 to 130 and MatrixCoefficients codepoint values 18 to 23

5. Editorial changes

It is also proposed to output a CICP version 5 working draft at this meeting based on the attached specification text.

For the first aspect, the motivation is that unspecified logically comes before a variety of specified values.

For the second aspect, it was discussed that instead of a variable flag HasColourCoordinates, this could be extended to an idc value, e.g. indicating that additional information is necessary to interpret a depth map. For the scope of the current proposal, this is not necessary.

For the third aspect, the motivation is that GBR is more commonly used than GRB (logical order)

For the fourth aspect, also matrix coefficients would be used for unspecified, alpha and depth, when carried in the monochromatic picture. The update in version 2 of the document clarifies that this can only be used in combination with matrix coefficient types 18, 19 and 20. It was commented that the equations 88-92 are not actually needed for depth maps and alpha carried in the Y component, but the bitstream should contain information how to interpret them, e.g. by SEI message. Further study may be necessary to clarify how this SEI message could be made available, as currently SEI messages relating to alpha or depth can only be used and associated with auxiliary layers. An informal note should be added that some external means would be necessary to interpret the usage of the values 128-130. A draft of such a note was provided in v3 of JVET-AM0089 and reviewed Wed. 2 July afternoon. The note was agreed to be appropriate.

Aspects 1-3 as well as fifth aspect (editorial) should be agreeable

Before deciding of giving it a more official draft status, it needs to be clarified if the other aspect of the TuC JVET-AH1005 is still relevant, and technically mature – there has been no contribution since April 2024. Revisit after review of JVET-AM0335.

[JVET-AM0335](https://jvet-experts.org/doc_end_user/current_document.php?id=16003) Signaling of Generic Subsample Information [L. Barnes, A. Tourapis, D. Podborski (Apple)] [late]

In the CICP TuC document, a definition is provided for subsampling and generic sample location signaling. The current HEIF amendment already defines such signaling, and we believe that including this signaling in the CICP specification is the appropriate approach. We therefore propose to move the relevant parts from the TuC document into an amendment of the CICP specification, and updating the definitions to align with the HEIF amendment.Some values in table 10 of JVET-AH1005 were found to be not consistent with the definitions in an amendment of HEIF that is currently under development in WG 3. Otherwise, some editorial updates are proposed.

Agreed to include in TuC or Draft of CICP extension.

Decision: Issue JVET-AM1005 as “CICP extensions (draft 1)” including JVET-AM0089 and JVET-AM0335.

# Low-level tool technology proposals (94)

## AHG11/AHG14: Neural network-based video coding (25)

### Summary and BoG reports (2)

Contributions in this area were discussed during 1500–1620 on Thursday 26 June 2025 (chaired by JRO).

[JVET-AM0023](https://jvet-experts.org/doc_end_user/current_document.php?id=15913) 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 NNVC13.0, anchor is default configuration of **NNVC-13.0** (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 was used. 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 close to existing NNVC tool complexity, but not exceeding it**:**

1. kMAC/pxl of EE1 test ≤ kMAC/pxl NNVC (*must*),
2. the number of channels (both input and output) in neural network modules which are modified **must be keep multiple of 16**,
3. Number of Parameters EE1 test ≤ Number of Parameters NNVC (*if possible*).

If it is not possible to respect both constrains 1) and 2) at the same time then two sub tests need to be performed: first test respecting the constrain 1) only – in order to prove the value of the proposed change, and the second test respecting constrain 2) with minor violation of 1) - in order to provide software and hardware friendly design.

Only tests with results provided to quantized (int 16) model are considered for adoption to NNVC, float point model results are provided just for information.

Exact parameters settings were announced by proponents by 2nd AhG11/14 teleconference on May 23 [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.

**List of tests**

This round of EE1 tests includes:

* *EE1-1: LOP in-loop filter* 
  + EE1-1.1 – Sample-based adaptive blending weight selection for LOP [JVET-AM0123](https://jvet-experts.org/doc_end_user/current_document.php?id=15770)
  + EE1-1.2 – Over-Parameterized LOP In-Loop Filter [JVET-AM0120](https://jvet-experts.org/doc_end_user/current_document.php?id=15767)
  + EE1-1.3 – Backbone Block Enhancement of LOP In-Loop Filter with Over-Parameterized Training and Variable Channels [JVET-AM0122](https://jvet-experts.org/doc_end_user/current_document.php?id=15769)
  + EE1-1.4 – Conditional loop-filter (withdrawn)
* *EE1-2: VLOP in-loop filter* 
  + EE1-2.1 – Improved VLOP with Attention [JVET-AM0135](https://jvet-experts.org/doc_end_user/current_document.php?id=15782)
  + EE1-2.2 – Conditional loop-filter [JVET-AM0053](https://jvet-experts.org/doc_end_user/current_document.php?id=15700)
* *EE1-3: NN-inter prediction*
  + EE1-3.1 – RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding [JVET-AM0114](https://jvet-experts.org/doc_end_user/current_document.php?id=15761)
  + EE1-3.2 – Deep Reference Frame Generation for Inter Prediction Enhancement [JVET-AM0175](https://jvet-experts.org/doc_end_user/current_document.php?id=15822)
* *EE1-4: NN-based super-resolution*
  + EE1-4.1 – Cross-component enhanced NNSR [JVET-AM0257](https://jvet-experts.org/doc_end_user/current_document.php?id=15924)

**Test results summary**

Details of each test can be found in attached presentation.

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

The complexity for LOP filter is 16.6 kMAC/pxl (including MaxPool and HardSigmoid), 247 K parameters.

Results of tests in this category are summarized in the

*Table 1* ***EE1 LOP in-loop filter modifications***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Random Access | | | | | Low-delay-B | | | | | kMAC/pxl | | | Num Param, M | | |
| Y | U | V | EncT | DecT | Y | U | V | EncT | DecT | Total | Filter | Intra | Total | Filter | Intra |
| NNVC-LOP6 | 0.0% | 0.0% | 0.0% | 100% | 100% | 0.0% | 0.0% | 0.0% | 100% | 100% | 21.4 | 16.6 | 4.8 | 1.5 | 0.247 | 1.3 |
| EE1-1.1.1 | -0.1% | -0.2% | -0.2% | 100% | 103% | -0.1% | -0.7% | -0.8% | 102% | 101% | 21.4 | 16.6 | 4.8 | 1.5 | 0.247 | 1.3 |
| EE1-1.1.2 | -0.1% | -0.2% | -0.2% | 99% | 103% | -0.1% | -0.8% | -0.9% | 100% | 102% | 21.4 | 16.6 | 4.8 | 1.5 | 0.247 | 1.3 |
| EE1-1.1.3 | -0.1% | -0.2% | -0.2% | 99% | 103% | -0.1% | -1.0% | -1.3% | 101% | 102% | 21.4 | 16.6 | 4.8 | 1.5 | 0.247 | 1.3 |

Tests EE1-1.1 do not require training. Only filter use has been changed, by modifying blending weights at sample level.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Random Access | | | | | All Intra | | | | | kMAC/pxl | | | Num Param, M | | |
| Y | U | V | EncT | DecT | Y | U | V | EncT | DecT | Total | Filter | Intra | Total | Filter | Intra |
| NNVC-LOP6 | 0.0% | 0.0% | 0.0% | 100% | 100% | 0.0% | 0.0% | 0.0% | 100% | 100% | 21.4 | 16.6 | 4.8 | 1.5 | 0.247 | 1.3 |
| EE1-1.2 |  |  |  |  |  | 0.0% | -0.2% | -0.2% |  |  | 21.4 | 16.6 | 4.8 | 1.5 | 0.247 | 1.3 |
| EE1-1.3 |  |  |  |  |  | -0.1% | -0.6% | -0.2% |  |  | 21.4 | 16.6 | 4.8 | 1.5 | 0.247 | 1.3 |

Tests EE1-1.2 and 1.3 require change of training. Due to the over-parametrization training time increases from 170 to 180 (EE1-1.2) and 190 (EE1-1.3) hours. Run time is not reported.

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Random Access | | | | | Low-delay-B | | | | | kMAC/pxl | | | Num Param, M | | |
| Y | U | V | EncT | DecT | Y | U | V | EncT | DecT | Total | Filter | Intra | Total | Filter | Intra |
| NNVC-VLOP3 | 0.0% | 0.0% | 0.0% | 100% | 100% | 0.0% | 0.0% | 0.0% | 100% | 100% | 9.9 | 5.1 | 4.8 | 1.4 | 0.067 | 1.3 |
| EE1-1.2.1 | 0.0% | 0.0% | 0.0% | 99% | 101% | -0.1% | -0.5% | -1.0% | 100% | 102% | 9.9 | 5.1 | 4.8 | 1.4 | 0.067 | 1.3 |
| EE1-1.2.2 | 0.0% | 0.1% | 0.1% | 100% | 101% | -0.1% | -0.3% | -1.2% | 100% | 102% | 9.9 | 5.1 | 4.8 | 1.4 | 0.067 | 1.3 |
| EE1-2.1 | -0.5% | -1.1% | -0.4% | 99% | 110% | -0.3% | -1.9% | 0.0% | 102% | 113% | 9.9 | 5.1 | 4.8 | 1.4 | 0.073 | 1.3 |
| EE1-2.2.1 | 0.0% | -0.2% | -0.1% | 100% | 113% | 0.0% | -0.8% | -2.0% | 100% | 109% | 10.7 | 5.9 | 4.8 | 1.4 | 0.073 | 1.3 |
| EE1-2.2.2 | 0.1% | 0.0% | 0.0% | 101% | 100% | 0.1% | -1.1% | -2.1% | 101% | 103% | 9.9 | 5.1 | 4.8 | 1.4 | 0.073 | 1.3 |

Tests EE1-1.1 and EE1-2.2 do not require training. Only filter use has been modified. N the worst case some operations (head and fusion blocks) in EE1-2.2.1 design will be executed twice, additional complexity is 0.8 kMAC/pxl so total complexity of filter is 5.9 kMAC/pxl.

In test EE1-2.1 attention module (similar to one in LOP) has been added to VLOP. Training time reported to be 240 hours. In variant of EE1-2.1 with improved SIMD code, decoding run time increase is lower (not 110%, but 103% in RA test).

*Table 3* ***EE1 NN-Inter tests***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 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% | 21.4 | 0 | 1.5 | 0 |
| EE1-3.1 | -4.2% | -4.8% | -5.4% | 101% | ??? | -3.3% | -4.9% | -4.1% | 102% | ??? | 508 | 487 | 7 | 5.5 |
| EE1-3.2 | -1.9% | -1.0% | -1.0% | 133% | 2188% |  |  |  |  |  | 525 | 504 | 5.3 | 3.8 |

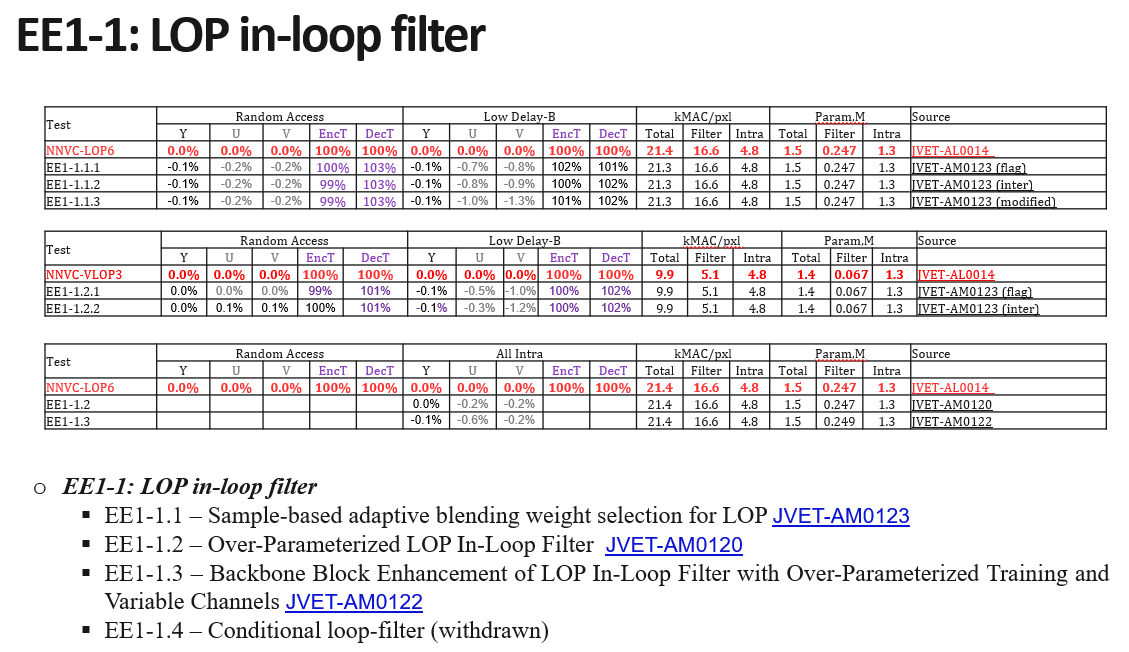
No decoding run time reported for EE1-3.1. Increases of computational complexity is significant.

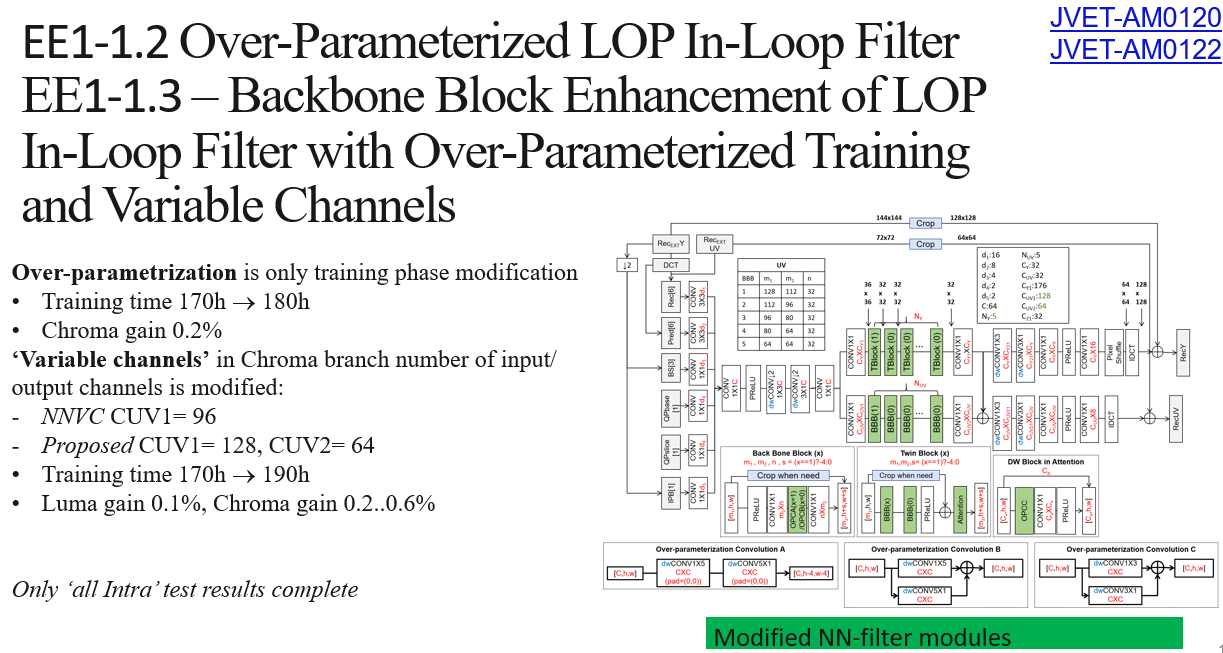
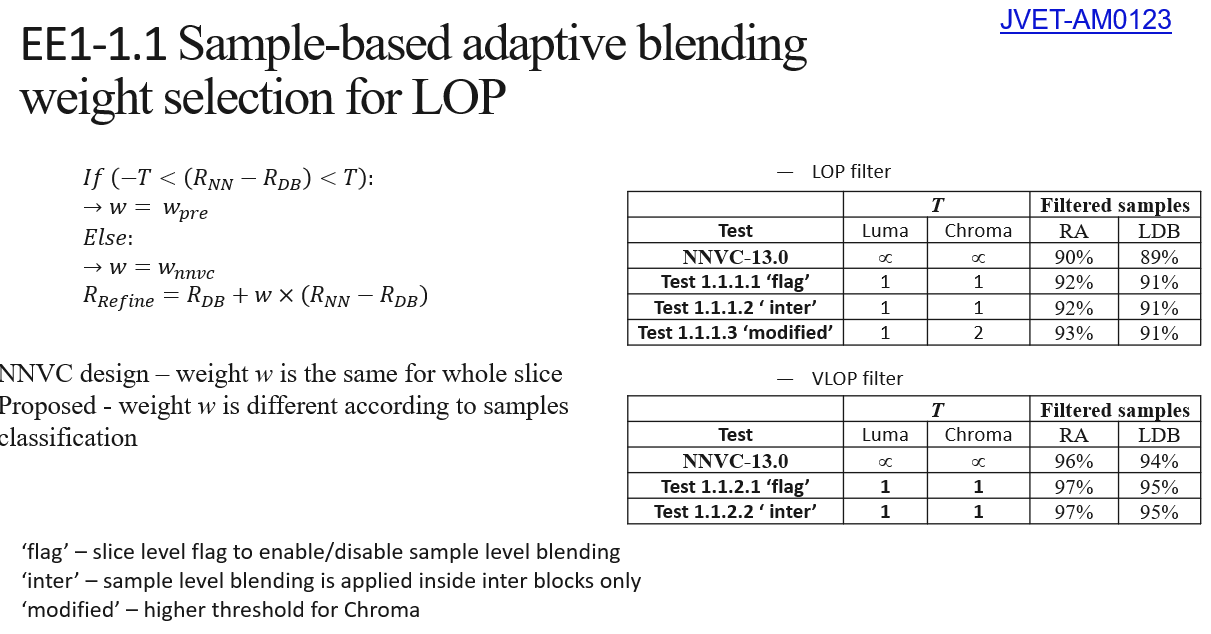
Code for EE1-3.2 made available after deadline, no LD-B results provided.

*Table 4* ***EE1 NN-super resolution test***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 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% | 26.1 | 4.7 | 21.1 | 0.020 |
| EE1-4.1 |  |  |  |  |  | -0.2% | -1.2% | .0.9% | 105% | ??? | 26.6 | 5.2 | 29.0 | 0.027 |

Dec Run time is not reported, only all-intra test conducted. BD-rate is very content dependent, varies in a range -3%...1%.



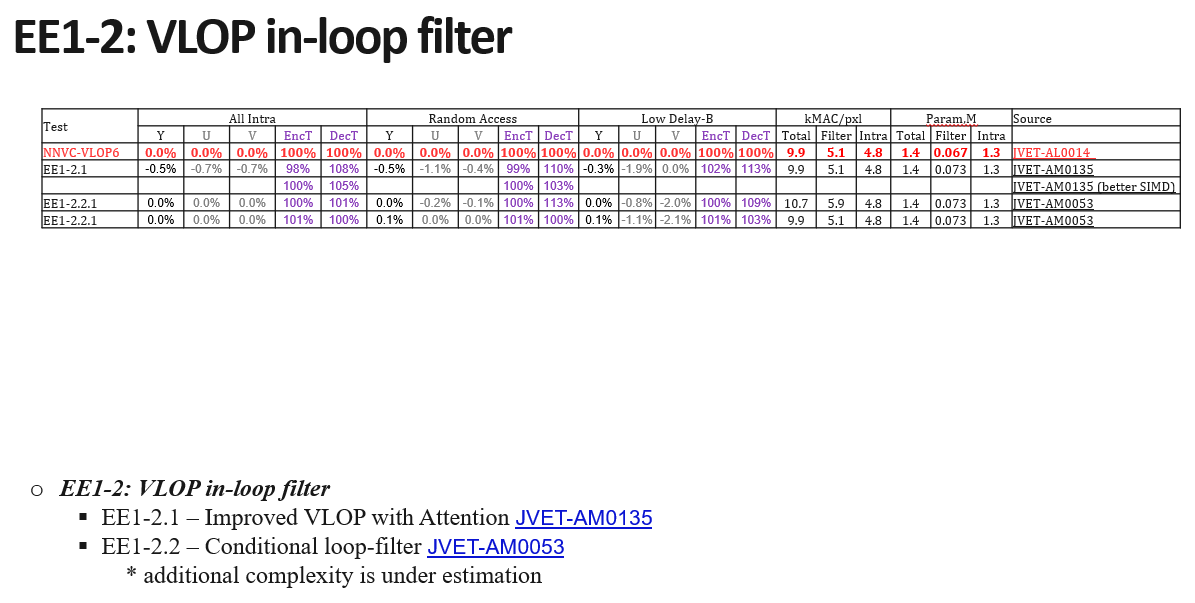


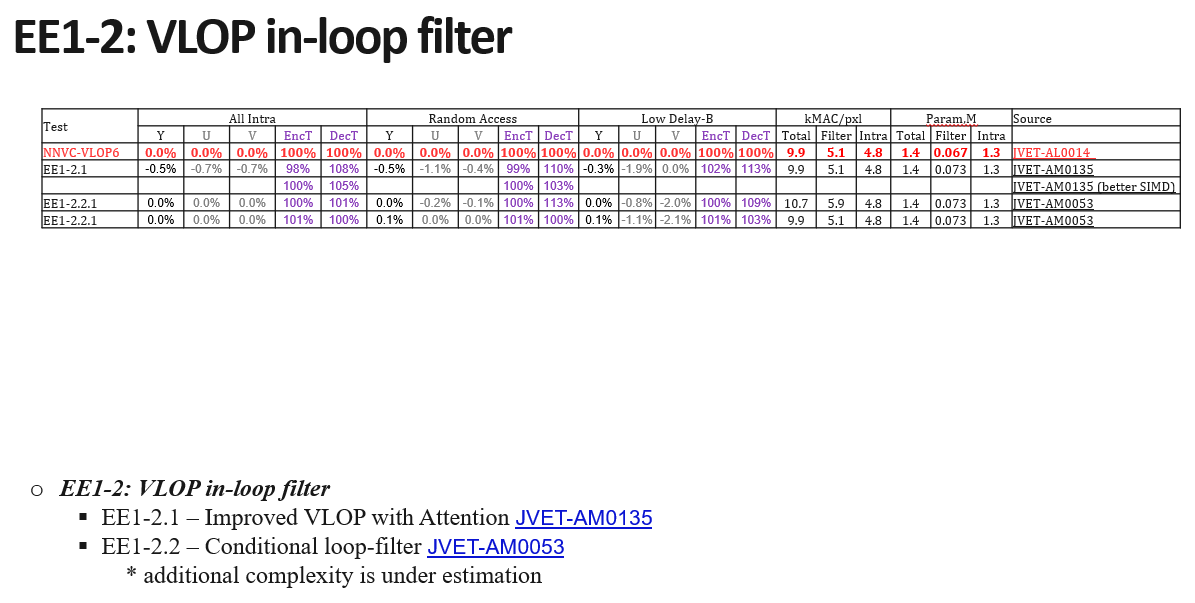
Test 1.1 inference crosscheck still running (results matching so far). However, the adaptive blending requires some additional processing that is reflected by increased decoder runtime, also an additional pass at the encoder to determine samples used to calculate the weights, and gain is relatively low. It is noted that this additional processing is not reflected in kMAC/pix numbers.

Not enough benefit to justify adoption.

For tests 1.2 and 1.3, training crosscheck was not performed yet. It was also commented that it is still floating-point implementation.

Not mature yet.



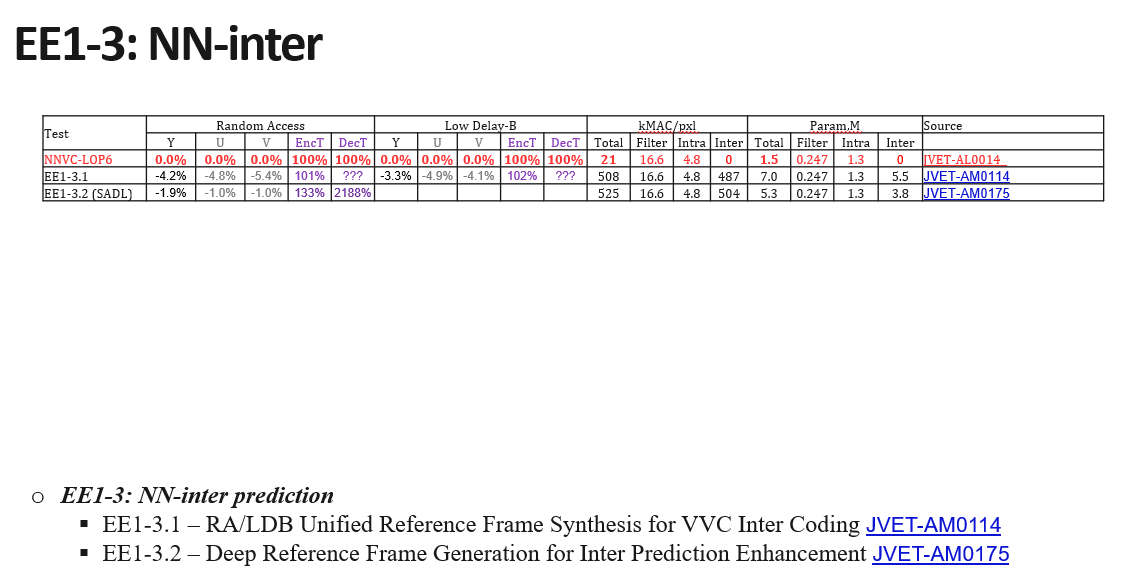


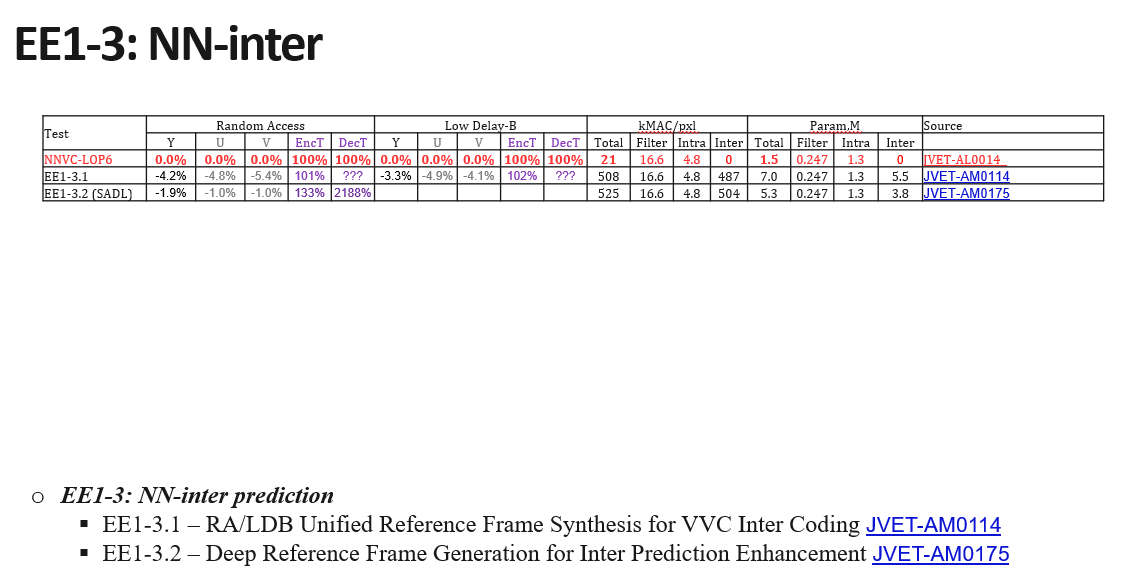
2.1 uses an equivalent attention mechanism in VLOP as already included in LOP (which in previous experiments had produced loss in VLOP). Gain of 0.5% is attractive, but decoder runtime is significantly increased. The SIMD implementation has a much better tradeoff, but it was asked if a similar optimization could not also implemented in the VLOP anchor. Candidate for adoption. It is also noted that the attention mechanism had also dec runtime impact for LOP, and SIMD implementation could be beneficial for LOP as well.

Follow-up discussion on Tuesday 1 July 1145. More results provided in v2 of JVET-AM0135, which indicate (with comparable SIMD optimization) 1% CPU encoding run time increase and 7% CPU decoding runtime increase relative to the anchor. It is asserted that the runtime on GPU would be even faster than the anchor.

Decision: Adopt JVET-AM0135 test 2.1

2.2 has compression benefit only for chroma in LB, but decoder runtime increase is significant. Not fully crosschecked yet – further study in EE for better tradeoff.

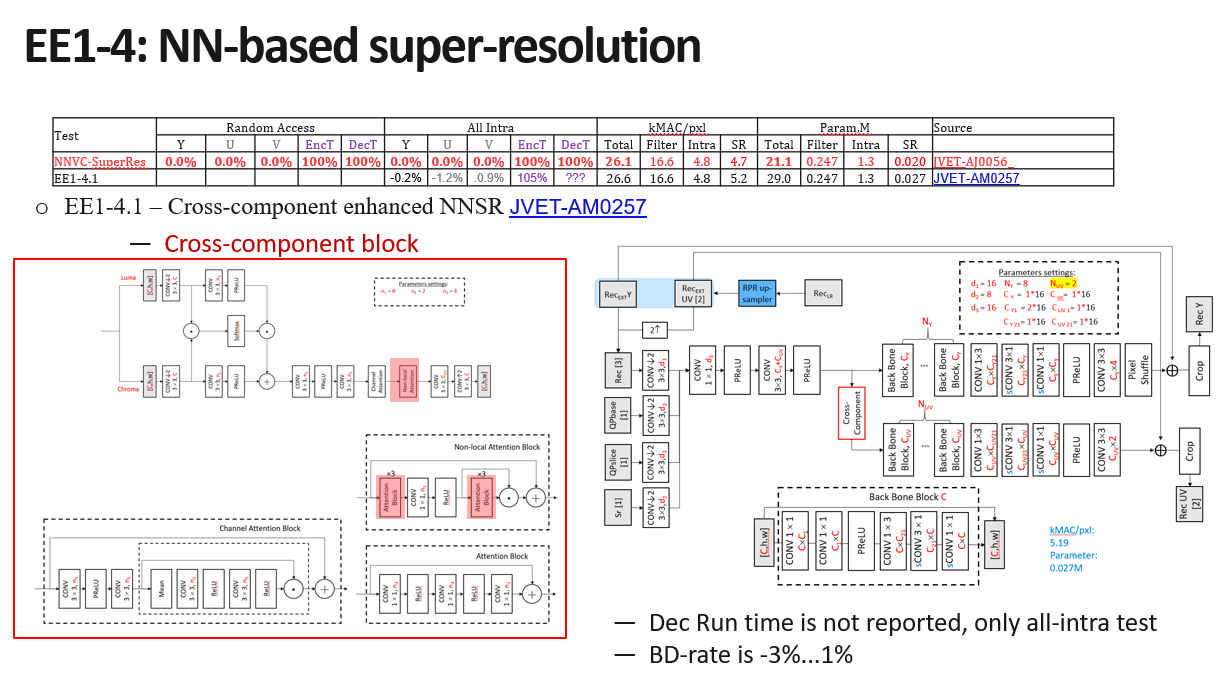




3.1 (though giving higher gain) does not fulfill requirements for adoption yet (not integerized, decoding runtime unknown, training crosscheck not finished).

3.2 is fully integerized and cross-checked (including training using Vimeo90K, also training script is available). Though the runtime tradeoff is not good, it is a new element not available in NNVC so far, and including it in the software is beneficial as starting point for further study. Decision: Adopt JVET-AM0175 (non CTC, also provide training script).

It was later reported that the original implementation was not fully converted to integer, but this had been fixed with the help of the software coordinator, and even minor performance improvement was achieved.



4.1 is not fully cross-checked yet. Results also indicate high dependency on sequence (loss in several cases). It was commented that potentially the switched-resolution processing has disadvantages for some sequences. Further study in EE.

[JVET-AM0043](https://jvet-experts.org/doc_end_user/current_document.php?id=15690) [AHG11] [AHG14] Teleconference on NNVC [E. Alshina, F. Galpin]

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

Contributions in this area were discussed in the context of the EE summary report JVET-AM0023.

[JVET-AM0053](https://jvet-experts.org/doc_end_user/current_document.php?id=15700) EE1-2.2: Conditional loop-filter [M. Santamaria, F. Cricri, N. Le (Nokia)]

[JVET-AM0114](https://jvet-experts.org/doc_end_user/current_document.php?id=15761) EE1-3.1: RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding [Q. Qin, C. Jung (Xidian Univ.)]

[JVET-AM0282](https://jvet-experts.org/doc_end_user/current_document.php?id=15949) Crosscheck of JVET-AM0114 (EE1-3.1: RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding) [N. Bhaskar (Huawei)] [late]

[JVET-AM0120](https://jvet-experts.org/doc_end_user/current_document.php?id=15767) EE1-1.2: Over-Parameterized LOP In-Loop Filter [J. Han, C. Jung, Q. Qin (Xidian Univ.)]

[JVET-AM0293](https://jvet-experts.org/doc_end_user/current_document.php?id=15961) Crosscheck of JVET-AM0120 (EE1-1.2: Over-Parameterized LOP In-Loop Filter) [T. Yang, W.-X. He, Y.-Q. Zhu, J.-D. Ye, X.-T. Xie, J.-S. Gong, Q. Liu (HUST), Z.-Y. Lv (vivo)] [late]

[JVET-AM0122](https://jvet-experts.org/doc_end_user/current_document.php?id=15769) EE1-1.3: Backbone Block Enhancement of LOP In-Loop Filter with Over-Parameterized Training and Variable Channels [J. Han, C. Jung, Q. Qin (Xidian Univ.)]

[JVET-AM0294](https://jvet-experts.org/doc_end_user/current_document.php?id=15962) Crosscheck of JVET-AM0122 (EE1-1.3: Backbone Block Enhancement of LOP In-Loop Filter with Over-Parameterized Training and Variable Channels) [[T. Yang](mailto:y_tian@hust.edu.cn), W.-X. He, Y.-Q. Zhu, J.-D. Ye, X.-T. Xie, J.-S. Gong, Q. Liu (HUST), Z. -Y. Lv (vivo)] [late]

[JVET-AM0123](https://jvet-experts.org/doc_end_user/current_document.php?id=15770) EE1-1.1: Sample-based adaptive blending weight selection for NN-based in-loop filter [H. Kwon, H. Ko (Hanyang Univ.)]

[JVET-AM0318](https://jvet-experts.org/doc_end_user/current_document.php?id=15986) Crosscheck of JVET-AM0123 (EE1-1.1: Sample-based adaptive blending weight selection for NN-based in-loop filter) [J. Yoon, J. Lim (LGE)] [late]

[JVET-AM0135](https://jvet-experts.org/doc_end_user/current_document.php?id=15782) EE1-2.1: Improved VLOP Attention with SIMD acceleration [Y. Li, M. Coban, M. Karczewicz, L. Kerofsky (Qualcomm)]

[JVET-AM0272](https://jvet-experts.org/doc_end_user/current_document.php?id=15939) Crosscheck of JVET-AM0135 (EE1-2.1: Improved VLOP Attention with SIMD acceleration) [M. Santamaria (Nokia)] [late]

[JVET-AM0175](https://jvet-experts.org/doc_end_user/current_document.php?id=15822) EE1-3.2: Deep Reference Frame Generation for Inter Prediction Enhancement [X. Chen, N. Fu, W. Zhang, J. Zhang, D. Ding, W. Ma, Z. Chen (Wuhan Univ.)]

[JVET-AM0267](https://jvet-experts.org/doc_end_user/current_document.php?id=15934) Crosscheck of JVET-AM0175 (EE1-3.2: Deep Reference Frame Generation for Inter Prediction Enhancement) [N. Bhaskar (Huawei?)] [late]

[JVET-AM0283](https://jvet-experts.org/doc_end_user/current_document.php?id=15950) crosscheck of JVET-AM0175 (EE1-3.2: Deep Reference Frame Generation for Inter Prediction Enhancement) [Z. Xie (OPPO)] [late]

[JVET-AM0257](https://jvet-experts.org/doc_end_user/current_document.php?id=15924) EE1-4.1: Cross-component enhanced NNSR [T. Yang, W.-X. He, Y.-Q. Zhu, J.-D. Ye, X.-T. Xie, J.-S. Gong, Q. Liu (HUST), Z.-Y. Lv (vivo)] [late]

[JVET-AM0275](https://jvet-experts.org/doc_end_user/current_document.php?id=15942) Crosscheck of JVET-AM0257 (EE1-4.1: Cross-component enhanced NNSR) [J. Han, C. Jung, Q. Qin (Xidian Univ.)] [late]

### EE1 related and beyond-EE contributions: Neural network-based video coding (13)

Contributions in this area were discussed during 0800–1155 on Sunday 29 June 2025 (chaired by JRO).

[JVET-AM0050](https://jvet-experts.org/doc_end_user/current_document.php?id=15697) AHG 14: Work on NN-coded Base Layer in VTM / NNVC [F. Brand, T. Solovyev, E. Alshina Huawei), F. Urban, F. Galpin (InterDigital)]

In the April meeting, JVET decided to start developing a framework for including NN-coded reference frames into VVC / NNVC. A first version was provided by InterDigital. This version required an additional YUV sequence containing the reconstructed NN-coded frames, which needs to be passed to both encoder and decoder. This strategy makes the system very versatile with respect to the used NN-coder, however it has the drawback that is not easy to verify that the reported results are correct, since it relies on external bit-stream counting. This contribution presents modifications made to the code to alleviate this problem. In particular this includes

• Providing hooks in form of external scripts which call the NN-based coder

• Including the bitstream of the NN-coder into the main bitstream

• Decoding the NN-coder bitstream during encoding time

The code is available under <https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/VVCSoftware_VTM/-/tree/hybrid_codec_e2e_dev>

NN intra stream is transported in a new type of NAL unit. Possible to use with any NN based intra codec by modifying script.

Still more development necessary (bug fixes, extension to more than one I picture, enable LMCS, integration in new NNVC based on VTM23) – planned for subsequent meeting cycle.

Software should also work without NN coded base layer (was tested in an earlier stage of development).

Some loss observed for class A1.

Currently, only limited possibility of joint optimization of NN based and VTM layers. Quality of NN codec can be controlled by QP. As a first step, a CTU based switching might be implemented. Joint RDO may be difficult.

No immediate action – further development in AHG11/14

It was later reported that the reason for the mismatch had been found and fixed during the meeting.

[JVET-AM0057](https://jvet-experts.org/doc_end_user/current_document.php?id=15704) AHG11: A Hybrid Framework Integrating End-to-End Learned Image 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 image 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 (W/O PFT):

Class A1 -1,08 % (Y), 0,07 % (Cb), -0,94 % (Cr)

Class A2 -0,96 % (Y), 0,07 % (Cb), 1,27 % (Cr)

Class B -0,62 % (Y), -3,06 % (Cb), -1,56 % (Cr)

Class C -0,72 % (Y), -3,37 % (Cb), -3,62 % (Cr)

Class D -0,92 % (Y), -2,55 % (Cb), -2,57 % (Cr)

The system finetuned further with MSE, MS-SSIM and rate losses (W/ PFT):

Class A1 1,71 % (Y), 4,46 % (Cb), -0,42 % (Cr)

Class A2 -0,38 % (Y), -4,51 % (Cb), 2,14 % (Cr)

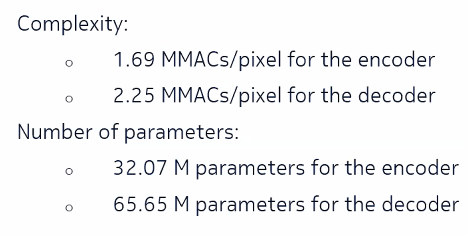
Class B -0,16 % (Y), -6,27 % (Cb), -5,90 % (Cr)

Class C 1,25 % (Y), 1,74 % (Cb), 1,38 % (Cr)

Class D 0,20 % (Y), 1,42 % (Cb), 0,79 % (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 | -5,90% | -6,79% | -5,16% | -6,29% | -5,31% | -6,67% | -5,71% | -4,27% | -5,37% |
| W/ PFT | -10,06% | -13,29% | -7,96% | -8,69% | -7,63% | -11,93% | -6,16% | -4,83% | -14,75% |



It was commented that the approach could be fully implemented using the framework developed in JVET-AM0050. The switching could be implemented by either putting zero information into base layer (pure VVC) or zero information into enhancement layer (pure NN).

Further investigation in jointly developing the interface proposed in JVET-AM0050, such that it also supports the approach of JVET-AM0057.

[JVET-AM0115](https://jvet-experts.org/doc_end_user/current_document.php?id=15762) EE1-related: URFS Performance Comparison on NNVC-4.0 and NNVC-9.0 Training Sets [Q. Qin, C. Jung (Xidian Univ.)]

This contribution explores how varying degrees of compression artifacts affect the training and performance of reference frame generation models. Specifically, two versions of the NNVC codec, NNVC-4.0 and NNVC-9.0, are employed to compress the Vimeo-90K triplet dataset and generate two compressed training sets, respectively. NNVC-4.0, LOP and NN-Intra disabled by default, generates reconstruction data with more compression artifacts, while LOP and NN-Intra are enabled by default in NNVC-9.0, resulting in fewer compression artifacts in the generated compressed dataset. To study the impact of training sets with varying degrees of compression artifacts on reference frame generation, the Unified Reference Frame Synthesis (URFS) model, as proposed in JVET-AL0105, is trained separately on the NNVC 4.0 and NNVC 9.0 training sets. Then, two generated URFS models are evaluated under the RA and LDB configurations of NNVC-12.0 (LOP and NN-Intra enabled by default). The BD-rate performance in PSNR are as follows:

 For training sets from NNVC-4.0 (LOP and NN-Intra disabled), URFS achieves average {RA: 3.30%, 3.70%, 4.36%} and {LDB: 2.73%, 4.69%, 5.52%} BD-rate gains for {Y, U, V} components.

 For training sets from NNVC-9.0 (LOP and NN-Intra enabled), URFS achieves average {RA: 4.25%, 4.73%, 5.38%} and {LDB: 3.35%, 4.22%, 4.50%} BD-rate gains for {Y, U, V} components.

Further investigate in EE (only if there is no encoder/decoder mismatch or decoding from bitstream crashes, to be proven until the finalization of EE plan)

Also integerization and SADL implementation to be conducted and tested until next meeting if it is put into EE.

[JVET-AM0116](https://jvet-experts.org/doc_end_user/current_document.php?id=15763) EE1-related: Comparative Analysis of URFS in AJ0099, AK0077, and AL0105 [Q. Qin, C. Jung (Xidian Univ.)]

The RA/LDB unified reference frame synthesis (URFS) models for VVC inter coding have been proposed in the previous JVET meetings. This contribution reports a performance comparison of three URFS models (i.e., JVET-AJ0099, JVET-AK0077, and JVET-AL0105) in the RA configuration, all of which are trained on the compressed Vimeo-90K triplets. On top of the NNVC-12.0 anchor (NNVC tools are enabled by default), URFS achieves the following BD-rate performance improvements:

 JVET-AJ0099 URFS-1.0 achieves average BD-rate reductions of {3.48% (Y), 4.38% (U), 4.30% (V)}. The complexity is 727kMAC/pixel and 1.90M.

 JVET-AK0077 URFS-2.0 achieves average BD-rate reductions of {x.xx% (Y), x.xx% (U), x.xx% (V)}. The complexity is 649kMAC/pixel and 1.63M.

 JVET-AL0105 URFS-3.0 achieves average BD-rate reductions of {4.25% (Y), 4.73% (U), 5.38% (V)}. The complexity is 487kMAC/pixel and 2.75M.

See comments under JVET-AM0115.

[JVET-AM0131](https://jvet-experts.org/doc_end_user/current_document.php?id=15778) AHG11: LOP with Overlapped Feature Integration [J. Chi, A. Li, Y. Du, Ce Zhu, L. Luo, H.Guo (UESTC), Y. Huo, Y. Liu (Transsion)]

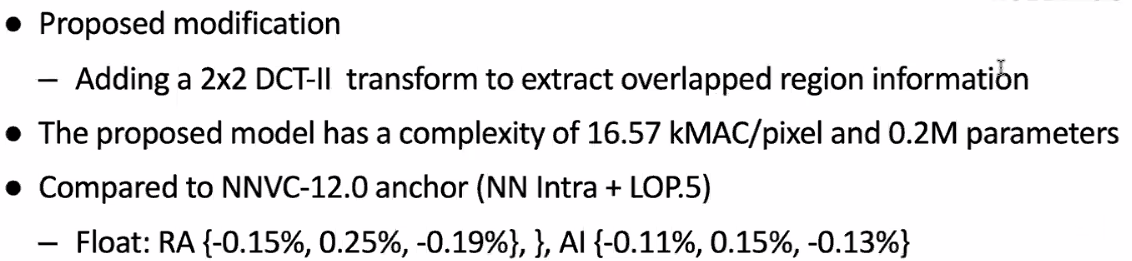
This contribution propose to leverage overlapped pixel features to enhance reconstruction quality while maintaining low complexity. By introducing innovative cropping and padding operations, the design captures spatial correlations at adjacent DCT block boundaries, addressing the limitation of traditional 2×2 DCT-based methods that ignore overlapping region information. The proposed model employs a grouped convolution fusion framework for Y and UV components, reducing computational redundancy and achieving a balance between complexity and performance.

The performance of the LOP float model (including NNIntra) compared to the NNVC-12.0 anchor (NNIntra+LOP5) is reported to be:

AI {-0.11%, 0.15%, -0.13%},

RA {-0.15%, 0.25%, -0.19%},

It is proposed to study the overlapped feature integration model in the next EE.



Decreased decoding time reported for RA is unreliable. Increase of decoding time for AI (125%) due to group accumulation?

Comparison is done against LOP float model. Number of kMAC/pix not increased compared to LOP

Gain is lower when the training strategy of current LOP is used. Could LOP also be improved by modifying the training strategy?

Investigate in EE. The benefits of the three aspects: Overlap, group accumulation, changed training should be investigated separately, and decoder run time shall become more reasonable.

[JVET-AM0143](https://jvet-experts.org/doc_end_user/current_document.php?id=15790) AHG11: Feature Fusion-Based Post-Filter for Efficient Video Enhancement [T. Das, K. Choi (KHU), B.-S. Kim, I. Cho, S. Hahm (KBS)]

This contribution investigates the application of a neural network-based post filter for the VVC compressed frames. A deep feature fusion based convolutional neural network (CNN) architecture (VVC-PPFF) is introduced as a post-processing method aimed at further improving the quality of reconstructed frames from the advanced codec VVC. By combining deep features from early and later convolution layers, the network learns to extract both low-level and high-level features, resulting in more generalized outputs that adapt to different quantization parameter (QP) values. Experimental results demonstrate an improvement of coding gains of -5.81%, -14.52%, and -16.19% for RA and -6.98%, -24.68%, and- 26.74% for LD scenarios, across a range of QP values from low to high.

Contribution for information, no specific action proposed.

Coded by and compared against VVEnc (which may also explain the relative better performance in LD)

Approx. 4000 kMAC/pix.

[JVET-AM0144](https://jvet-experts.org/doc_end_user/current_document.php?id=15791) AHG11: GAN-Based Post-Filter for Quality Enhancement of VVC Compressed Video [T. Das, K. Choi (KHU), B.-S. Kim, I. Cho, S. Hahm (KBS)]

This contribution investigates the application of a neural network-based post filter for the VVC compressed frames. A Deep Residual Enhanced Feature Generative Adversarial Network (DREFNet) is introduced as a post-processing method aimed at further improving the quality of reconstructed frames from the advanced codec VVC. By utilizing the benefits of Deep Residual Blocks and Enhanced Feature Block, the generator network aims to make the reconstructed frame as similar as possible to the original frame. The discriminator network, a crucial element of our proposed method, plays a vital role in guiding the generator by evaluating the authenticity of generated frames. By distinguishing between fake and original frames, the discriminator enables the generator to improve the quality of its output. This feedback mechanism ensures that the generator learns to create more realistic frames, ultimately enhancing the overall performance of the model. Experimental results demonstrate an improvement in image quality using the neural network-based post filter. The experimental results demonstrate an improvement of -13.05% and -5.00% for VMAF and Y MS-SSIM in the RA scenario, respectively, and -11.09% and -5.87% for VMAF and Y MS-SSIM in the AI scenario.

A screenshot of a computer

AI-generated content may be incorrect.

Generator architecture of proposed GAN.

A purple rectangle with black text

AI-generated content may be incorrect.

A screenshot of a computer

AI-generated content may be incorrect.

(a) Deep Residual Block (b) Enhanced Feature Block.

A group of rectangular objects with text

AI-generated content may be incorrect.

Discriminator architecture of proposed GAN.

VMAF was used for training. It was commented that it would be interesting to test with VVEnc in perceptual optimization setting.

It was commented that it would also be interesting to report PSNR based results.

It was suggested to try adding more patches from higher resolution classes.

It was suggested to investigate whether there may be temporal inconsistency?

Complexity 2000 kMAC/pixel

Contribution for information, no specific action requested.

[JVET-AM0177](https://jvet-experts.org/doc_end_user/current_document.php?id=15824) AHG11: Deep Reference Frame Generation for Inter Prediction Enhancement with Structural Re-parameterization [W. Zhang, C. Gui, N. Fu, X. Chen, W. Ma, Z. Chen (Wuhan Univ.)]

This proposal builds upon the lightweight deep reference frame generation (LDRF) method of JVET-AG0122 by introducing a structural re-parameterized interpolation diverse branch block (Inter-DBB), which further enhances inter prediction efficiency of the original LDRF in NNVC. During training, Inter-DBB employs multi-branch convolutions to capture diverse spatial-channel correlations, while at inference these branches are converted into a single 3×3 convolution via structural re-parameterization, preserving model structure and computational complexity. It provides average BD-rate gains of about −1.67% for luma (Y) and −0.71%/−0.77% for chroma (U/V) components compared to the NNVC-12.0 anchor for the RA configuration. Relative to the baseline DRF model in JVET-AG0122, the proposed method achieves −0.13 % BD-rate for Y and +0.20 %/+0.06 % for U/V, respectively.

图示

描述已自动生成

The framework of the proposed DRF method

图示

描述已自动生成

The architecture of the DRF networks

2900 K parameters, 69 kMAC/pixel

Slightly less gain than method from EE1-3.2, but also significantly lower complexity.

Investigate in EE, including integer conversion and training crosscheck.

[JVET-AM0300](https://jvet-experts.org/doc_end_user/current_document.php?id=15968) Crosscheck of JVET-AM0177 (AHG11: Deep Reference Frame Generation for Inter Prediction Enhancement with Structural Re-parameterization) [Y. Wang (Tencent)] [late]

[JVET-AM0185](https://jvet-experts.org/doc_end_user/current_document.php?id=15832) AhG11: Decomposed Content-Adaptive VLOP [Z. Xu, J. Konieczny, A. Filippov, C. Hollmann, V. Rufitskiy, T. Dong, H. Qin (TCL)]

This contribution studies the dimension-wise decomposed representation of multiplier in case of content-adaptive VLOP (CAVLOP). The BD-rate gain under RA configuration are reported as below.

 Compared with NNVC-13 with CAVLOP ON, the averaged gain is reported to be:

{-0.09 %, -0.40%, -0.32%, EncT: XX.X%, DecT: XX.X%}

Previously, the decomposed approach was considered for LOP but not adopted, as the training time increase (which is critical for content adaptation) did not justify the additional compression benefit. The proponents believe that it is almost the same training time as for existing VLOP, as in case of VLOP less parameters are trained.

Investigate in EE. Comparison of using NNVC14 VLOP for content-adaptive filtering, and compare it against the dimension-wise decomposed approach (also with attention mechanism in case that EE1-2.1 becomes VLOP4).

[JVET-AM0186](https://jvet-experts.org/doc_end_user/current_document.php?id=15833) AhG11: Content-Adaptive Neural Network-based Super Resolution [Z. Xu, J. Konieczny, A. Filippov (TCL)]

This contribution studies content adaptation per random-access segment in case of Neural Network-based Super Resolution. The BD-rate gain under RA configuration are reported as below.

 Compared with NNVC-13 with NNSR ON, the averaged gain is reported to be:

ClassB: -2.27%, -3.03%, -3.53%

ClassC: -2.90%, -3.14%, -1.04%

ClassD: -8.57%, -1.34%, 0.30%

Results for A classes not available yet.

It was commented that enforcing NNSR in anchor for classes B, C and D might be wrong, as it is known to give losses. Therefore, the proposal might just show better results, because the adaptive approach may decide to never use NNSR in theses classes (and not better than NNVC without NNSR).

Further study encouraged with results for classes A. It is also suggested to study the amount of rate needed for network parameters, which should establish a higher percentage in low resolution classes.

[JVET-AM0199](https://jvet-experts.org/doc_end_user/current_document.php?id=15846) AHG11: NNSR with consistent backbone block [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 for the body to align with the operations performed in the head and tail by analyzing and decomposing the latest NNSR of NNVC-13.0 into head, tail, and body parts. Specifically, the body adopts the same operations as used in the head and tail which are spatial mixing and channel mixing. Technically, the proposed backbone block employs a depth-wise 3×3 convolution for spatial mixing and 1×1 convolutions for channel numbers amplifying and reduction. These methods have been implemented based on the NNSR of NNVC-13.0 using SADL.

The BD-Rate results over the NNSR of NNVC-13.0 for float are as follows:

* AI: {-0.01%, -0.35%, -0.71%}
* RA: {-0.01%, -0.54%, -0.99%}

The BD-Rate results over the NNSR of NNVC-13.0 for integer are as follows:

* AI: {0.01%, -0.47%, -0.35%}
* RA: {0.01%, -0.41%, -0.4%}

Complexity over the NNSR of NNVC-13.0 is as follows:

* Parameter Counts: 19.6k 🡪 18.8k (proposed)
* MAC per Pixel: 4.67k 🡪 4.58k (proposed)

Small loss in luma (which could be in the margin of typical fluctuations by retraining), but gain in chroma. Complexity reduction compared to current NNSR.

Investigate in EE.

[JVET-AM0214](https://jvet-experts.org/doc_end_user/current_document.php?id=15861) AHG 11: Motion Vector Restriction in Multi-Layer Hybrid NN-based and Conventional Coding [F. Brand, T. Solovyev, E. Alshina (Huawei)]

In the April meeting, JVET decided to start developing a framework for including NN-coded reference frames into VVC / NNVC. In an approach, multi-layer coding is used, where the base layer consists of NN-coded frames while the enhancement layer consists of VTM coded frame, which have the NN-coded frames as reference. This proposal shows that omitting the motion vector search and transmission, and instead setting them to zero gives a encoding runtime reduction, without noticeable performance change.

AI -0.02%/0.25%/0.20% 88% EncT

Loss in chroma is only coming from one sequence (Basketball). The reason for that seems to require further

Only merge mode is kept.

It is agreed that it definitely makes sense to disable motion estimation in the context of the multi.layer interface for NN intra base layer, also as for more local adaptivity the blocks in base and enhancement need to be co-located.

It is commented that the effect of encoder runtime reduction would be less relevant for RA.

[JVET-AM0224](https://jvet-experts.org/doc_end_user/current_document.php?id=15871) AHG11: Multi-scale LOP backbone blocks with cross-scale interactions [L. Murn, M. Santamaria, F. Cricri (Nokia)]

This contribution proposes the use of multi-scale blocks with cross-scale interactions in the backbone of the LOP6 filter. The input signal to a residual block is processed at two different scales and the intermediate signals at two scales communicate with each other via a 3x3 2D convolution. It is reported that applying this approach in the RA configuration yields average BD-rates of -0.22% (Y), -1.30% (U), -1.49% (V) compared to NNVC-v13 in floating point precision, at same complexity. Additionally, it is reported that PSNR BD-rates compared to NNVC-v13 in the LDB configuration are -0.22% (Y), -1.51% (U), -1.52% (V), while in the AI configuration they are -0.27% (Y), -1.27% (U), -1.57% (V).

kMAC/pix slightly lower than LOP6, but number of parameters is higher.

Integerization needs further investigation.

Current decoder runtime increase (SADL) around 40%. It was commented that this might be due to the interaction between luma and chroma, together with the fact that some channel numbers are multiple of 8, and the missing integer implementation.

Further study on these aspects is recommended (not yet in EE, as the tradeoff with runtime is not attractive, and not known if integer implementation can be achieved with reasonable coding gain).

### SADL and NNVC implementation, CTC (4)

Contributions in this area were discussed during 1155–1230 on Sunday 29 June 2025 (chaired by JRO).

[JVET-AM0073](https://jvet-experts.org/doc_end_user/current_document.php?id=15720) [AHG11] Comparison of execution time of NN on different devices [A. Karabutov, E. Alshina, F. Brand (Huawei)]

This contribution provides information about the execution time of neural networks across different devices using the JPEG-AI framework. Two devices were tested: a Huawei Mate50 Pro and a high-end PC with an RTX 3090 GPU. Experiments focused on decoding a 4K stream and varying image sizes, with the prediction and synthesis parts of the codec optimized into a single model for efficiency. The results showed that the ratio between running time of a NN model on CPU and GPU depends on the model complexity in terms of kMAC/px and number of processed pixels. It was proposed empirical formula to calculate the ratio of inferencing time on CPU/GPU for used hardware in the experiments. It is applicable to convolutional type of networks. For attention-based networks it was observed non-linear dependency between CPU and GPU running time, therefore they were excluded from consideration. The formula shows that considering only CPU runtime and complexity in kMAC/px NN model is not sufficient for prediction actual time of its inference on GPU.

For JPEG-AI simple and base profiles, the ratio between kMAC/p and run times is almost linearly depending on image size (but linear factor is different for different block sizes), for high profile not even the linear dependency on image size is given (likely due to higher number of attention mechanisms such as transformer). However, the ratio between CPU and GPU is not as constant.

As a consequence, comparing different architectures only by kMAC/pixel does not allow concluding about runtime.

Further study necessary to get better criteria to judge complexity of NN architectures, and also investigate impact for more devices with different property in processor type, memory, etc.

[JVET-AM0136](https://jvet-experts.org/doc_end_user/current_document.php?id=15783) AhG14: Improvement of SIMD implementation with expanded SIMD operators in SADL for LOP with Attention [Y. Li, M. Coban, M. Karczewicz (Qualcomm)]

In this document, the results from the SIMD acceleration for some extra operators and improved SIMD implementation of the current operators are shown. The results demonstrate an improvement of the decoding time for the extended implementation.

It is suggested to change the current SIMD implementation and add the extra SIMD operators in SADL.

The contribution provides improved implementations for 3 operators for the SADL, and they are Interpolation\_utils, Mul, PreLu. In addition, SIMD acceleration is added for Maxpool and Conv2d with a stride greater than 1. These operators are widely used in the current LOP with attention models of NNVC.

To accelerate the inference of the model with SADL, the following is given consideration for the implementation: 1) SIMD latency and throughput for the above-mentioned operators is taken into account to minimize the execution time, and 2) extra memory transferring of data is avoided. In addition, all operations of the instructions, including shift and saturation, are carried out with SIMD. The implementation utilizes the AVX2 instruction set.

Merge request was already issued, and benefit is verbally confirmed by SADL coordinator. Agreed to be included.

[JVET-AM0170](https://jvet-experts.org/doc_end_user/current_document.php?id=15817) AhG14: SADL update [F. Galpin (InterDigital)] [late]

(include abstract and list of new/updated elements)

No need for presentation – for information.

[JVET-AM0178](https://jvet-experts.org/doc_end_user/current_document.php?id=15825) AHG14: The extension of SADL library [N. Fu, W. Ma, Z. Chen (Wuhan Univ.)]

This contribution presents the extensions in the Small AdHoc Deep Learning (SADL) library from Wuhan University. These extensions include a new layer Pad and SIMD256/SIMD512 acceleration for the Conv2d\_2x2.

|  |  |
| --- | --- |
| Language | Pure C++, header only |
| Compatibility | Support PyTorch and TensorFlow, while also updating the ONNX to SADL converter |
| Extended layers | Conv2d and **Pad (The latter is new)** |
| Type support | float, int32, int16, int8 |
| License | BSD 3-Clause |

Merge request was already issued, and benefit is verbally confirmed by SADL coordinator. Agreed to be included.

## AHG6/AHG12: Enhanced compression beyond VVC capability (69)

### Summary and BoG reports (1)

Contributions in this area were discussed during 1650–1950 on Thursday 26 June 2025, and during 0825–1000 on Friday 26 June 2025 (chaired by JRO).

[JVET-AM0024](https://jvet-experts.org/doc_end_user/current_document.php?id=15914) EE2: Summary report of exploration experiment on enhanced compression beyond VVC capability [V. Seregin, D. Bugdayci Sansli, J. Chen, R. Chernyak, K. Naser, J. Ström, F. Wang, M. Winken, X. Xiu, K. Zhang (EE coordinators)]

1. **List of tests**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Intra prediction** | | | |
| 1.1 | TIMD fusion with neural network based intra prediction | Y.-H. Lin (Sharp)  K. Naser (InterDigital) | N. Zouidi (Ofinno) |
| 1.2a | TIMD fusion with block vector based prediction | J. Fu (PKU)  K. Naser (InterDigital)  D. Ruiz Coll (Ofinno) |  |
| 1.2b | BV merge list improvement | D. Ruiz Coll (Ofinno)  K. Naser (InterDigital) J. Fu (PKU) |  |
| 1.2c | Test 1.2a + Test 1.2b | J. Fu (PKU)  K. Naser (InterDigital)  D. Ruiz Coll (Ofinno) |  |
| 1.3 | IntraTMP template type adaptation | T. Dumas (InterDigital) |  |
| 1.4 | Test 1.2c + Test 1.3 | J. Fu (PKU)  K. Naser (InterDigital)  D. Ruiz Coll (Ofinno) |  |
| 1.5 | Test 1.1 + Test 1.4 | J. Fu (PKU)  K. Naser (InterDigital)  D. Ruiz Coll (Ofinno) Y.-H. Lin (Sharp) |  |
| 1.6a | Intra merge mode | M. Blestel  (Ofinno)  Y.-J. Chang (Qualcomm)  J. Fu (PKU) |  |
| 1.6b | Intra merge mode using another adjacency map. | M. Blestel  (Ofinno)  Y.-J. Chang (Qualcomm)  J. Fu (PKU) |  |
| 1.7a | Block prediction with cubic interpolation filter in TIMD | Yang Wang  (Bytedance) | L. Xu  (OPPO) |
| 1.7b | Template prediction with 6-tap interpolation filter in TIMD | Yang Wang  (Bytedance) | L. Xu  (OPPO) |
| 1.7c | Test 1.7a + Test 1.7b | Yang Wang  (Bytedance) | L. Xu  (OPPO) |
| 1.8 | Harmonization of SGPM-BV and LIC | J. Huo, Y. Fei  (Xidian Univ) |  |
| 1.9 | Block vector-based intra mode derivation | J.-K. Lee  (Ofinno) |  |
| 1.10a | Matrix-based position dependent intra prediction for GPM | Z. Sun  (OPPO) |  |
| 1.10b | Matrix-based position dependent intra prediction for CIIP | Z. Sun  (OPPO) |  |
| 1.10c | Matrix-based position dependent intra prediction for GPM/CIIP | Z. Sun  (OPPO) |  |
| 1.10d | Extension to regression GPM | Z. Sun  (OPPO) |  |
| **2 Inter prediction** | | | |
| 2.1a | Chained candidates in AMVP list | D. Bugdayci Sansli (Nokia) | Y. Kidani (KDDI) |
| 2.1b | Chained candidates in AMVP and merge lists | D. Bugdayci Sansli (Nokia) | Y. Kidani (KDDI) |
| 2.2a | Regression-based GPM intra-inter blending weights derivation in original domain | R. Yu  (Qualcomm) | K. Jia  (Alibaba) |
| 2.2b | Regression-based GPM intra-inter blending weights derivation in LMCS domain | R. Yu  (Qualcomm) | K. Jia  (Alibaba) |
| 2.3 | Affine bilateral matching merge mode | H. Huang  (Qualcomm) |  |
| **3 Transform and coefficients coding** | | | |
| 3.1a | Predictive transform coefficient coding | Thuong Nguyen Canh (Dolby) |  |
| 3.1b | Test 3.1a on very high bitrate (QP 2, 7, 12, 17) | Thuong Nguyen Canh (Dolby) |  |
| 3.2 | Directional sign prediction | L. Xu (OPPO) | P. Onno (Canon) |
| 3.3 | Third transform set selection for IntraNN | Z. Xie  (OPPO) |  |
| 3.4a | Reduced zero-out for NSPT kernels | G. Verba  (Qualcomm) |  |
| 3.4b | Decreased number of NSPT kernels | G. Verba  (Qualcomm) |  |
| 3.4c | Test 3.4a + Test 3.4b | G. Verba  (Qualcomm) |  |
| 3.5 | Test 3.3 + Test 3.4 | Z. Xie  (OPPO)  G. Verba  (Qualcomm) |  |
| 3.6a | Modified binarization of bypass-coded TSRC | Y. Yu  (OPPO)  M. Abdoli  (Xiaomi) |  |
| 3.6b | Modified priority of sig\_coeff\_flag context coding in TSRC | Y. Yu  (OPPO)  M. Abdoli  (Xiaomi) |  |
| 3.6c | Test 3.6b with relaxed budget constraint | M. Abdoli  (Xiaomi)  Y. Yu  (OPPO) |  |
| 3.6d | ECM anchor with no budget restraint | M. Abdoli  (Xiaomi)  Y. Yu  (OPPO) |  |
| **4 In-loop filtering** | | | |
| 4.1 | TALF with reconstructed samples | C. Ma  (Kwai) |  |
| 4.2 | Reuse of ALF control information | N. Hu  (Qualcomm) |  |
| 4.3 | On ALF-CCCM | N. Song  (OPPO) |  |
| 4.4 | NN-ILF integration with ALF | D. Rusanovskyy (Nokia) |  |
| 4.5 | Improvement of the NN ILF in ALF | Y. Li  (Qualcomm) |  |

1. **Description of tests**
   1. ***Intra prediction***

**Test 1.1: TIMD fusion with neural network based intra prediction (**[**JVET-AM0077**](https://jvet-experts.org/doc_end_user/current_document.php?id=15724)**)**

The TIMD process selects two intra prediction modes and one non-angular intra prediction mode to conditionally generate a fusion prediction.

In the test, non-angular intra prediction mode is conditionally replaced by the neural network-based intra prediction mode in the TIMD fusion process as follows:

* Applied only when the block size is less than or equal to 64.
* Only applied to default TIMD and TIMD merge, but not to TIMD SAD.
* PDPC is not applied to the neural network-based intra prediction samples within the TIMD fusion process.

Test 1.1: TIMD fusion with neural network based intra prediction.

**Test 1.2: TIMD-BV extension with enhanced IntraTMP merge list (**[**JVET-AM0138**](https://jvet-experts.org/doc_end_user/current_document.php?id=15785)**)**

In Test 1.2a, one of the three intra predictors in TIMD or TIMD SAD modes is replaced by a predictor derived by BV if the cost is smaller. BV may come from IntraTMP merge list and ARBVP list.

In Test 1.2b, to derive intra merge BVs and AR-BVs, the method collects not only the BVs utilized by IntraTMP and IBC but also those employed by DIMD, OBIC, SGPM, TIMD, and TIMD-SAD when block vector prediction is applied. Additionally, each CU coded by IntraTMP now preserves up to 5 fusion BVs for the IntraTMP merge and ARBVP lists.

To alleviate complexity increase in constructing merge list, the refinement window is dynamically reduced based on its template cost if the cost is less than a threshold (set to 32 in the test). Furthermore, when two BV candidates within the IntraTMP list overlap, the refinement window is further resized according to their disparity in template costs. Finally, for the search regions R4 and R5, if the top-left position within these regions is invalid, an early termination is applied to these areas. Conversely, if the bottom-right position of those regions is valid, the entire validation process is bypassed.

Test 1.2a: TIMD fusion with block vector based prediction

Test 1.2b: BV merge list improvement

Test 1.2c: Test 1.2a + Test 1.2b

**Test 1.3: IntraTMP sub-modes depending on the template type information (**[**JVET-AM0229**](https://jvet-experts.org/doc_end_user/current_document.php?id=15876)**)**

In the test, the process of each IntraTMP sub-mode is adapted to the template type (“top-only”, “left-only”, “full”) of the involved candidate reconstructed block(s), the modifications can be described as follows:

1. **Local illumination compensation**

The same template type (“top-only”, “left-only”, “full”), which is specified by the IntraTMP index is used for deriving the LIC parameters instead of using the full template.

1. **Filter linear model**

The same template type (“top-only”, “left-only”, “full”), which is specified by the IntraTMP index is used for deriving the FLM parameters instead of using the full template.

1. **Sub-pel**

The same template type (“top-only”, “left-only”, “full”), which is specified by the IntraTMP index is used, during the search for the fractional parameters, to compute template matching SAD/MR-SADs instead of using the full template.

1. **Fusion**

For the current luma block predicted with IntraTMP fusion with IntraTMP index equal to 2, if at least one candidate reconstructed block from the IntraTMP search has either “top-only” template type or “left-only” template type, the prediction of the current luma block is further position-dependent blended with this candidate reconstructed block.

In IntraTMP fusion, one sub-mode is added, which derives the prediction of the current luma block by position-dependent blending of at most four candidate reconstructed blocks associated with the last four positions inside the IntraTMP list.

Test 1.3: IntraTMP template type adaptation.

**Test 1.4: Combination of Test 1.2c and Test 1.3 (**[**JVET-AM0232**](https://jvet-experts.org/doc_end_user/current_document.php?id=15879)**)**

Test 1.4: Test 1.2a + Test 1.2b + Test 1.3

**Test 1.5: Combination of Test 1.1 and Test 1.4 (**[**JVET-AM0233**](https://jvet-experts.org/doc_end_user/current_document.php?id=15880)**)**

Test 1.5: Test 1.1 + Test 1.2a + Test 1.2b + Test 1.3

**Test 1.6: Intra merge mode (**[**JVET-AM0074**](https://jvet-experts.org/doc_end_user/current_document.php?id=15721)**)**

In the test, a list of intra-mode candidates is derived from the intra modes of adjacent and non-adjacent blocks coded as DIMD, OBIC, Intra Merge, TIMD, TIMD SAD, TIMD Merge, MPM-based, or IntraTMP. Up to 5 neighbouring blocks' information is used to derive intra merge candidates. Redundancy checks (pruning stage) are applied to prevent duplicate candidates.

The completed list is sorted based on the candidate's TIMD cost, which is a weighted sum of the template matching cost of each IPM included in the intra merge candidate.

The final step consists of applying a BV prediction mode replacement for all intra modes of the intra merge candidate. The BVs are derived using the IntraTMP merge BV derivation process. Each BV’s cost is computed and replaces an intra-prediction mode from a candidate list when its cost is lower than the intra-prediction’s template cost.

A flag is signalled after DIMD flag to indicate the usage of the mode followed by the candidate index.

There are two non-adjacent blocks patterns: as in inter mode (tested in Test 1.6a) and as in OBIC mode (tested in Test 1.6b).

Test 1.6a: Intra merge mode with inter non-adjacent pattern.

Test 1.6b: Intra merge mode with OBIC non-adjacent pattern.

**Test 1.11: Combination of Test 1.2c and Test 1.6a (**[**JVET-AM0299**](https://jvet-experts.org/doc_end_user/current_document.php?id=15967)**)**

Test 1.11: Test 1.2a + Test 1.2b + Test 1.6a.

**Test 1.12: Combination of Test 1.2c, Test 1.3, and Test 1.6a (**[**JVET-AM0307**](https://jvet-experts.org/doc_end_user/current_document.php?id=15967)**)**

Test 1.12: Test 1.2a + Test 1.2b + Test 1.3 + Test 1.6a.

**Test 1.7: On interpolation filter for TIMD (**[**JVET-AM0163**](https://jvet-experts.org/doc_end_user/current_document.php?id=15810)**)**

In the test, two changes applied to interpolation filter for TIMD are tested.

In Test 1.7a, a cubic interpolation filter is used in block prediction for TIMD, instead of selection between the cubic filter and the Gaussian filter.

In Test 1.7b, a 6-tap cubic interpolation filter is used to replace the 4-tap cubic interpolation filter in template prediction for TIMD.

Test 1.7a: Block prediction with cubic interpolation filter in TIMD.

Test 1.7b: Template prediction with 6-tap interpolation filter in TIMD.

Test 1.7c: Test 1.7a + Test 1.7b.

**Test 1.8: Harmonization of SGPM-BV and LIC (**[**JVET-AM0157**](https://jvet-experts.org/doc_end_user/current_document.php?id=15804)**)**

In ECM, LIC flag can be inherited from a merge candidate in IBC merge mode. However, in the current SGPM, LIC flag is not inherited when the BV information from a merge candidate is inherited.

In the test, LIC flag and model parameters from a neighbouring block are inherited in addition to BV when constructing merge candidates list in SGPM mode.

Test 1.8: LIC flag and model parameters inheritance for SGPM.

**Test 1.9: Block vector based intra mode derivation (**[**JVET-AM0084**](https://jvet-experts.org/doc_end_user/current_document.php?id=15731)**)**

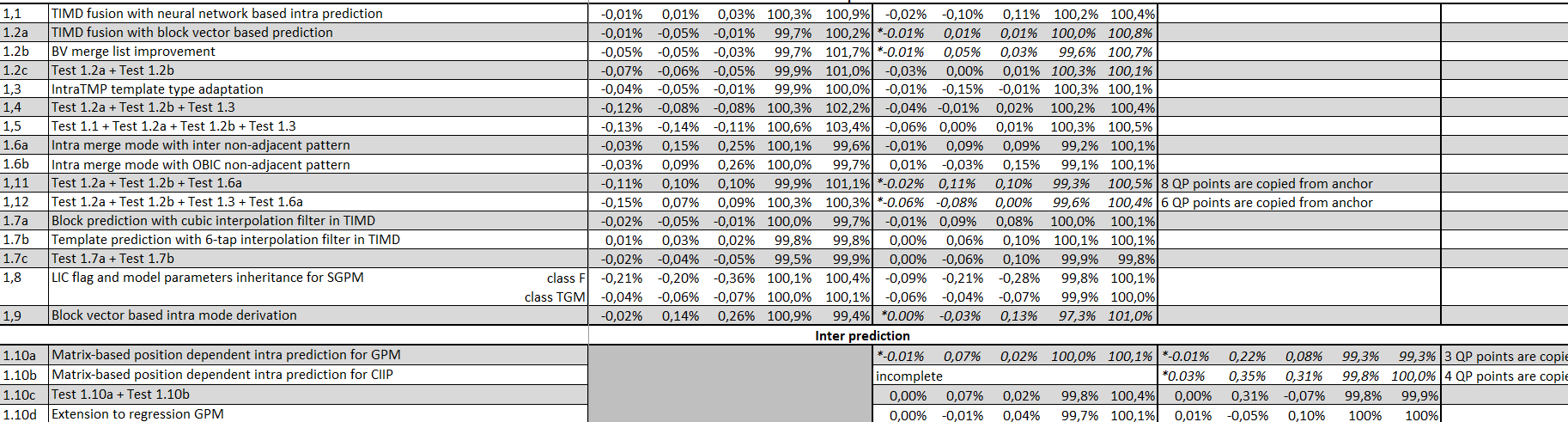
In this test, a block vector-based intra mode derivation is evaluated, which derives an intra prediction mode that minimizes the block-shaped template cost between the reference block from the block vector and the predicted blocks generated using the candidate intra mode.

This method utilizes a block vector associated with the IntraTMP BV candidates, and the first BV candidate is selected from the list.

A list of candidate IPMs is constructed to include intra modes from four corners and center of the reference block and the most probable modes of the current block excluding the default modes. Then, the intra modes candidates are reordered based on block-shaped template costs to compute the similarity between the reference block, pointed to by the block vector, and each of the predicted blocks derived by intra mode candidates.

Two modes with the smallest cost are selected and blended with the weights based on the similarity cost to perform the prediction.

Test 1.9: Block vector based intra mode derivation.



Combination 1.12 has best tradeoff, gains of 1.2a/b, 1.3 and 1.6a are somewhat additive, whereas the other combinations including also 1.1 are not competitive.

Decision: Adopt JVET-AM0307 test 1.12.

Test 1.7a avoids switching between interpolation filters and has a small gain. This is supported to be advantageous by several experts.

Test 1.7b does not provide benefit, neither standalone, nor in the combination with 1.7a.

Decision: Adopt JVET-AM0163 test 1.7a.

Test 1.8 has some benefit for screen content, and according to proponents has no impact on camera-captured content (not documented in the contribution). Proponents were asked to provide results for other classes.

Further review on Tuesday 1 July 1200. Results for other classes are presented which show changes up to +/-0.01%, but according to cross-checker no run-time increase on average.

Decision: Adopt JVET-AM0157 test 1.8.

Test 1.9 provides small/no gain in luma for AI/RA, but losses in chroma, whereas encoder/decoder run time is changing. Overall, no benefit.

* 1. ***Inter prediction***

**Test 1.10: Matrix-based position dependent intra prediction for GPM/CIIP (**[**JVET-AM0059**](https://jvet-experts.org/doc_end_user/current_document.php?id=15706)**)**

In the GPM mode using both inter and intra predictions, the final prediction samples are generated by weighting inter prediction samples and intra prediction samples for each GPM-separated region. As shown in next figure, for example, the available IPM candidates are the parallel angular mode along the direction of the GPM partition boundary (Parallel mode), the perpendicular angular mode perpendicular to the GPM partition boundary (Perpendicular mode), and the Planar mode, respectively

A diagram of a sample

AI-generated content may be incorrect.

In ECM, there are 3 intra prediction mode candidates in the GPM-IPM list. Among these three candidate modes in the GPM-IPM list, some may not be MPDIP modes. In general, if a block is eligible for MPDIP prediction, there may be a better chance to select an MPDIP mode because this mode may provide a better prediction.

In the CIIP mode, the prediction samples are generated by weighting inter predicted samples and intra predicted samples, where a TIMD derived intra prediction mode or CIIP PDPC is used to generate the intra prediction. The ciipPDPC flag indicates the intra prediction method used in CIIP.

In the test, if the current block is eligible for MPDIP, i.e., the decoded left and the above reference samples are available and the current block size supports MPDIP, some of the non-MPDIP modes in the GPM-IPM list are substituted by the adjacent MPDIP modes as shown in formula. The processes for constructing the GPM-IPM list are kept unchanged.

where is the initial non-MPDIP mode in the GPM-IPM list, and is the MPDIP mode that replaces the initial non-MPDIP mode.

It is further modified in the test that the MPDIP prediction is used in the calculation of the template cost, instead of using the conventional angular prediction for the MPDIP modes in sorting the GPM candidate list as well as in the TIMD mode derivation for CIIP coded blocks.

Furthermore, when the current block is coded with the CIIP mode and is eligible for MPDIP prediction, the intra prediction samples are always generated by using the derived intra prediction mode from TIMD. As a result, the ciipPDPC flag is no longer coded in the bitstream.

Test 1.10a: Matrix-based position dependent intra prediction for GPM.

Test 1.10b: Matrix-based position dependent intra prediction for CIIP.

Test 1.10c: Test 1.10a + Test 1.10b.

Test 1.10d: Extension to regression GPM.

**Test 2.1: Chained candidates in AMVP and merge lists (**[**JVET-AM0106**](https://jvet-experts.org/doc_end_user/current_document.php?id=15753)**)**

In ECM, during AMVP list construction, when the motion information of a spatially located source block does not point to the given reference picture, this candidate is skipped.

In the test, AMVP list derivation process for spatial candidates is modified to allow one-step tracing of spatial candidates in AMVP to create chained MV candidates. The same change is applied to existing chained MV candidates in merge list so that tracing is allowed to start from a position in the block from which the motion information is fetched, in addition to the existing starting positions.

Figure below illustrates the chained motion vector predictor generation from a left neighbor of the current block. Motion vector of left neighbor (purple) points to a position in P1 and the motion vector obtained from that position (green arrow) points to another position in P0. The accumulation of the motion vectors results in the chained motion vector predictor (black dashed arrow) candidate obtained from left neighbor for P0.

A diagram of a diagram

AI-generated content may be incorrect.

Test 2.1a: Chained candidates in AMVP list.

Test 2.1b-a: Chained candidates in merge list.

Test 2.1b: Test 2.1a + Test 2.1b

**Test 2.2: Regression-based GPM intra-inter prediction modification (**[**JVET-AM0215**](https://jvet-experts.org/doc_end_user/current_document.php?id=15862)**)**

GPM intra-inter prediction combines intra and inter predictors, while the blending weights derivation utilizes intra and inter prediction samples of the template from different domain when LMCS is enabled as shown in the next figure.

During the blending weights derivation, intra prediction samples of the template are kept in the LMCS domain, inter prediction samples of the template are kept in the original domain while the reconstructed samples of the template are mapped back to the original domain.

The derived blending weights are used for blending the current intra and inter prediction samples, however, before blending, the current inter prediction samples are mapped to the LMCS domain. Thus, the prediction sample blending occurs in different domains than the domain where the blending weights were derived.

A diagram of a diagram

AI-generated content may be incorrect.

In Test 2.2a, blending weights derivation and prediction sample blending are carried out in the original domain.

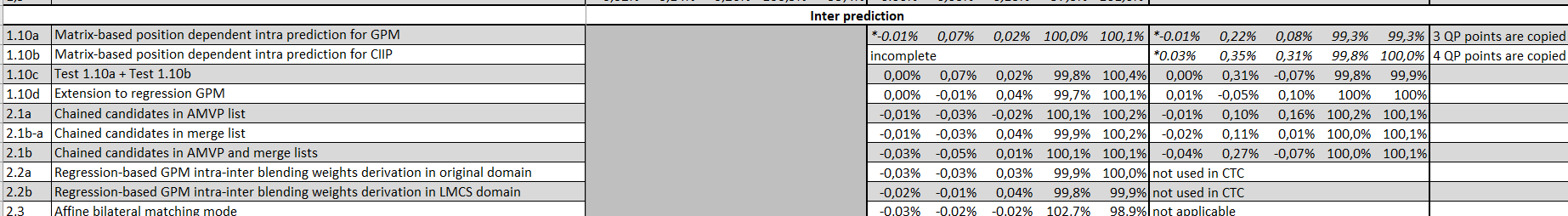
In Test 2.2b, blending weights derivation and prediction sample blending are carried out in the LMCS domain.

**Test 2.3: Affine bilateral matching mode (**[**JVET-AM0088**](https://jvet-experts.org/doc_end_user/current_document.php?id=15735)**)**

In current ECM, when an affine coded block meets the BDOF condition, BDOF is applied to the subblocks. Otherwise, regular MC is performed with adaptive subblock size. If an affine merge candidate meets the affine DMVR condition, it also meets the affine BDOF condition. Therefore, affine BDOF is always performed for motion compensation for such candidate.

In the test, an affine bilateral matching merge mode is introduced to ECM, wherein all the merge candidates that meet the affine DMVR condition, per-pixel based affine compensation is performed instead of affine BDOF. In the test, the maximum number of candidates in the new mode is set to 6.

Test 2.3: Affine bilateral matching merge mode.



1.10x does not show benefit, no gain or small loss, but more processing necessary.

2.1b has small gain in luma, but some loss in chroma for LB (which according to proponents is coming mainly from class E, whereas gains are more consistent for other classes). Number of candidates is not increased, the change is minor according to cross-checkers.

Decision: Adopt JVET-AM0106 test 2.1b.

2.2 tries to resolve an inconsistency that the blending weights in intra/inter GPM are derived in different domains (intra in LMCS, inter in original), whereas the blending itself is performed in the LMCS domain. The two tests resolve this by translating one of them such that either both determination of weights and blending are in original (2.2a), or both in LMCS (test 2.2b). Both variants give small gain, where the gain of 2.2a is slightly higher, even though one more step of domain mapping is necessary, but the complexity difference should be minor.

Decision: Adopt JVET-AM0215 test 2.2a.

Test 2.3 has encoding runtime increase of 2.7% while giving only relatively small gain (0.03% luma), likely due to the need of additional mode checks. No reasonable tradeoff.

* 1. ***Transform and coefficient coding***

**Test 3.1: Predictive transform coefficient coding (**[**JVET-AM0056**](https://jvet-experts.org/doc_end_user/current_document.php?id=15703)**)**

In residual coding of ECM, each coefficient’s magnitude (abs\_coeff\_level) is binarized into a series including a significant flag (sig\_flag), a set of greater-than-1 values (gt\_1 through gt\_N), parity (par) value; and the remaining value (remLevel), following the equation:

abs\_coeff\_level = sig\_flag +gt\_1+ gt\_2 +gt\_3 +… + gt\_N + par + 2\*remLevel.

In the test, a coefficient level predictor gt\_x ranges from 0 to N+1 is introduced, and an entry flag is signalled to indicate whether levels go above or below the predictor.

entry\_flag = coeff > clip(predictor – 1, [0, N]) ? 1 : 0

If it is above, then all subsequent gt\_n flags are signalled and the flags corresponding to lower than gt\_x are skipped. If it is below, then gt\_n flags larger than the predictor are skipped and only lower level gt\_n flags are signalled.

In the test, the gt\_x is set to gt\_1 and the predictor value is derived from the CABAC context probability of significant flag. The gt\_1 flag is predicted to be 1 when the probability of significant flag exceeds a predefined threshold , i.e. . The predictor value equal to 0 corresponds to the conventional coefficients coding.

This method is applied only for luma transform unit with the probability threshold set to 31000 (equivalent to 94.61%) for 15-bit precision CABAC.

Test 3.1a: Predictive transform coefficient coding.

Test 3.1b: Test 3.1a on very high bitrate (QP 2, 7, 12, 17).

**Test 3.2: Directional sign prediction (**[**JVET-AM0060**](https://jvet-experts.org/doc_end_user/current_document.php?id=15707)**)**

In ECM, sign prediction derives discontinuity cost across a transform block to predict the signs.

A picture containing text

Description automatically generated

where *R* is reconstructed neighbors, *P* is the prediction of the current block, and *r* is the residual hypothesis.

In the test, a direction is derived for sign prediction as illustrated in the next figure.

A screenshot of a game

AI-generated content may be incorrect.

The directions are derived using HoG for every 4-sample sub-boundary on the top row and left column of the transform block. The directions for the top boundary are restricted to the directions between intra prediction mode 34 and intra prediction mode 66. The directions for the left boundary are restricted to the directions between intra prediction mode 2 and intra prediction mode 34.

The boundary discontinuity is still measured by the sum of absolute derivatives in the residual domain. However, the samples along the derived directions are used.

A white and yellow circle on a black background

AI-generated content may be incorrect.

The samples at fractional positions are generated by interpolation. The 4-tap interpolation filters included in ECM for intra prediction are reused in the method.

The directional sign prediction is not applied to IntraNN, MIP, EIP, ISP and all the chroma blocks. Four new context models are introduced for coding the sign residual of the directional sign prediction. The context model index is selected based on the absolute level of the transform coefficient.

**Test 3.3: Third transform set selection for IntraNN (**[**JVET-AM0061**](https://jvet-experts.org/doc_end_user/current_document.php?id=15708)**)**

In ECM, multiple transform set selection for LFNST/NSPT is applied to IntraNN for luma blocks large than 64 samples. In addition to the 1st DIMD IPM, PLANAR is used as the additional IPM candidate. A flag indicating the IPM index is signalled for luma blocks larger than or equal to 64 luma samples.

In the test, a third transform set selection for IntraNN is introduces, where in addition to the 1st DIMD IPM and PLANAR, the 2nd DIMD IPM is used as the third candidate to select a LFNST/NSPT transform set for luma blocks larger than or equal to 128 luma samples. A CU-level flag indicating the 2nd DIMD IPM is signalled.

Test 4.3: Third transform set selection for IntraNN.

**Test 3.4: Reduced zero-out for NSPT kernels (**[**JVET-AM0228**](https://jvet-experts.org/doc_end_user/current_document.php?id=15875)**)**

In EMC, the amounts of NSPT output coefficients (left) and the amount of NSPT kernels (right) for each block size WxH are summarized below:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| H \W | 4 | 8 | 16 | 32 |  | H \W | 4 | 8 | 16 | 32 |
| 4 | 16 | 20 | 24 | 20 | 4 | 245 | 221 | 183 | 113 |
| 8 | 20 | 32 | 40 | 24 | 8 | 245 | 245 | 194 | 127 |
| 16 | 24 | 40 | - | - | 16 | 213 | 213 | - | - |
| 32 | 20 | 24 | - | - | 32 | 149 | 149 | - | - |

The worst-case operation count per TB is for block size 8x32/32x8: 24x256 = 6144 MACs.  
The worst-case operation count per sample is for block size 8x16/16x8: 40 MACs/sample.

In Test 3.4a, the amounts of output non-zero coefficients for NSPT are increased for block sizes 4x8, 4x16, 8x32 and corresponding transposed block shapes. The proposed NSPT output coefficient amounts for each block size WxH are summarized below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| H \W | 4 | 8 | 16 | 32 |
| 4 | 16 | **24** | **32** | 20 |
| 8 | **24** | 32 | 40 | **32** |
| 16 | **32** | 40 | - | - |
| 32 | 20 | **32** | - | - |

In Test 3.4b, kernel amounts are reduced for several block sizes. The reduction is achieved by sharing a retrained NSPT kernel between a larger number of modes. The number of NSPT kernels in for each block size WxH is summarized below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| H \W | 4 | 8 | 16 | 32 |
| 4 | **243** | **206** | **156** | **93** |
| 8 | 245 | 245 | **152** | **110** |
| 16 | **208** | **181** | - | - |
| 32 | **102** | **146** | - | - |

Test 3.4c is a combination of Test 3.4a and Test 3.4b.

The worst-case operation count per TB for Test 3.4c is for block size 8x32/32x8: 32x256 = 8192 MACs.  
The worst-case operation count per sample for Test 3.4c is for block size 8x16/16x8: 40 MACs/sample, which corresponds to ECM-17.0.

**Test 3.5: Combination of Test 3.3 and Test 3.4 (**[**JVET-AM0172**](https://jvet-experts.org/doc_end_user/current_document.php?id=15819)**)**

Test 3.3 and Test 3.4c are combined, where Test 3.3 is enabled only in the all-intra configuration of the combination tests.

**Test 3.6: On binarization of a coefficient level in TSRC (3.6ab -** [**JVET-AL0153**](https://jvet-experts.org/doc_end_user/current_document.php?id=15478)**, 3.6cd** [**JVET-AM0054**](https://jvet-experts.org/doc_end_user/current_document.php?id=15701)**)**

In ECM, a truncated Rice-Golomb binarization method with Rice parameter 1 is used to binarize the coefficient levels directly when the CABAC bin budget is exhausted in the TSRC. The binarized bins are coded in the bypass mode. For coefficient level 0, two bins are needed.

In the tests, a significant flag is used to indicate if the current coefficient level is zero or not when the CABAC bin budget is exhausted in the TSRC. In addition, Rice parameter is set to 0 to binarize the remaining levels in the TSRC. The binarized bins for remaining levels are coded with the bypass-mode.

In Test 3.6a, the significant flag is coded in the bypass-mode.

In Test 3.6b, the significant flag is coded with a context bin. To comply with the pre-defined CABAC bin budget constraint, Test 3.6b reserves as many context bins as the total number of positions of all non-zero subblocks so that the significant flag for each position is always coded with context bin. The pre-defined CABAC bin budget is updated by subtracting the number of reserved context bins. The updated CABAC bin budget is then used to control the coding of other context coded syntax in the TSRC.

Both Test 3.6a and Test 3.6b follow and comply with the current constraint of the CABAC bin budget and there is no excessive usage of the context coded bins.

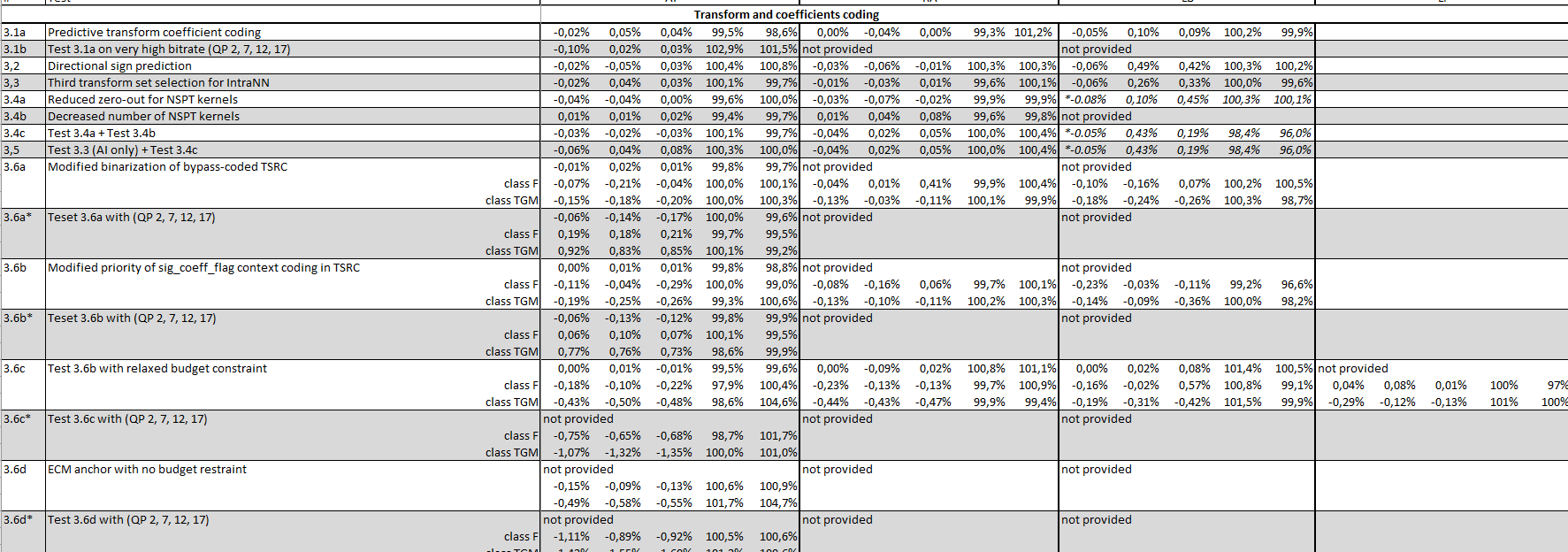
For low QP setting, both tests have gains for camera captured content, but loss for SCC. Similar to VVC v2, a slice level adaptive Rice parameter probably is needed for low QP applications while a fixed Rice parameter is good for CTC.

Additional tests for EE2-3.6b with Rice 1, 2, 3 show that a bigger Rice parameter may provide additional gains for low QP cases.

In Test 3.6c, Test 3.6b is tested with the relaxed budget constraint, where the significant flags are always context coded after the context budget is exhausted for the CG.

In test 3.6d, ECM anchor without budget constraint is tested.

Tests with asterisk (\*) indicate the low QP 2, 7, 12, 17 setting.



Test 3.1 provides some gain in particular for high rates. According to cross-checker, the impact on processing complexity should be small (some additional checking necessary in CABAC). Gain is better at high rate (3.1b), also the encoder/decoder runtime is further increased. Though the tradeoff runtime vs. compression benefit is not good, several experts expressed support, as it may also reduce the number of context coded bins.

Decision: Adopt JVET-AM0056

For test 3.2, for the proposed modification of sign prediction, additional processing is necessary for HoG computation applied at subblock basis. This reflected by increase of encoding and decoding run times (even though these were decreased relative to the previous proposal). For LB, a higher loss in chroma occurs than in the previous proposal. Some concern was raised about the tradeoff. No action.

Test 3.3 is allowing to use another (already existing) NSPT set for certain cases in intraNN. Benefit in compression is small, but impact on encoder/decoder runtime is only minor due to the selection rules that are used. Gain is mostly in classes A and B according to cross-checkers.

This was also tested in combination with 3.4 (test 3.5)

In test 3.4, the reduction of zero-out increases the necessary memory size for kernels by approximately 10%, whereas 3.4b standalone reduces it relative to the current ECM by additional merging of kernels, and the combination 3.4c requires approximately the same memory as current ECM.

It is commented that it is questionable which additional insight fine-tuning of existing tools is providing in the context of this exploration. No action on 3.3-3.5.

Test 3.6x investigates proposed methods for alternative budget constraint (where test 3.6d is an additional reference without any constraint). Tests 3.6a and 3.6b are actually sticking to a maximum budget of context coded bins, where 3.6b gives some preference to code significance context-based. Whereas some gain to the current method is observed for screen content under CTC, in the low-QP case more significant losses occur. Furthermore, it was commented that in case of mixed content, applications may coded regions with screen content with lower QP, therefore it is relevant to look at the low-QP case, where the case of invoking the constraint occurs more frequently. It would also not be desirable to impose different constraint mechanisms for low and high QP cases.

It was commented that it might be interesting to investigate method 3.6b with different configurations of Rice parameters.

It was further commented that enforcing the context coding of significance flags as in method 3.6b might introduce throughput problems.

No action on 3.6.

* 1. ***In-loop filtering***

**Test 4.1: TALF with reconstructed samples (**[**JVET-AM0133**](https://jvet-experts.org/doc_end_user/current_document.php?id=15780)**)**

In ECM, temporal adaptive loop filter (TALF) uses the reconstructed samples of the reference pictures as shown in the figure below. It generates offsets to the luma ALF’s output and the filter coefficients are carried in TALF APS. The usage of TALF for each CTB is signaled by a CTB-level flag.

A black background with white squares and black text

AI-generated content may be incorrect.

TALF has two filter shapes with 13 coefficients each.

A crossword puzzle with numbers

AI-generated content may be incorrect.

In the test, reconstructed samples right before ALF of the current picture are used as additional TALF filter inputs, where besides the existing inputs, 4 additional taps in a 5x5 cross-shape are applied to the neighborhood of one current sample. The figure below illustrates the specific filter shapes that are applied in the proposed TALF scheme: shape 0 (above) and shape1 (below).

A crossword puzzle with different symbols

AI-generated content may be incorrect.

Test 4.1: TALF with reconstructed samples.

**Test 4.2: Reuse of ALF control information (**[**JVET-AM0209**](https://jvet-experts.org/doc_end_user/current_document.php?id=15856)**)**

In ECM, ALF and CCALF coefficients are derived for each picture and signalled in APSs, which can be re-used by future encoded pictures.

In the test, CTB-level information of chroma ALF and CCALF of the current picture is stored and can be reused by future coded pictures. For each chroma component, two flags are signalled to indicate whether the current picture reuses ALF and CCALF CTB-level information from a previously coded picture. Encoder makes the decision for each picture individually such that no latency is introduced.

Test 4.2: Reuse of ALF control information.

**Test 4.3: On ALF-CCCM (**[**JVET-AM0063**](https://jvet-experts.org/doc_end_user/current_document.php?id=15710)**)**

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 entire block will not use the CCCM to do the filtering.

A diagram of a block diagram

AI-generated content may be incorrect.

In the test, the impact of applying an adaptive factor for ALF-CCCM and the updated usage of multi-models is investigated.

In Test 4.3a, an adaptive factor is selected from the candidate set of {1/4, 3/8, 5/8, 3/4} for ALF-CCCM. Each picture evaluated these factor candidates (including the fixed factor 0.5) to get the corresponding filtered results, then the corresponding distortion and bit cost for each factor are calculated. The factor corresponding to the minimum RD cost is selected as the best factor for the current frame. A flag indicating whether using the adaptive method or the fixed factor will be signaled in the bitstream. When using the adaptive method, two additional bits indicating the factor index will be also signaled in the bitstream.

In Test 4.3b, the multi-model’s usage is updated. When a block tries multi-models, if there is a sample whose correction exceeds the threshold, only the samples that are using the same model as this sample in the block will not be filtered by CCCM, rather than all the samples in the block will not be filtered.

Test 4.3a: Adaptive factor for ALF-CCCM.

Test 4.3b: Updated multi-models usage strategy

Test 4.3c: Test 4.3a + Test 4.3b.

**Test 4.4: On In-Loop filtering in ECM (**[**JVET-AM0219**](https://jvet-experts.org/doc_end_user/current_document.php?id=15866)**)**

In ECM, there are two interfaces to support NN ILF testing. Interface 1 is NNVC interface with NN loop filter applied in parallel to Deblocking Filter and before SAO, BIF, and ALF. NN filter includes all colour components.

Interface 2 has chroma channel removed in addition to placing the NN filter in parallel to the existing Fixed, Residual, and Gaussian filters.

Complexity-aware RDO to control the NN filter usage, and hence to control the decode runtime, is included in both interfaces, where NN filter can be switched off on a 128x128 or 256x256 block level if provided distortion reduction is found to be below a threshold, a flag is signalled to indicate the choice.

In 4.4 tests, alternative use of NN-ILF and fixed filters processing of ECM ALF for YCbCr filtering is tested with interface 1 for NNVC VLOP3 and VLOP from EE1-2.1. Alternative use of NN-ILF/Fixed Filters is being controlled by complexity-aware RDO and signalled in the bitstream.

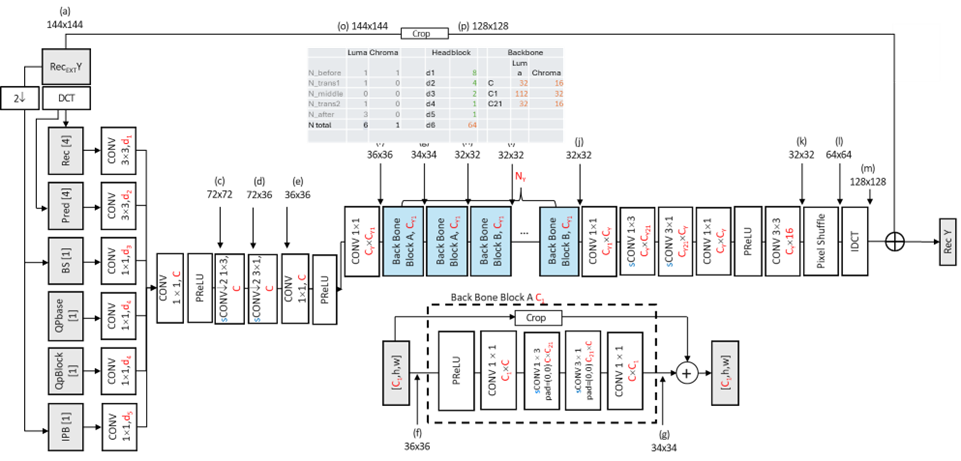
Test 4.4a: Alternative usage of VLOP3 filter with interface 1.

Test 4.4b: Alternative usage of VLOP filter from EE1-2.1 with interface 1.

**Test 4.5: On performance improvement of NN-ILF in ALF (**[**JVET-AM0231**](https://jvet-experts.org/doc_end_user/current_document.php?id=15878)**)**

In the test, luma only versions of VLOP3 and VLOP EE1-2.1 NN filters were evaluated with interface 2. The EE1-2.1 filter was trained as described in JVET-AM0135/AL0166. Luma only VLOP3 training follows the process of VLOP3 training.

The luma-only version of VLOP3 filter as shown in the next figure has 63904 parameters and 40 convolution layers with 4.78 kMAC/pixel.



The luma only version of EE1-2.1 VLOP filter as shown in the next figure has 67603 parameters and 45 convolution layers with 4.66 kMAC/pixel complexity.

A screenshot of a computer

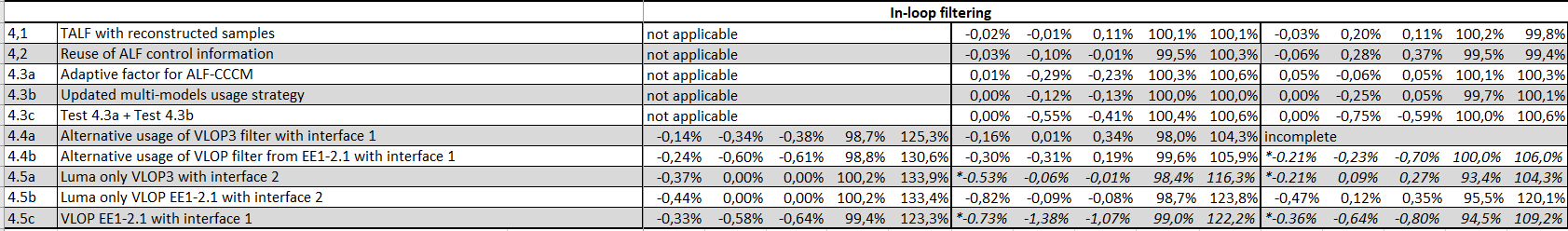
AI-generated content may be incorrect.

Complexity-aware RDO was used that NN filtering is disabled for blocks, if provided distortion reduction is found to be below a threshold. A flag is signalled to indicate whether NN-ILF or Gaussian filter is used when ALF is enabled.

Test 4.5a: Luma only VLOP3 with interface 2.

Test 4.5b: Luma only VLOP EE1-2.1 with interface 2.

Test 4.5c: VLOP EE1-2.1 with interface 1.



4.1 has very small gain in luma, some loss in chroma in LB, and requires additional processing using neighbored spatial samples. This is not attractive.

4.2 is re-using ALF/CCALF control information from the closest picture in coding order. This requires only low amount of memory (9 bits per CTB) and provides a small coding gain, should have no impact on runtime.

Decision: Adopt JVET-AM0209 test 4.2

4.3a and 4.3b target improvement of ALF-CCCM which results in chroma gain. Combination 4.3c shows that gains are additive (or more than additive in LB, where 4.3a shows loss, and also gain of 4.3b is small). Slight increase in encoder runtime due to 4.3a by determining the optimum weighting factor. Though the standalone proposals a/b would not be attractive, the gain of the combination (which is significantly higher than the addition of the two separate gains) gives a reasonable tradeoff.

Decision: Adopt JVET-AM0063 test 4.3c

4.4 and 4.5 use VLOP (two versions, VLOP3 and VLOP with attention from EE1-2.1), where 4.4 filters luma and chroma, 4.5 filters only luma (except 4.5c). 4.4 uses a “complexity aware RDO” to reduce decoder runtime by switching off.

It was asked why 4.5 gives significant reduction of encoding time in LB. A possible reason could be that ALF is less frequently used? Later in the discussion, the crosschecker reports that he did not observe such a decrease in encoder runtime.

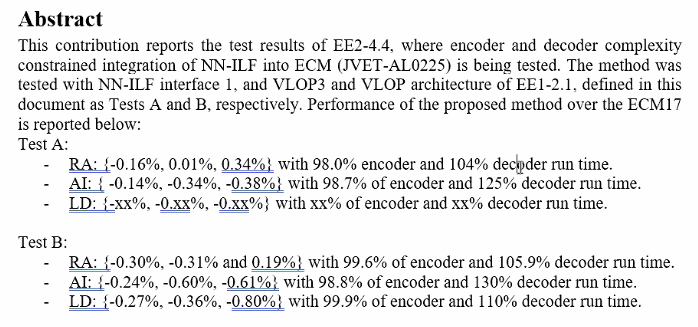
Results are not complete yet, also crosscheck is not finished yet.

For the cases which filter only luma, no true training crosscheck had been performed in EE1, as EE1 always investigated processing of luma and chroma, and here the chroma branch was disabled.

The difference between 4.4b and 4.5c (which are both using the EE1-2.1 filter on both luma and chroma) is the encoder optimization, which switches off the NNLF based on the amount of gain using a threshold parameter. It would even be possible to get more gain than 4.5c, but then the decoder runtime would further increase.

The method used in 4.4b and 4.5c is a candidate for adoption in ECM (non-CTC, for further investigations). This should also include the threshold parameter for decoder runtime control. Was further reviewed after complete results and crosscheck were available for 4.5c. It was further clarified that the reduction in encoder runtime in tests 4.5 LB/RA was an error in measuring, as confirmed by the cross-check. It was further confirmed that ALF and NNLF are procecessed independent in the encoder in tests 4.5 (disabling fixed filters is only used in 4.4).

In this context, also an update of JVET-AM0219 (test 4.4) was shown with complete LB results as follows:



After full results available, in terms of performance tradeoffs, 4.5c is slightly better than 4.4b in AI and LB, and clearly better in RA (even though 4.5c has clearly higher decoder run time).

As this is non-CTC, and the encoder software will allow to adjust the decoder run time by TDO parameters, and also there is no modification of ALF, 4.5c is asserted to be the better solution for non-CTC experimentation.

Decision: Adopt JVET-AM0231 (non-CTC) test 4.5c.

### EE2 contributions: Enhanced compression beyond VVC capability (26)

There was no presentation or discussion about specific proposals in this category.

For actions decided to be taken, see section 5.2.1, unless otherwise noted.

[JVET-AM0054](https://jvet-experts.org/doc_end_user/current_document.php?id=15701) EE2-3.6cd: On coefficient level binarization in Transform Skip [M. Abdoli, R. G. Youvalari, A. Tissier, F. Plowman (Xiaomi)]

[JVET-AM0251](https://jvet-experts.org/doc_end_user/current_document.php?id=15918) Crosscheck of JVET-AM0054 (EE2-3.6cd: On coefficient level binarization in Transform Skip) [Y. Yu, J. Gan (OPPO)] [late]

[JVET-AM0056](https://jvet-experts.org/doc_end_user/current_document.php?id=15703) EE2-3.1: Predictive transform coefficient coding [T. N. Canh, F. Pu, P. Yin, S. McCarthy (Dolby)]

[JVET-AM0243](https://jvet-experts.org/doc_end_user/current_document.php?id=15890) Crosscheck of JVET-AM0056 (EE2-3.1: Predictive transform coefficient coding) [P. Nikitin (Qualcomm)] [late] [miss]

[JVET-AM0059](https://jvet-experts.org/doc_end_user/current_document.php?id=15706) EE2-1.10: Matrix-based position dependent intra prediction for GPM/CIIP [Z. Sun, Y. Yu, L. Xu, H. Yu, D. Wang (OPPO)]

[JVET-AM0256](https://jvet-experts.org/doc_end_user/current_document.php?id=15923) Crosscheck of JVET-AM0059 (EE2-1.10: Matrix-based position dependent intra prediction for GPM/CIIP) [X. Li (Alibaba)] [late]

[JVET-AM0060](https://jvet-experts.org/doc_end_user/current_document.php?id=15707) EE2-3.2: Directional sign prediction [L. Xu, Y. Yu, Z. Sun, L. Zhang, H. Yu, D. Wang (OPPO)]

[JVET-AM0261](https://jvet-experts.org/doc_end_user/current_document.php?id=15928) Crosscheck of JVET-AM0060 (Test EE2-3.2 on directional sign prediction) [P. Onno (Canon)] [late]

[JVET-AM0061](https://jvet-experts.org/doc_end_user/current_document.php?id=15708) EE2-3.3: Third transform set selection for intraNN [Z. Xie, F. Wang, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AM0266](https://jvet-experts.org/doc_end_user/current_document.php?id=15933) Crosscheck of JVET-AM0061 (EE2-3.3: Third transform set selection for intraNN) [[G. Verba (Qualcomm)](mailto:gverba@qti.qualcomm.com)] [late]

[JVET-AM0062](https://jvet-experts.org/doc_end_user/current_document.php?id=15709) EE2-3.6ab: On binarization of a coefficient level in TSRC [Y. Yu, L. Xu, J. Gan, H. Yu, D. Wang (OPPO), M. Abdoli, R. G. Youvalari, F. Plowman, A. Tissier (Xiaomi)]

[JVET-AM0245](https://jvet-experts.org/doc_end_user/current_document.php?id=15892) Crosscheck of JVET-AM0062 (EE2-3.6ab: On binarization of a coefficient level in TSRC) [P. Nikitin (Qualcomm)] [late] [miss]

[JVET-AM0252](https://jvet-experts.org/doc_end_user/current_document.php?id=15919) Crosscheck of JVET-AM0062 (EE2-3.6ab: On binarization of a coefficient level in TSRC) [T. N. Canh (Dolby)] [late]

[JVET-AM0286](https://jvet-experts.org/doc_end_user/current_document.php?id=15953) Crosscheck of JVET-AM0062 (EE2-3.6ab: On binarization of a coefficient level in TSRC) [Z. Deng (Bytedance)] [late]

[JVET-AM0063](https://jvet-experts.org/doc_end_user/current_document.php?id=15710) EE2-4.3: On ALF-CCCM [N. Song, L. Xu, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AM0276](https://jvet-experts.org/doc_end_user/current_document.php?id=15943) Crosscheck of JVET-AM0063 (EE2-4.3: On ALF-CCCM) [C. Ma (Kwai)] [late]

[JVET-AM0291](https://jvet-experts.org/doc_end_user/current_document.php?id=15958) Crosscheck of JVET-AM0063 (EE2-4.3: On ALF-CCCM) [N. Hu (Qualcomm)] [late]

[JVET-AM0074](https://jvet-experts.org/doc_end_user/current_document.php?id=15721) EE2-1.6: Intra Merge Mode [M.Blestel, P. Andrivon, K. Suverov, N. Zouidi (Ofinno), Y. Chang, V. Seregin, M. Karczewicz (Qualcomm Inc.), J. Fu, J. Zhang, S. Ma (Peking University)]

[JVET-AM0290](https://jvet-experts.org/doc_end_user/current_document.php?id=15957) Cross-check of JVET-AM0074 "EE2-1.6: Intra Merge Mode" [F. Le Léannec (InterDigital)] [late]

[JVET-AM0077](https://jvet-experts.org/doc_end_user/current_document.php?id=15724) EE2-1.1: TIMD fusion with neural network based intra prediction [Y.-H. Lin, C.-Y. Teng, K.-W. Liang, Y.-C. Yang (Sharp), K. Naser, T. Dumas, E. François, F. Le Léannec (InterDigital)]

[JVET-AM0137](https://jvet-experts.org/doc_end_user/current_document.php?id=15784) Crosscheck of JVET-AM0077 (EE2-1.1: TIMD fusion with neural network based intra prediction) [N. Zouidi (Ofinno)]

[JVET-AM0084](https://jvet-experts.org/doc_end_user/current_document.php?id=15731) EE2-1.9: Block Vector-based Intra Mode Derivation [J.-K. Lee, D. Ruiz Coll, M. Blestel (Offinno)] [late]

[JVET-AM0304](https://jvet-experts.org/doc_end_user/current_document.php?id=15972) crosscheck of JVET-AM0084: EE2-1.9: Block Vector-based Intra Mode Derivation [K. Naser (InterDigital)] [late]

[JVET-AM0088](https://jvet-experts.org/doc_end_user/current_document.php?id=15735) EE2-2.3: Affine bilateral matching mode [H. Huang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AM0106](https://jvet-experts.org/doc_end_user/current_document.php?id=15753) EE2-2.1a/b: Chained candidates in AMVP and merge lists [D. Bugdayci Sansli, J. Lainema (Nokia)]

[JVET-AM0271](https://jvet-experts.org/doc_end_user/current_document.php?id=15938) Crosscheck of JVET-AM0106 (EE2-2.1a/b: Chained candidates in AMVP and merge lists) [Y. Kidani (KDDI)] [late]

[JVET-AM0133](https://jvet-experts.org/doc_end_user/current_document.php?id=15780) EE2-4.1: TALF with reconstructed samples [C. Ma, X. Xiu, X. Wang (Kwai)]

[JVET-AM0305](https://jvet-experts.org/doc_end_user/current_document.php?id=15973) Crosscheck of JVET-AM0133 (EE2-4.1: TALF with reconstructed samples) [N. Song (OPPO)] [late] [miss]

[JVET-AM0138](https://jvet-experts.org/doc_end_user/current_document.php?id=15785) EE2-1.2a/b/c: TIMD-BV extension with enhanced IntraTMP merge list [J. Fu, J. Zhang, Y. Zhao, S. Ma (PKU), Y. Gao, C. Huang (ZTE), K. Naser, M. Radosavljević, S. Puri, T. Dumas (InterDigital), D. Ruiz Coll, J.-K Lee (Ofinno)]

[JVET-AM0255](https://jvet-experts.org/doc_end_user/current_document.php?id=15922) Crosscheck of JVET-AM0138 (EE2-1.2a/b/c: TIMD-BV extension with enhanced IntraTMP merge list) [X. Li (Alibaba)] [late]

[JVET-AM0157](https://jvet-experts.org/doc_end_user/current_document.php?id=15804) EE2-1.8: Harmonization of SGPM-BV and LIC [J. Huo, Y. Fei, L. Wang, Y. Ma, F. Yang (Xidian Univ.)]

[JVET-AM0253](https://jvet-experts.org/doc_end_user/current_document.php?id=15920) Crosscheck of JVET-AM0157 (EE2-1.8: Harmonization of SGPM-BV and LIC) [X. Li (Alibaba)] [late]

[JVET-AM0163](https://jvet-experts.org/doc_end_user/current_document.php?id=15810) EE2-1.7: On interpolation filter for TIMD [Y. Wang, W. Yin, K. Zhang, Z. Deng, N. Zhang, L. Zhao, M. Salehifar, L. Zhang (Bytedance)]

[JVET-AM0236](https://jvet-experts.org/doc_end_user/current_document.php?id=15883) Crosscheck of JVET-AM0163 (EE2-1.7: On interpolation filter for TIMD) [L. Xu, Y. Yu (OPPO)] [late]

[JVET-AM0172](https://jvet-experts.org/doc_end_user/current_document.php?id=15819) EE2-3.5: a combination of EE2-3.3 and EE2-3.4 [Z. Xie, F. Wang, Y. Yu, H. Yu, D. Wang (OPPO), G. Verba, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AM0310](https://jvet-experts.org/doc_end_user/current_document.php?id=15978) Cross-check of JVET-AM0172 (EE2-3.5: a combination of EE2-3.3 and EE2-3.4) [T. Dumas (InterDigital)] [late]

[JVET-AM0209](https://jvet-experts.org/doc_end_user/current_document.php?id=15856) EE2-4.2: Reuse of ALF control information [N. Hu, H. Wang, M. Karczewicz, V. Seregin (Qualcomm)]

[JVET-AM0306](https://jvet-experts.org/doc_end_user/current_document.php?id=15974) Crosscheck of JVET-AM0209 (EE2-4.2: Reuse of ALF control information) [N. Song (OPPO)] [late]

[JVET-AM0215](https://jvet-experts.org/doc_end_user/current_document.php?id=15862) EE2-2.2: Regression-based GPM intra-inter prediction modification [R. Yu, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AM0258](https://jvet-experts.org/doc_end_user/current_document.php?id=15925) Crosscheck of JVET-AM0215 (EE2-2.2: Regression-based GPM intra-inter prediction modification) [K. Jia (Alibaba)] [late]

[JVET-AM0219](https://jvet-experts.org/doc_end_user/current_document.php?id=15866) EE2-4.4: On In-Loop filtering in ECM [D. Rusanovskyy, S. Hong, K. Panusopone, L. Wang, J. Lainema (Nokia), N. Hu, M. Karczewicz, M. Coban, H. Wang, Y. Shao, J. Wang, Y. Li, V. Seregin (Qualcomm)]

[JVET-AM0241](https://jvet-experts.org/doc_end_user/current_document.php?id=15888) crosscheck of JVET-AM0219 (EE2-4.4) [T. Poirier, F. Galpin (InterDigital)] [late]

[JVET-AM0228](https://jvet-experts.org/doc_end_user/current_document.php?id=15875) EE2-3.4: Reduced zero-out for NSPT kernels [G. Verba, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AM0262](https://jvet-experts.org/doc_end_user/current_document.php?id=15929) Crosscheck of JVET-AM0228 (EE2-3.4: Reduced zero-out for NSPT kernels) [M. Abdoli (Xiaomi)] [late]

[JVET-AM0229](https://jvet-experts.org/doc_end_user/current_document.php?id=15876) EE2-1.3: Intra TMP sub-modes depending on the template type information [T. Dumas, K. Naser, M. Radosavljević, F. Le Léannec (InterDigital)]

[JVET-AM0248](https://jvet-experts.org/doc_end_user/current_document.php?id=15915) Crosscheck of JVET-AM0229 (EE2-1.3: Intra TMP sub-modes depending on the template type information) [H. Qin, V. Rufitskiy, A. Filippov (TCL)] [late]

[JVET-AM0320](https://jvet-experts.org/doc_end_user/current_document.php?id=15988) Crosscheck of JVET-AM0229 Test1.3 (EE2-1.3: Intra TMP sub-modes depending on the template type information) [Z. Sun (OPPO)] [late] [miss]

[JVET-AM0231](https://jvet-experts.org/doc_end_user/current_document.php?id=15878) EE2-4.5: On performance improvement of NN-ILF in ALF [N. Hu, M. Karczewicz, M. Coban, H. Wang, Y. Shao, J. Wang, Y. Li, V. Seregin (Qualcomm), D. Rusanovskyy, S. Hong, K. Panusopone, L. Wang, J. Lainema (Nokia)]

[JVET-AM0240](https://jvet-experts.org/doc_end_user/current_document.php?id=15887) crosscheck of JVET-AM0231 (EE2-4.5) [F. Galpin, T. Poirier (InterDigital)] [late]

[JVET-AM0232](https://jvet-experts.org/doc_end_user/current_document.php?id=15879) EE2-1.4: combination of EE2-1.2c and EE2-1.3 [J. Fu, Y. Zhao, J. Zhang, S. Ma (PKU), Y. Gao, C. Huang (ZTE), T. Dumas, K. Naser, M. Radosavljević, S. Puri (InterDigital), D. Ruiz Coll, J.-K. Lee (Ofinno)]

[JVET-AM0249](https://jvet-experts.org/doc_end_user/current_document.php?id=15916) Crosscheck of JVET-AM0232 (EE2-1.4: combination of EE2-1.2c and EE2-1.3) [H. Qin, V. Rufitskiy, A. Filippov (TCL)] [late]

[JVET-AM0233](https://jvet-experts.org/doc_end_user/current_document.php?id=15880) EE2-1.5: combination of EE2-1.1 and EE2-1.4 [Y.-H. Lin, C.-Y. Teng, K,-W. Liang, Y.-C. Yang (Sharp), J. Fu, Y. Zhao, J. Zhang, S. Ma (PKU), Y. Gao, C. Huang (ZTE), T. Dumas, K. Naser, M. Radosavljević, S. Puri (InterDigital), D. Ruiz Coll, J.-K. Lee (Ofinno)]

[JVET-AM0250](https://jvet-experts.org/doc_end_user/current_document.php?id=15917) Crosscheck of JVET-AM0233 (EE2-1.5: combination of EE2-1.1 and EE2-1.4) [H. Qin, V. Rufitskiy, A. Filippov (TCL)] [late]

[JVET-AM0299](https://jvet-experts.org/doc_end_user/current_document.php?id=15967) EE2-1.11: a combination of EE2-1.2c and EE2-1.6a [J. Fu, J. Zhang, S. Ma (Peking University), Y. Gao, C. Huang (ZTE), T. Dumas, K. Naser, M. Radosavljević, S. Puri (InterDigital), M.Blestel, P. Andrivon, K. Suverov, N. Zouidi, D. Ruiz Coll, J.-K. Lee (Ofinno), Y. Chang, V. Seregin, M. Karczewicz (Qualcomm Inc.)] [late]

[JVET-AM0302](https://jvet-experts.org/doc_end_user/current_document.php?id=15970) Crosscheck of JVET-AM0299 (EE2-1.11: a combination of EE2-1.2c and EE2-1.6a) [X. Li (Alibaba)] [late]

[JVET-AM0307](https://jvet-experts.org/doc_end_user/current_document.php?id=15975) EE2-1.12: a combination of EE2-1.2c, EE2-1.6a and EE2-1.3 [J. Fu, J. Zhang, S. Ma (Peking University), Y. Gao, C. Huang (ZTE), T. Dumas, K. Naser, M. Radosavljević, S. Puri (InterDigital), M.Blestel, P. Andrivon, K. Suverov, N. Zouidi, D. Ruiz Coll, J.-K. Lee (Ofinno), Y. Chang, V. Seregin, M. Karczewicz (Qualcomm)] [late]

[JVET-AM0308](https://jvet-experts.org/doc_end_user/current_document.php?id=15976) Crosscheck of JVET-AM0307 (EE2-1.12: a combination of EE2-1.2c, EE2-1.6a and EE2-1.3) [S. Blasi (Nokia)] [late]

### EE2 related contributions (8)

Contributions in this area were discussed during 1000–1205 on Friday 17 June 2025 (chaired by JRO).

[JVET-AM0055](https://jvet-experts.org/doc_end_user/current_document.php?id=15702) EE2-3.6 related: On Context Budget Control for Transform Skip Residual Coding [T. N. Canh, P. Yin, S. McCarthy (Dolby)]

This contribution proposes two methods to control context budget in transform skip residual coding (TSRC) in ECM. The first method is named significant first budget control (SigFirst) which guarantees to always encode significant flag in context mode. The second method, named two tiers (TwoTiers) budget control, defines an additional significant flag budget. Both methods are designed to retain the improvement of EE2-3.6c while without excessive context budget increase. The current implementations are based on EE2-3.6c version 1 in ECM-17.0 which itself already increased the context budget beyond the significant flags. As a result, the proposed SigFirst and TwoTiers utilize a smaller context budget than EE2-3.6c-v1 but a higher context budget than EE2-3.6b.

The BD-rates of sigFirst overs ECM-17.0 at CTC condition are as follows (2 copied rate points of ParkRunning3 in RA from anchor):

AI (Y/ Cb/ Cr): Natural { 0.00%, -0.01%, 0.00%, 97.0%, 98.4%}

F {-0.10%, -0.16%, -0.03%, 98.1%, 100.5%}

TGM {-0.34%, -0.39%, -0.45%, 100.1%, 100.3%}

RA (Y/ Cb/ Cr): Natural { 0.00%, -0.05%, -0.01%, 100.0%, xxx.x%}

F {-0.15%, -0.10%, -0,19%, 98.7%, xxx.x%}

TGM {-0.37%, -0.38%, -0.39%, 96.5%, xxx.x%}

The BD-rates of TwoTiers overs ECM-17.0 at CTC condition are as follows (2 copied rate points of ParkRunning3 in RA from anchor):

AI (Y/ Cb/ Cr): Natural { 0.00%, 0.00%, 0.01%, 97.8%, 98.3%}

F {-0.13%, -0.26%, -0.14%, 99.0%, 99.8%}

TGM {-0.37%, -0.47%, -0.49%, 99.9%, 100.9%}

RA (Y/ Cb/ Cr): Natural {0.00%, -0.01%, -0.02%, 98.7%, xxx.x%}

F {-0.14%, -0.14%, 0,16%, 100.8%, xxx.x%}

TGM {-0.38%, -0.46%, -0.42%, 98.1%, xxx.x%}

Runtime results might not be reliable.

Related to EE2-3.6 which was discontinued – no need for presentation according to proponents.

[JVET-AM0319](https://jvet-experts.org/doc_end_user/current_document.php?id=15987) Crosscheck of JVET-AM0055 (EE2-3.6 related: On context budget control for transform skip residual coding) Y. Yu, L. Xu, J. Gan (OPPO) [late]

[JVET-AM0064](https://jvet-experts.org/doc_end_user/current_document.php?id=15711) EE2-related: Updated multi-models’ usage strategy for ALF-CCCM [N. Song, L. Xu, Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)]

In the current EE2-TEST-4.3, when ALF-CCCM is applied to a block, if there is a pixel whose correction exceeds the threshold, this pixel among with other pixels that use the same model with this pixel will not be filtered by CCCM. In this contribution, multi-models usage strategy is further updated. Instead of first calculating a single model and then checking whether to use multi-models, the proposed method directly applies multi-models to a block. On top of EE2-TEST-4.3C, the test results are summarized as follows:

AI: {not applicable}

RA\*: 0.01%(Y), -0.39%(U), -0.45%(V), 99.9%(EncT), 100.3% (DecT))

LDB: 0.03%(Y), -1.44%(U), -1.40%(V), 100.2%(EncT), 100.7% (DecT))Investigate in EE.

[JVET-AM0278](https://jvet-experts.org/doc_end_user/current_document.php?id=15945) Crosscheck of JVET-AM0064 (EE2-related: Updated multi-models’ usage strategy for ALF-CCCM) [C. Ma (Kwai)] [late]

[JVET-AM0104](https://jvet-experts.org/doc_end_user/current_document.php?id=15751) EE2-related: On reference sample filtering for TIMD [V. Rufitskiy, A. Filippov, T. Dong (TCL)]

This contribution relates to the EE2-1.7 in which always non-smoothing 8-tap interpolation filter is used to obtain TIMD prediction. In this contribution it is proposed to disable usage of {1, 2, 1}-filtered reference samples when a TIMD intra prediction mode (no matter primary or secondary) is integer slope. It is reported that on top of ECM-17.0, the overall coding performance for {Y, U, V, EncT, DecT} is: {-0.03%, -0.04%, -0.06%, 99.8%, 99.8%} for AI configuration.

Benefit on top of EE2-1.7a is 0.01%. Some more simplification by removing the 3-tap filter.

According to cross-checker, 1 line of code change on top of 1.7a. Cross-checker would support immediate adoption, as it is very simple. Cross-check matching so far, but not complete for classes A.

Contributors were requested to provide a software attachment and detailed Excel sheet. Follow-up review on Tuesday 1 July 1235. The requested information was provide, and it was confirmed by independent experts an the software coordinator that the software modification is straightforward and simple.

Decision: Adopt JVET-AM0104.

[JVET-AM0309](https://jvet-experts.org/doc_end_user/current_document.php?id=15977) Crosscheck of JVET-AM0104 (EE2-related: On reference sample filtering for TIMD) [G. Kulupana, S. Blasi (Nokia)] [late]

[JVET-AM0105](https://jvet-experts.org/doc_end_user/current_document.php?id=15752) EE2-related: Candidate replacement in MPM list [H. Tian, Y. Gao, S. Li, J. Lei (Shandong Univ.), B. Li, F. Xing, P. Han (Hisense)] [late]

In EE2, the MPM list is constructed based on the best RD mode of neighbors. In MPM list, it already has an advantage of bitrate saving. Thus the candidates in MPM list should be the mode of neighbors with the lowest distortion. In this proposal, a candidate replacement in MPM list is presented based on the mode of neighbors with the lowest distortion.

On top of ECM-13.0, results of the proposed method are:

AI: %, %, %, EncT: % , DecT: %.

Table 1. experimental results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | |
|  | **Over ECM-13.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -0.02% | -0.06% | 0.00% | 111% |  |  |  |
| Class C | -0.01% | 0.02% | 0.03% | 107% |  |  |  |
| Class E | -0.09% | -0.14% | 0.03% | 124% |  |  |  |
| **Overall** |  |  |  |  |  |  |  |
| Class D | -0.01% | -0.20% | -0.12% | 113% |  |  |  |
| Class F | 0.01% | 0.10% | 0.05% | 123% |  |  |  |

According to current results, the tradeoff of compression vs. encoder runtime is not acceptable. This happens likely due to increased number of mode checks. Further study to demonstrate if compression benefit with better tradeoff can be achieved.

It is also noted that the results are compared to an outdated version of ECM.

[JVET-AM0127](https://jvet-experts.org/doc_end_user/current_document.php?id=15774) EE2-3.6 related: Advanced Budget Control for TSRC [R. Xu, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang, W. Song (Hisense)]

In TSRC, allocating the context budget with higher priority to syntax elements that have high coding efficiency can yield performance gains, as demonstrated in EE2-3.6b [1][2]. Following this principle, this contribution proposes to increase the priority of coeff\_sign\_flag, which also possesses a relatively high coding efficiency.

On top of ECM-17.0, simulation results of the proposed method + EE2-3.6b are reported as below:

The proposed method + EE2-3.6b over ECM-17.0 :

All-Intra:

Class F: {-0.12%, -0.01%, -0.10%, xx.x%, xx.x%}

Class TGM: {-0.23%, -0.29%, -0.28%, xx.x%, xx.x%}

The proposed method + EE2-3.6b over EE2-3.6b :

All-Intra:

Class F: {-0.01%, 0.03%, 0.19%, xx.x%, xx.x%}

Class TGM: {-0.04%, -0.03%, -0.02%, xx.x%, xx.x%}

Further study to demonstrate that the loss that EE2-3.6b has in the low QP range can be avoided by this method (not in EE).

[JVET-AM0139](https://jvet-experts.org/doc_end_user/current_document.php?id=15786) EE2-related: On Chained Motion Vector Prediction [X. Zeng, M. Jia, Z. Li, C. Huang (ZTE)]

This contribution proposes changes to the chained MV candidate derivation process in merge mode. In addition to the five positions in the current block, other positions derived from spatial neighbor blocks and their MVs are used for motion trace.

Compared to ECM-17.0, performance under the Common Test Conditions is reported to be:

RA : -0.00%, -0.00%, 0.04% for Y, U, V respectively, EncT 100.3% DecT 98.6%

LDB : -0.04%, 0.20%, 0.13%, for Y, U, V respectively, EncT 100.3% DecT 98.2%

Compared to EE2-Test2.1b, performance under the Common Test Conditions is reported to be:

RA : -0.xx%, -0.xx%, -0.xx% for Y, U, V respectively, EncT xx% DecT xx%

LDB : -0.03%, -0.08%, 0.32%, for Y, U, V respectively, EncT xx% DecT xx%

Maximum number of merge candidates unchanged, but more effort to construct the list.

Results incomplete, and benefit over EE2-2.1b from the available results is only for class E in LB. As it was not possible to deliver complete results during the meeting, it was recommended to perform further study to achieve more consistent gain over various classes on top of the adopted method from EE2-2.1b.

[JVET-AM0284](https://jvet-experts.org/doc_end_user/current_document.php?id=15951) Crosscheck of JVET-AM0139 (EE2-related: On Chained Motion Vector Prediction) [Z. Xie (OPPO)] [late]

[JVET-AM0176](https://jvet-experts.org/doc_end_user/current_document.php?id=15823) EE2-related: ECM NNLF evaluation using AhG11 trained models [T. Poirier, F. Galpin (InterDigital)]

This contribution reports the performance of the models trained and cross checked in AhG11 using NNVC software using the interface similar to the one used in NNVC software. The results on top of ECM 17.0 are as follow:

VLOP3:

* AI configuration {-0.79%,-1.81%, -1.72%} bdrate gains for Y,U,V with {100.1%, 223.0%} Encoding and decoding time
* RA configuration {-1.16%, -1.51%, -1.25%} bdrate gains for Y,U,V with {101.1%,205.1%} Encoding and decoding time

VLOP3 with TDO:

* RA configuration {-0.94%, -1.40%, -1.16%} bdrate gains for Y,U,V with {101.1%,150.9%} Encoding and decoding time

VLOP3 with TDO alternative lambdas:

* RA configuration {-X.XX%, -X.XX%, -X.XX%} bdrate gains for Y,U,V with {XXX.X%, XXX.X%} Encoding and decoding time

LOP5:

* AI configuration {-1.86%, -5.81%, -5.85%} bdrate gains for Y,U,V with {100.3%, 404.2%} Encoding and decoding time
* RA configuration {-2.54%, -5.13%, -4.70%} bdrate gains for Y,U,V with {101.2%, 337.6%} Encoding and decoding time

LOP5 with TDO:

* RA configuration {-2.35%, -5.05%, -4.70%} bdrate gains for Y,U,V with {101.2%, 241.5%} Encoding and decoding time

HOP5:

* AI configuration {-4.88%, -0.65%, -1.94%} bdrate gains for Y,U,V with {115.7%, 13928.2%} Encoding and decoding time
* RA configuration {-7.01%, -1.49%, -2.65%} bdrate gains for Y,U,V with {114.0%, 9890.9%} Encoding and decoding time

Contribution for information, no specific action required. The results indicate that for LOP without using TDO, the coding gain could be increased compared to EE2-4.5, but also the decoder runtime increase further. It is noted that the method used in TDO/alternative are different from those in 4.4/4.5.

It is noted that with some TDO settings, LOP may have a better tradeoff compression vs. decoder run time than VLOP.

It is commented that from the perspective of decoder manufacturers, TDO would not have impact on worst case decoder runtime and implementation cost.

[JVET-AM0217](https://jvet-experts.org/doc_end_user/current_document.php?id=15864) EE2-related: Simplification of TMVP Refinement [T. M. Bae, S. Deshpande (Sharp)]

This contribution proposes a simplification of motion vector (MV) refinement for TMVP in AMVP mode. In AMVP mode, TMVP is first refined using the collocated block as a template [1], and then refined again using the templates of the current and reference blocks if the TMVP is selected as MVP. The proposed method disables the second refinement stage to avoid redundant refinement. The test results are summarized as follows:

LDB: -0.01% (Y), -0.02% (U), 0.38% (V), 97.2% (EncT), 98.5% (DecT)

RA:

It is asserted that the encoder, decoder complexity can be reduced at the same time achieving some gain using the proposed approach.

From the preliminary results, the benefit in RA is less obvious: No decrease in encoding/decoding time, losses in classes D and F.

It would not be useful to use a different approach for LB and RA, and it is questionable whether the benefit for LB is significant enough to take action. No other experts expressed interest for investigation in EE.

### ECM modifications and software improvements beyond EE2 (31)

#### Intra and CIIP (11)

Contributions in this area were discussed during 1205–1235 on Friday 27 June 2025 and during 1400–1530 on Sunday 29 June 2025 (chaired by JRO).

[JVET-AM0067](https://jvet-experts.org/doc_end_user/current_document.php?id=15714) Non-EE2: Enhanced CCP merge mode with BVG-CCCM model [H. Zhang, Y. Yu, H. Yu, D. Wang (OPPO)]

This contribution proposes to store the current CU’s coded BVG-CCCM parameters for the following coding of subsequent chroma intra and inter blocks. If the current block is coded by the BVG-CCCM mode, the CCP model type and parameters will be stored and inherited for the following coding of subsequent chroma intra and inter blocks. On top of ECM-17.0, the average results are presented as follows (Y, U, V, Enc time, Dec time):

RA: -0.01%, 0.04%, 0.06%; EncT 99.7% DecT 100.2%

LB: -0.07%, 0.07%, 0.51%; EncT 99.9% DecT 100.0%

Minor benefit for RA.

Luma gain and chroma loss in LB mainly from class E, inhomogeneous for remaining classes. Overall benefit not clear.

[JVET-AM0313](https://jvet-experts.org/doc_end_user/current_document.php?id=15981) Cross-check of JVET-AM0067 (Non-EE2: Enhanced CCP merge mode with BVG-CCCM model) [R. G. Youvalari (Xiaomi)] [late]

[JVET-AM0076](https://jvet-experts.org/doc_end_user/current_document.php?id=15723) Non-EE2: Enhanced DD-CCP and CCP-Merge Fusion [P. Bordes, T. Dumas, F. Galpin, Y. Chen (InterDigital)]

This contribution presents a DD-CCP and CCP-Merge fusion method based on RGPM. The experimental results over ECM-17.0 are summarized as follows:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | BD-rate Y | BD-rate U | BD-rate V | EncT | DecT | VmPeakE | VmPeakD |
| All intra | -0,03% | 0,06% | 0,17% | 99,6% | 100,2% | 100,4% | 100,0% |
| Random access | -0,01% | 0,00% | 0,05% | 100,1% | 99,9% | 100,0% | 99,8% |

Small gain in AI, no impact on runtime. One expert expressed interest to investigate in EE.

[JVET-AM0140](https://jvet-experts.org/doc_end_user/current_document.php?id=15787) Non-EE2: Modifications of the unwrapping and interpolation filtering processes for angular modes [V. Rufitskiy, A. Filippov, T. Dong (TCL)]

In this contribution several improvements of angular intra prediction are proposed: selection of interpolation filter is performed with respect to whether prediction is obtained for a fusion component of TIMD or DIMD, and it is proposed to disable reference smoothing filter when obtaining TIMD predictions. It is reported that on top of ECM-17.0, the overall coding performance for {Y, U, V, EncT, DecT} is: {-0.05%, -0.03%, 0.01%, 99.6%, 99.7%} for AI configuration.

It was asked if the change would have impact on combining TIMD and MRL (which is currently disabled).

Interest was expressed by other experts to investigate in EE. The two aspects (not using smoothing, selection of IF in unwrapping) should be investigated separately.

See further notes under JVET-AM0167.

[JVET-AM0141](https://jvet-experts.org/doc_end_user/current_document.php?id=15788) Non-EE2: Adaptive Planar Weight for DIMD [J.-H. Lee, K. Choi (KHU), C. W. Ryu (Kaon Group)]

This contribution proposes an improvement to the blending process in Decoder-side Intra Mode Derivation (DIMD). In the original DIMD method, a fixed weight is always assigned to the Planar mode during blending, limiting its ability to adapt to the characteristics of each prediction block. To address this limitation, an adaptive planar weighting strategy is proposed, which dynamically adjusts the contribution of the Planar mode based on the directional characteristics of the prediction block. Specifically, the proposed method analyzes whether the top-1, top-2, and top-3 modes involved in blending fall within the same directional range. Based on the number of directionally consistent modes, the weight of the Planar mode is adjusted accordingly. On top of ECM-15.0, the reported PSNR-Y, Cb, and Cr BD-rate results are -0.00%, -0.02%, and -0.01%, respectively, in the AI configuration.

Very small gain for AI, and only on top of an outdated ECM version. Further study if still relevant gain is possible on top of newest ECM.

[JVET-AM0145](https://jvet-experts.org/doc_end_user/current_document.php?id=15792) AHG12: TMRL blend [S. Blasi, G. Kulupana, D. Bugdayci Sansli, J. Lainema (Nokia)]

In this contribution, a new mode is proposed based on blending TMRL predictors. A template search is performed to determine pairs of intra mode and MRL index. Corresponding predictors are then blended together to compute a prediction for the current block. Blending weights are computed based on the template costs.

The impact on coding efficiency and runtimes of the proposed method over ECM-17.0 are reportedly {for Y, U, V, EncT, DecT, EncVmPeak, DecVmPeak}:

AI {-0.06%, -0.01%, -0.01%, 101.7%, 100.3%, 99.6%, 100.1%}

Encoding time increases by additional RD check.

It was asked how much gain is due to the non-directional mode.

No replacement of TMRL, rather an addition on top.

Interest was expressed to investigate in EE. Options should be investigated to reduce encoding time, and also investigate the aspect of non-directional mode.

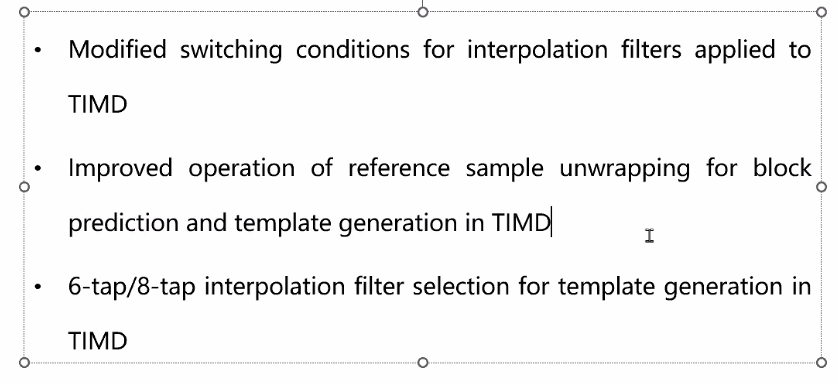
[JVET-AM0149](https://jvet-experts.org/doc_end_user/current_document.php?id=15796) Non-EE2: On filtering for angular modes [T. Dong, V. Rufitskiy, A. Filippov (TCL)]

In this proposal, unification for interpolation filters used in intra prediction of blocks predicted using TIMD fusion mode and other modes is presented. In addition to this unification a set of related improvements to enhance angular mode prediction is proposed. The overall coding gain for all intra is Y -0.04% U -0.04% V -0.01%.

Interest was expressed by other experts to investigate in EE. It was asked if there would still be gain in combination with JVET-AM0140, as there is some overlap (see JVET-AM0167).

It was commented that some gain may be lost after adoptions (1.7a, 1.12).

3-4 different aspects (second bullet point is basically two items), to be studied separately.



See further notes under JVET-AM0167

[JVET-AM0150](https://jvet-experts.org/doc_end_user/current_document.php?id=15797) Non-EE2: Extension of reconstructed area types for EIP [W. Niu, S. Xie, M. Jia, Y. Bai, C. Huang (ZTE)]

This contribution proposes an extension method of reconstructed area types for EIP mode. The number of reconstructed area types is extended from three to six, each with distinct shapes. The proposed method was implemented on top of ECM-17.0 software. The simulation results are summarized as follows,

AI: -0.02%/-0.06%/0.01% Y/U/V, 101.9%/99.7% EncT/DecT,

The tradeoff almost 2% encoding time increase vs. 0.02% compression is far from being attractive.

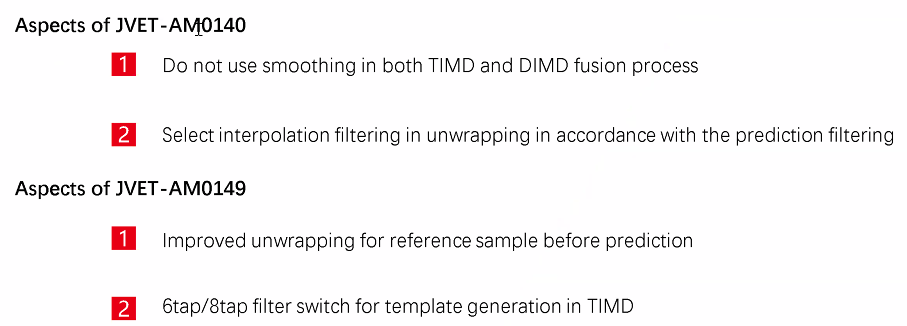
[JVET-AM0274](https://jvet-experts.org/doc_end_user/current_document.php?id=15941) Crosscheck of JVET-AM0150 (Non-EE2: Extension of reconstructed area types for EIP) [C. Zhou (vivo)] [late]

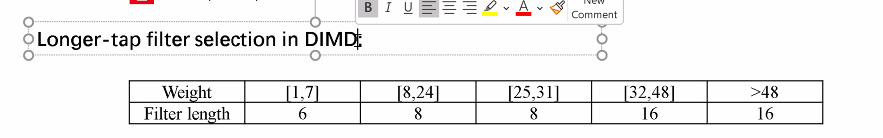
[JVET-AM0167](https://jvet-experts.org/doc_end_user/current_document.php?id=15814) Non-EE2: On long-tap interpolation filtering for angular modes [T. Dong, V. Rufitskiy, A. Filippov (TCL)]

This contribution is a combination of aspects proposed in JVET-AM0140 “Non-EE2: Modifications of the unwrapping and interpolation filtering processes for angular modes” and JVET-AM0149 “Non-EE2: On filtering for angular modes”. Besides, a longer-tap interpolation filters are used in intra prediction for DIMD fusion components.

It was commented that some gain may be lost after adoptions (1.7a, 1.12).

It is reported that on top of ECM-17.0, the overall coding performance for {Y, U, V, EncT, DecT} is: {-0.06%, -0.04%, -0.04%, 99.6%, 100.2%} for AI configuration.





It is noted that the switch between 6/8 tap was removed for prediction in EE2-1.7a, whereas the TM currently does not use switching. EE1.7b had proposed to replace the 4tap filter in TM 6tap, but it was not adopted due to complexity vs. insufficient benefit in compression. It appears inconsistent to add even more complexity, and according to proponents it only provides 0.01%.

Investigate in EE: Aspects 1 and 2 from JVET-AM0140 and aspect 1 from JVET-AM0149 in EE from list above, and the longer-tap filter selection from JVET-AM0167. (separate and in combination). 8-tap filter for TM (without switching) may also be tested. For adoption, also complexity in terms of increased number of operations shall be considered, not only runtime.

[JVET-AM0169](https://jvet-experts.org/doc_end_user/current_document.php?id=15816) Non-EE2: Reducing Candidate Modes in DDCCP [S. Wan, Y. Yin, Z. Zhu (NWPU), S. Xie, X. Zeng, C. Huang (ZTE)]

In ECM 17.0, Decoder-Derived Cross-Component Prediction (DDCCP) derives the best CCP mode from a DDCCP candidate list containing LB-CCP filtering. However, in the current ECM version, LB-CCP filtering is not used for single-model CCCM (S-CCCM), and filtering increases the complexity of the DDCCP derivation process. It is proposed to remove S-CCCM with LB-CCP and MM-CCCM with LB-CCP modes from the DDCCP list, i.e., removing the LB-CCP filtering process from DDCCP.

The experimental results on the top of ECM-17.0 are summarized as follows. The DDCCP derivation process and codec time are reduced with similar coding performance.

AI(Y/U/V): 0.02%/-0.13%/-0.11%, EncT 99.7%, DecT 99.3%

Number of modes checked in DDCCP is reduced to roughly half.

Though this is not of primary importance in this exploration, it appears straightforward and simplification confirmed by cross-checker. Some interest expressed by other experts to investigate in EE

[JVET-AM0316](https://jvet-experts.org/doc_end_user/current_document.php?id=15984) Crosscheck of JVET-AM0169 (Non-EE2: Reducing Candidate Modes in DDCCP) [C. Zhou (vivo)] [late]

[JVET-AM0196](https://jvet-experts.org/doc_end_user/current_document.php?id=15843) Non-EE2: Adaptive subsampling filter selection for CCLM/CCCM [Y. Kidani, H. Kato, K. Kawamura (KDDI)]

This contribution proposes an adaptive subsampling filter selection for the cross-component linear model (CCLM) and convolutional cross-component model (CCCM). Considering that many 4:2:0 color format videos are generated from 4:4:4 color format videos using different subsampling filters, it may not be optimal to utilize only one subsampling filter for CCLM and CCCM in the current ECM. This is because it occurs phase shifts between luma and chroma samples. To align the subsampling filters between the generation process of 4:2:0 color format videos and CCLM and CCCM processes, an adaptive subsampling filter selection method for CCLM and CCCM is proposed. Specifically, in the proposed method, different subsampling filters are adaptively used 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 color format and spatial allocation of luma and chroma samples. Similarly, the adaptive filter selection method is also introduced into the filter derivation and application processes of inter-CCCM.

On top of the ECM-17.0, the proposed method provides some coding gains without increasing encoder and decoder runtime in specific test sequences of CTC and the draft of Joint Call for Evidence on video compression with capability beyond VVC. These simulation results {Y, U, V, EncT, DecT} for the all-intra configuration are reported below:

* CTC:
  + CatRobot {-0.07%, -0.99%, -0.97%, 100.5%, 100.0%},
  + FourPeople {-0.01%, -0.12%, -0.40%, 100.5%, 99.7%},
  + SlideShow {-0.24%, -4.09%, -5.01% , 99.6%, 100.1%},
* Draft of Joint Call for Evidence on video compression with capability beyond VVC:
  + SDR\_RA\_UHD:
    - CrowdRun {-0.03%, -0.83%, -0.66%, 100.0%, 99.4%},
    - FireDance {-0.14%, -0.29%, -0.12%, 99.6%, 99.0%},
  + SDR\_LD\_HD:
    - GregoryCactus2 {-0.02%, -0.04%, -0.03%, 100.3%, 99.3%},
  + HDR\_RA\_8Kcrop:
    - ChandelierCropBR {-0.02%, -0.31%, -0.02%, 99.3%, 99.9%},
    - FashionLadyCrop1 {-0.06%, -0.29%, -0.76%, 98.6%, 100.1%},
    - WaterfallForest {-0.18%, -0.66%, -0.71%, 99.5%, 100.4%},
    - WomenFootball {-0.08%, -0.29%, -0.83%, 99.6%, 100.6%},
  + Gaming\_LD\_HD:
    - DOTA2s360 {-0.15%, -1.77%, -1.81%, 99.4%, 99.1% },
    - GTAVs090 {0.00%, -1.51%, -0.65%, 99.2%, 100.1%},
    - Minecraft {-0.13%, -4.25%, -2.62%, 99.9%, 99.4%},
  + UGC\_RA\_HD:
    - Camellia {-0.08%, -0.61%, -0.61%, 100.5%, 99.6% }.

Two tests: For both CCLM and CCCM, or for CCLM only. The latter has less gain. For CCCM, also a new model is proposed.

Gain is in some sequences quite significant for chroma, and also for some cases artifacts are observed.

Investigate in EE. The benefit of the additional CCCM model shall be investigated separately. Instead of using individual parameter files per sequence, an encoder-side method to detect the chroma position of a given sequence would be desirable.

[JVET-AM0312](https://jvet-experts.org/doc_end_user/current_document.php?id=15980) Cross-check of JVET-AM0196 (Non-EE2: Adaptive subsampling filter selection for CCLM/CCCM) [D. Bugdayci Sansli (Nokia)] [late]

[JVET-AM0301](https://jvet-experts.org/doc_end_user/current_document.php?id=15969) AHG12: IntraTMP with DMVR [K. Naser, F. Le Léannec, P. Bordes, P. Le Guyadec (InterDigital)] [late]

This contribution is about enabling DMVR (decoder side motion vector refinement) technology to 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:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | |
|  | **Over ECM-17.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -0.01% | 0.09% | 0.11% | 100.9% | 100.8% | #DIV/0! | #DIV/0! |
| Class A2 | -0.04% | 0.04% | -0.03% | 100.4% | 101.0% | #DIV/0! | #DIV/0! |
| Class B | -0.03% | -0.04% | -0.12% | 100.9% | 100.4% | #DIV/0! | #DIV/0! |
| Class C | -0.03% | 0.01% | -0.09% | 100.1% | 98.4% | #DIV/0! | #DIV/0! |
| Class E | -0.02% | -0.20% | -0.17% | 100.5% | 99.3% | #DIV/0! | #DIV/0! |
| **Overall** | -0.03% | -0.02% | -0.07% | 100.6% | 99.9% | #DIV/0! | #DIV/0! |
| Class D | 0.00% | 0.05% | -0.10% | 100.3% | 97.4% | #DIV/0! | #DIV/0! |
| Class F | 0.09% | 0.18% | 0.09% | 100.0% | 98.4% | #DIV/0! | #DIV/0! |
| Class TGM | #VALUE! | #VALUE! | #VALUE! | #NUM! | #NUM! | #DIV/0! | #DIV/0! |

It is noted that the change is only implemented in the bilateral matching of DMVR, not in more sophisticated extensions that were added later.

Encoding time is increased, and decoding time is also increased for some classes.

Further study recommended, to make the implementation more complete, and try to improve the tradeof compression vs. encoder/decoder runtime.

#### Inter (5)

Contributions in this area were discussed during 1530–1625 on Sunday 29 June 2025 (chaired by JRO).

[JVET-AM0072](https://jvet-experts.org/doc_end_user/current_document.php?id=15719) Non-EE2: Diversity reordering for ARMC pairwise candidates [C. Wang, Y. Yu, L. Zhang, Z. Xie, H. Yu, D. Wang (OPPO)]

This contribution proposes a modification to the process of Adaptive Reordering Merge Candidates list (ARMC). It is proposed to apply diversity reordering after the first reordering process and before deriving the pairwise-average merge candidates, aiming to establish a more diverse list of merge candidates for the pairwise-average merge. The test results on top of ECM-17.0 are summarized as follows:

RA: -0.01%/0.01%/0.00%; EncT X% DecT X%；

LDB: -0.03%/0.21%/0.16%; EncT X% DecT X%；

Runtime roughly constant for RA, but some increase in LB for decoding runtime (less in cross-check, may be unreliable).

Some additional checks necessary at decoder, and gain is not significant (also not consistent across classes). Further study recommended.

[JVET-AM0281](https://jvet-experts.org/doc_end_user/current_document.php?id=15948) Crosscheck of JVET-AM0072 (Non-EE2: Diversity reordering for ARMC pairwise candidates) [N. Zhang (Bytedance)] [late]

[JVET-AM0107](https://jvet-experts.org/doc_end_user/current_document.php?id=15754) AHG12: Generated Merge Candidates [D. Bugdayci Sansli, J. Lainema (Nokia)]

This contribution proposes new merge candidates for regular and TM merge, generated from existing merge candidates. It is proposed to collect uni-predictors of existing candidates (both from uni and bi-predicted candidates) into two lists corresponding to list 0 and list 1, calculate the template cost of each uni-predictor and sort these lists based on cost. Finally, new uni or bi-prediction merge candidates are generated from the lowest cost uni-predictors.

Proposed method is implemented in ECM-17.0, performance under the Common Test Conditions is reported to be:

RA: -0.03 % -0.08 % -0.07 %for Y, U, V respectively, EncT 100.6% DecT 100.8%

Disabled for LB (as it does not provide benefit), but still enabled for LD pictures in RA.

Up to 4 additional candidates are added to the merge list finally, but the number of candidates initially checked and undergoing some sorting process is larger. Additional processing necessary at decoder, which is reflected in increased decoder runtime.

Some interest expressed to investigate in EE. The amount of additional processing should be reduced (current tradeoff not attractive), and it should only be applied to the non-LD pictures in RA. The worst-case number of additional operations shall be reported.

[JVET-AM0331](https://jvet-experts.org/doc_end_user/current_document.php?id=15999) Cross-check of JVET-AM0107 (AHG12: Generated Merge Candidates) [[F. Le Léannec (InterDigital)](mailto:fabrice.lelannec@interdigital.com)] [late]

[JVET-AM0132](https://jvet-experts.org/doc_end_user/current_document.php?id=15779) AHG12: Amvp temporal candidates derived from temporal collocated picture [Z. Li, X. Zeng, M. Jia, C. Huang (ZTE)]

This contribution proposes to add more temporal candidates derived from temporal collocated picture into amvp temporal candidate list when template matching is used. Specifically, in the proposed scheme, new temporal candidates are derived from more position from temporal collocated picture. The simulation results on top of ECM-17.0 are summarized as follows:

RA : {-0.01%, -0.04%, 0.05%, 100.7%, 99.9%}, LDB : {-0.05%, 0.10%, 0.12%, 100.96%, 99.2%};

From current results, tradeoff is not attractive in RA, and also in LB the gain is unequally distributed over classes

No interest expressed to investigate in EE – further study recommended.

[JVET-AM0259](https://jvet-experts.org/doc_end_user/current_document.php?id=15926) Crosscheck of JVET-AM0132 (AHG12: Amvp temporal candidates derived from temporal collocated picture) [K. Jia (Alibaba)] [late]

[JVET-AM0148](https://jvet-experts.org/doc_end_user/current_document.php?id=15795) Non-EE2: Multi-template selection for inter CCP merge mode with zero luma CBF [J. Huo, J. Liu, Y. Ma, F. Yang (Xidian Univ.)]

This contribution proposes to extend inter CCP merge mode with zero luma CBF by allowing the current block to be used as an alternative template. The proposed method is applied on SCC.

The results over ECM-17.0 are:

RA :

Class F: 0.00%, -0.03%, 0.01%, with 101.0% EncT, 99.4% DecT.

Class TGM: -0.01%, -0.15%, -0.21%, with 103.9% EncT, 100.1% DecT.

LDB :

Class F: -0.11 %, -0.05%, -0.17%, with 101.8% EncT, 99.7% DecT.

Class TGM: -0.14%, -0.48%, -0.54%, with 104.7% % EncT, 98.3% DecT.

From current results, tradeoff is not at all attractive in RA, and also in LB the gain is very low for the case of screen content, while encoding time is significantly increased.

No interest expressed to investigate in EE – further study recommended.

[JVET-AM0254](https://jvet-experts.org/doc_end_user/current_document.php?id=15921) Crosscheck of JVET-AM0148 (Non-EE2: Multi-template selection for inter CCP merge mode with zero luma CBF) [X. Li (Alibaba)] [late]

[JVET-AM0247](https://jvet-experts.org/doc_end_user/current_document.php?id=15894) Non-EE2: Extension of AMVP MVP Index Range [T. M. Bae, S. Deshpande (Sharp)] [late]

This contribution proposes:

• Extending the MVP index range in AMVP uni-directional prediction.

• A new signaling method for MVP index to reduce the signaling overhead

On top of ECM-17.0, simulation results of the proposed method are as follows:

LDB: -0.04% (Y), 0.06% (U), 0.26%(V), EncT: %, DecT: %.

RA: <To be completed>

**Simulation results (1 bitstream of class B is copied from anchor, EncT/Dec T are not accurate)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay B Main 10** | | | | | | |
|  | **Over ECM-17.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | 0.00% | -0.02% | 0.00% | 101.9% | 103.2% | #NUM! | #NUM! |
| Class C | -0.03% | -0.13% | 0.04% | 96.2% | 98.4% | 100.0% | 100.0% |
| Class E | -0.16% | 1.02% | 1.09% | 100.8% | 100.6% | 100.0% | 100.0% |
| **Overall** | -0.05% | 0.20% | 0.28% | 99.7% | 100.9% | #NUM! | #NUM! |
| Class D | 0.10% | -0.38% | 0.56% | 96.0% | 96.8% | 100.0% | 99.7% |
| Class F | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! |
| Class TGM | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! |

Further study to see benefit for RA, unbalanced benefit over classes in LB. Changing AMVP signalling different for RA and LB would be undesirable. Better understanding and more information is requested if additional processing/checks are necessary at encoder.

#### GPM (3)

Contributions in this area were discussed during 1645–1720 on Sunday 29 June 2025 (chaired by JRO).

[JVET-AM0065](https://jvet-experts.org/doc_end_user/current_document.php?id=15712) Non-EE2: Joint reordering of GPM with intra prediction [Z. Sun, Y. Yu, L. Zhang, H. Yu, D. Wang (OPPO)]

This contribution proposes modifications to the joint reordering of GPM split modes and partition indices, where intra-prediction mode candidates are introduced to the reordering GPM. With the proposed method JRGPM-Intra, the GPM modes consisting of intra-prediction, regular GPM and TM-GPM will be reordered jointly. Simulation results of the proposed method on top of ECM-17.0 are reported below:

RA: -0.08%, -0.06 %, -0.11 %, EncT 101.5%, DecT 100.7%

LB: -0.09%, -0.01 %, 0.06 %, EncT 101.8%, DecT 100.8%

Results confirmed by crosscheckers. Relevant coding gain, consistent over classes.

Interest was expressed by other experts to investigate in EE. Better tradeoff with encoding time should be achieved.

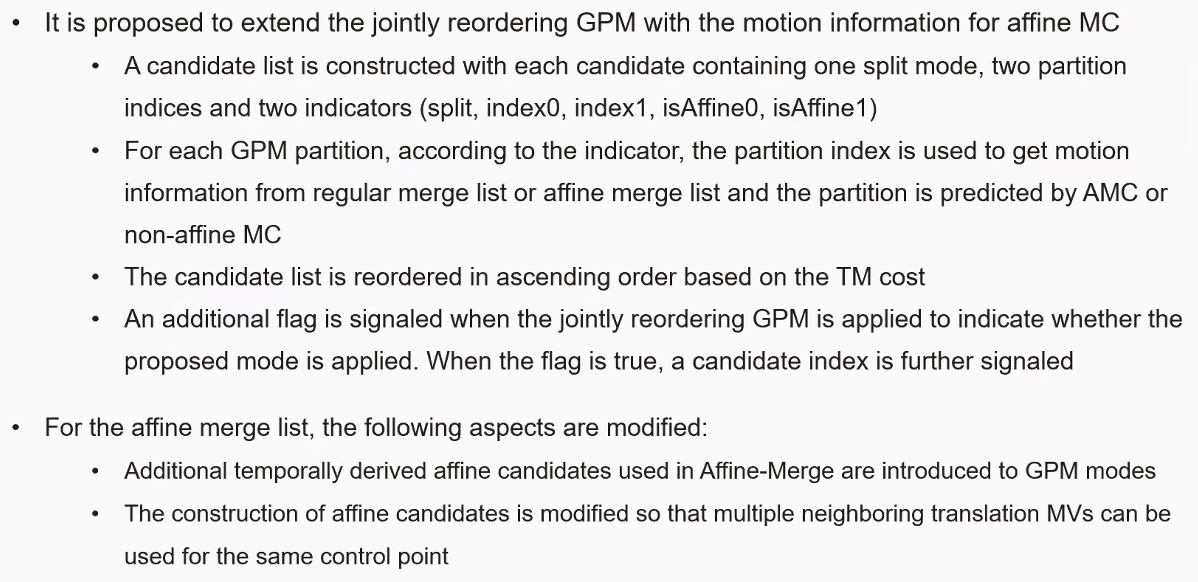
[JVET-AM0303](https://jvet-experts.org/doc_end_user/current_document.php?id=15971) Crosscheck of JVET-AM0065 (Non-EE2: Joint reordering of GPM with intra prediction) [X. Li (Alibaba)] [late]

[JVET-AM0066](https://jvet-experts.org/doc_end_user/current_document.php?id=15713) Non-EE2: Joint reordering of GPM with affine prediction [L. Zhang, Y. Yu, Z. Sun, H. Yu, D. Wang (OPPO)]

This contribution proposes a method that jointly reorders the split modes and motion information of the GPM, where the motion information could be used for affine motion compensation or non-affine motion compensation. The proposed method is implemented on top of ECM-17.0, and the simulation results are reported as follows:

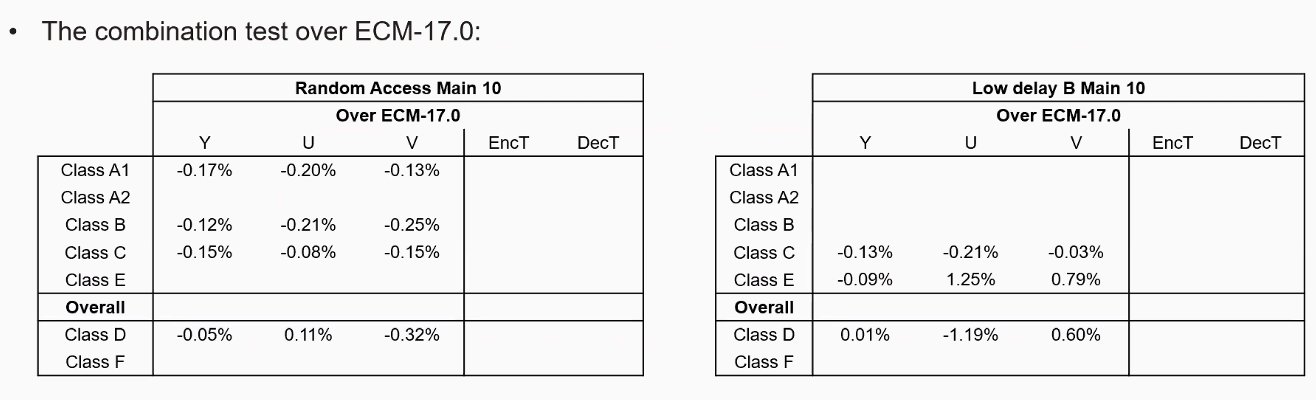
RA: { -0.12% Y, -0.18% U, -0.13% V, 101.8% EncT, 101.9% DecT }

LDB: { -0.07% Y, 0.27% U, 0.08% V, 102.4% EncT, 101.3% DecT }



Increase in encoding time due to additional RDO checks (up to 5) for the new mode.

Initial results of a combination with JVET-AM0065 were presented, indicating that the gain would be not fully additive:



Investigate in EE, also in combination with JVET-AM0065. The benefit of the modification of affine merge list shall be reported separately. Better tradeoff with encoding time should be achieved.

[JVET-AM0277](https://jvet-experts.org/doc_end_user/current_document.php?id=15944) Crosscheck of JVET-AM0066 (Non-EE2: Joint reordering of GPM with affine prediction) [C. Ma (Kwai)] [late]

[JVET-AM0129](https://jvet-experts.org/doc_end_user/current_document.php?id=15776) Non-EE2: binarization improvement of GPM [X. Wang, J. Chen, Ce Zhu, L. Luo, H. Guo (UESTC), Y. Huo, Y. Liu (Transsion)]

This contribution proposes an improved index binarization table for GPM. The new table merges the last two groups of indices in the previous table. Experimental results of the proposed binarization, implemented on top of the ECM-17.0, are reported as follows:

RA: {-0.01% -0.03% 0.00% 118.6% 99.8%}

RA: Class F {-0.06%, -1.30%, -1.47%, 172.0%, 98.0%},

Class TGM {-0.19%, -0.15%, -0.14%, 104.6%, 99.7%}.

Binarization is differently modified for camera-captured content and for screen content. For camera content it does not give any benefit. Generally, different binarization for relatively low benefit (0.19% for TGM is low compared to other SCC tools) is undesirable.

Further study, potentially better gain might be achieved in LB where GPM is often giving more benefit? Resaonable encoding time to be reported.

#### In-Loop Filters (7)

Contributions in this area were discussed during 1720–1900 on Sunday 29 June 2025 (chaired by JRO until 1750, by Y. Ye afterwards).

[JVET-AM0070](https://jvet-experts.org/doc_end_user/current_document.php?id=15717) Non-EE2: On regularization of ALF-CCCM [Z. Xie, N. Song, Y. Yu, H. Yu, D. Wang (OPPO)]

In this contribution, two elements are proposed for ALF-CCCM. Firstly, the regularization method used in EIP is applied to the calculation of filter coefficients for ALF-CCCM. Secondly, it is proposed to have different bad-point checking thresholds in ALF-CCCM. On top of ECM-17.0, the simulation results are summarized as below:

The proposed method on top of ECM-17.0:

RA: 0.00% (Y), -0.29% (U), -0.21% (V), 99.8% (EncT), 100.3% (DecT)

LDB: -0.05% (Y), -0.07% (U), 0.50% (V), 99.8% (EncT), 100.3% (DecT)

The proposed method on top of EE2-4.3c:

RA: -0.02% (Y), -0.26% (U), -0.21% (V), 100.0% (EncT), 100.2% (DecT)

LDB: -0.06% (Y), -0.31% (U), 0.13% (V), 99.5% (EncT), 100.1% (DecT)

The luma gain compared to EE2-4.3c may indicate that a bit rate reduction is achieved additionally, and the impact on complexity/run time should be minor.

Results confirmed by cross-checker.

Investigate in EE. Also test if the modifications made are justifying to enable ALF-CCCM in AI.

[JVET-AM0270](https://jvet-experts.org/doc_end_user/current_document.php?id=15937) Crosscheck of JVET-AM0070 (Non-EE2: On regularization of ALF-CCCM) [H. Qin, A. Filippov, J. Konieczny (TCL)] [late]

[JVET-AM0071](https://jvet-experts.org/doc_end_user/current_document.php?id=15718) AHG12: Extensions on ALF-CCCM [L. Xu, N. Song, Y. Yu, H. Yu, D. Wang (OPPO)]

This contribution proposes two changes to the ALF-CCCM. The first change is to introduce the non-downsampled filters in the ALF-CCCM. The second change is to reuse the CU coding partition in the ALF-CCCM. The proposed two changes are tested on top of ECM-17.0 [1] software. The simulation results are shown as below:

Overall: 0.01%/-0.13/-0.11%, ClassF: 0.00%/-0.25%/-0.31%, TGM: -0.01%/-0.48%/-0.57% for RA

Overall: 0.00%/-0.51%/-0.37%, ClassF: -0.10%/-0.42%/-0.57%, TGM: -0.12%/-1.01%/-1.08% for LDB

Overall: 0.01%/-0.70%/-0.67%, ClassF: -0.05%/-0.82%/-0.92%, TGM: -0.02%/-0.93%/-1.01% for LDP

It was asked what the benefit of the two aspects was, and how often these are used. Not known.

Interest was expressed to investigate in EE. The two aspects shall be investigated separately, and also in combination with JVET-AM0070.

[JVET-AM0297](https://jvet-experts.org/doc_end_user/current_document.php?id=15965) Crosscheck of JVET-AM0071 (AHG12: Extensions on ALF-CCCM) [W. Yin (Bytedance)] [late]

[JVET-AM0110](https://jvet-experts.org/doc_end_user/current_document.php?id=15757) AHG12: Weighted averaging for bi-directional samples of TALF [K. Takada, S. Deshpande (Sharp)]

This contribution proposes to derive and signal the weight information for averaging the bi-directional samples of Temporal ALF when the bi-filtering mode is selected on a slice or picture. The weight information is signaled as APS parameters, and it is supported to switch the weights on a CTU basis. The proposal is implemented on the top of ECM-17.0. The BD-rate PSNR of proposed approach compared to ECM-17.0 is as follows:

• RA: {0.00%, -0.01%, 0.06%} for {Y, Cb, Cr} and 100.6%/100.4% for EncT/DecT

* LDB: {-0.04 %, 0.04 %, -0.05 %} for {Y, Cb, Cr} and 100.9%/99.0% for EncT/DecT

Discussion chaired by Y. Ye.

Proposed weights are signaled in the APS, and can be switched at the CTU level.

The proposed method allows the weight values of 0 and 4, which effectively allows the switching between bi and uni TALF at the CTU level.

It was commented that there is no gain in RA, and the LDB gain is mainly coming from class E, which is known to have unstable performance.

Further study recommended.

[JVET-AM0159](https://jvet-experts.org/doc_end_user/current_document.php?id=15806) Non-EE2: On ALF coefficient coding [I. Jumakulyyev, D. Bugdayci Sansli, J. Lainema (Nokia)]

In this contribution, two methods are proposed to improve ALF coefficient coding. Method 1 proposes to extend coding groups while method 2 proposes to re-assign the coding groups of coefficients.

The coding efficiency and runtimes of the proposed methods over ECM-17.0 (with Huffman frequency table re-trained) are reported as below {for Y, U, V, EncT, DecT}:

Method 1:

AI { -0.01%, 0.02%, -0.02%, 100.0%, 99.8%}

RA { -0.01%, -0.01%, -0.02%, 99.8%, 99.7%}

LDB { -0.02%, -0.15%, -0.17%, 99.8%, 99.8%}

Method 2:

AI { 0.00%, 0.01%, -0.01%, 99.8%, 99.3%}

RA { -0.01%, 0.03%, 0.02%, 99.7%, 100.2%}

LDB { -0.04%, -0.18%, -0.10%, 99.5%, 99.7%}

Discussion chaired by Y. Ye.

Method 1 extends the 2 groups of coefficients in the current ECM to 3 groups of coefficients.

Method 2 adjusts how the coefficients are assigned to each group, only 2 groups are used.

Huffman tables for each method are retrained.

It was commented that method 1 and method 2 cannot coexist, and one of them needs to be eventually selected, if we decide to change how coefficient grouping is done in ECM.

Proponent suggests to test both methods.

It was asked how much gain comes from Huffman table retraining. But method 1 requires new Huffman tables.

The proposal also reports that retraining of Huffman tables gives no gain on average (some classes have gain and others have loss).

Cross checker confirmed the results are matched.

It was commented that the reported results are not stable, with some sequences showing relatively large losses, esp. for chroma. It was commented that retraining the chroma ALF Huffman tables could alleviate the loss.

It was noted that the gains reported in this contribution are not under CTC, because the anchors have been changed to perform somewhat worse (with retrained Huffman tables).

Cross checker report contains comparison with ECM-17 without the retraining changes under CTC, and small gains were observed for RA and LDB for method 1, and LDB for method 2. Several experts expressed interest in further investigating the proposed methods, but some also expressed doubts about the benefits of this proposal.

Further study recommended.

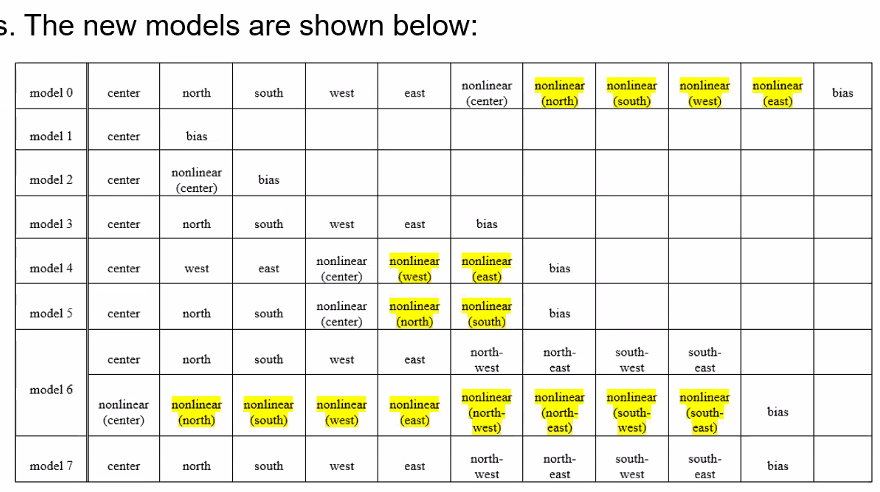
[JVET-AM0264](https://jvet-experts.org/doc_end_user/current_document.php?id=15931) Crosscheck of JVET-AM0159 (Non-EE2: On ALF coefficient coding) [V. Shchukin (Ericsson)] [late]

[JVET-AM0171](https://jvet-experts.org/doc_end_user/current_document.php?id=15818) AHG12: On ALF-CCCM Model [F. Wang, N. Song, Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)]

This contribution proposes to add more nonlinear terms for model 0, model 4, model 5 and model 6 of ALF-CCCM. The proposed method is tested on top of ECM-17.0 software. The simulation results are shown as below:

RA: (preliminary results indicate gain, but less than in LDB)

LDB: 0.00%(Y), -0.42%(U), -0.22%(V), 99.8%(EncT), 100.0%(DecT)



Investigate in EE along with JVET-AM0070 and JVET-AM0071. Also the impact on necessary memory and possible impact on complexity for selecting the model shall be reported.

[JVET-AM0279](https://jvet-experts.org/doc_end_user/current_document.php?id=15946) Crosscheck of JVET-AM0171 (AHG12: On ALF-CCCM Model) [C. Ma (Kwai)] [late]

[JVET-AM0183](https://jvet-experts.org/doc_end_user/current_document.php?id=15830) Non-EE2: Look-up table based loop filtering for ECM [Y. Du, J. Chen, A. Li, J. Liu, C. Zhu, L. Luo, H. Guo (UESTC), Y. Huo, Y. Liu (Transsion)]

To balance complexity and coding performance, various loop filtering architectures have been proposed for Neural Network-based Video Coding (NNVC). These include the High-performance Operation Point (HOP, 460kMAC/Pixel) in JVET-AD0380, the Low-performance Operation Point (LOP, 17kMAC/Pixel) in JVET-AE0281, and the Very Low-performance Operation Point (VLOP, 5kMAC/Pixel) in JVET-AH0051. Additionally, JVET-AJ0210 introduces an approach that combines neural network-based loop filtering with the ECM encoder.

In this contribution, we propose a look-up table (LUT)-based loop filtering method designed to enhance compressed frames. Firstly, we train NN models to enhance the compressed images. Then we transform the pre-trained NN models to LUTs to enable efficient and fast inference.

The proposed method was tested using ECM CTC. The results reportedly provide the following BD-rate{Y, Cb, Cr} changes compared to the respective anchor, the native ECM17.0 encoder:

AI configuration: overall {-0.41%, 0.0%, 0.0%, 98.7%, 213.0%}.

RA class D: Class D {0.39%, -0.42%, -0.24%, 99.4%, 90.3%}

Discussion chaired by Y. Ye.

It was asked what the size of the LUT is – the proponent reported that it’s about 10MB in size. Only 1 large LUT is used, but reportedly the large LUT contains many small sub-LUTs.

The proposed method uses LUT-based inference, inputs to the LUT are features.

It was commented that the inference operations (including preprocessing and feature generation) in this proposal should be more clearly described.

It was commented that it might be more suitable to discuss this proposal in the context of NNVC.

Further study recommended.

[JVET-AM0285](https://jvet-experts.org/doc_end_user/current_document.php?id=15952) AHG12: Reuse of TALF control information [Y. Bai, M. Jia, W. Niu, S. Xie, C. Huang (ZTE)] [late]

In this contribution, it is proposed to store the Slice-level and CTB-level TALF control information for use in future frames. Compared to ECM-17.0 anchors, partial simulation results are:

* RA:
* Class B, {0.00%, -0.03%, 0.00%};
* Class C {-0.02%, -0.02%, -0.01%}
* LDB:
* Class B\*{ 0.00%, -0.04%, 0.05%}
* Class C {-0.02%, 0.04%, 0.20%}
* Class E {-0.05%, 0.44%, 0.30%}

Restriction based on temporal layers is applied in this proposal.

Both cross checker confirmed that the partial results are matching, and commented that the concept is straightforward and has no impact on runtime.

It was commented that the gains are very small, but several experts expressed interest given the proposal likely doesn’t introduce additional complexity.

Investigate in EE

[JVET-AM0326](https://jvet-experts.org/doc_end_user/current_document.php?id=15994) Crosscheck of JVET-AM0285 (AHG12: Reuse of TALF control information) [[Z. Xie](mailto:xiezhihuang@oppo.com), [L. Xu (OPPO)](mailto:xuluhang@oppo.com) [late]

[JVET-AM0328](https://jvet-experts.org/doc_end_user/current_document.php?id=15996) Crosscheck of JVET-AM0285 (AhG12: Reuse of TALF control information) [[I. Jumakulyyev (Nokia)](mailto:ikram.jumakulyyev@nokia.com)] [late]

#### Entropy coding, transforms, quantization, and transform coefficient coding (4)

Contributions in this area were discussed during 1900–2020 on Sunday 29 June 2025 (chaired by Y. Ye).

[JVET-AM0068](https://jvet-experts.org/doc_end_user/current_document.php?id=15715) AHG12: On Shifting Quantization Center [Y. Yu, H. Yu, J. Gan, L. Xu, H. Huang, F. Wang, Z. Xie, D. Wang (OPPO)]

A method of shifting quantization centers was adopted in the ECM software where the shifting amount is inversely proportional to the quantization indices of DQ. This contribution first proposes to apply the quantization center shifting to both RRC and TSRC when DQ is not enabled (i.e., in a non-CTC setting). In addition, when DQ is enabled, this contribution further proposes for both RRC and TSRC the amount of quantization center shifting is inversely proportional to the quantization level of individual quantizer instead of the quantization indices of DQ. On top of ECM-17.0, the simulation results are reported as follows.

Non-CTC (DQ off, and as a result, sign prediction is also off)

AI: Natural content: { -0.22%, -0.45%, -0.57%, 101.0%, 100.8%}

Class F: {-0.21%, -0.30%, -0.13%, 98.6%, 100.1%}

Class TGM: {-0.16%, -0.13%, -0.13%, 98.8%, 100.1%}

RA: Natural content: { -0.13%, -0.51%, -0.50%, 100.3%, 100.8%}

Class F: {-0.13%, -0.08%, 0.10%, 100.3%, 99.3%}

Class TGM: {0.03%, -0.13%, -0.07%, 99.7%, 99.5%}

LDB: Natural content { -0.09%, 0.27%, -0.25%, 99.8%, 100.9%}

Class F: {-0.26%, 0.30%, 0.72%, 99.3%, 100.1%}

Class TGM: {-0.15%, -0.08%, -0.13%, 99.8%, 96.4% }

CTC

AI: Natural content: { -0.02%, -0.09%, -0.05%, 100.2%, 99.6%}

Class F: {-0.07%, -0.04%, -0.11%, 99.4%, 100.6%}

Class TGM: {-0.11%, -0.04%, -0.10%, 98.4%, 99.7%}

RA: Natural content: { 0.00%, -0.08%, -0.05%, 99.8%, 100.3%}

Class F: {-0.05%, -0.03%, 0.21%, 99.9%, 100.6%}

Class TGM: {0.02%, -0.01%, -0.12%, 99.8%, 99.6%}

LDB: Natural content { -0.05%, 0.30%, 0.50%,}

Class F: {0.06%, 0.75%, 1.94%}

Class TGM: {-0.18%, -0.33%, -0.21%}

It was reported by the proponent that some encoder related operations of two previously adopted JVET-AE0102 (coding of LFNST and NSPT transform coefficients) and JVET-AG0100 (adding greater than flags in RRC) were not at all implemented in the ECM-17.0 when dependent quantization is off. This implementation has been added by the proponent.

Proponent of JVET-AE0102 and JVET-AG0100 (also one of the cross checkers of this proposal) confirmed the implementation was correct.

Decision (SW): add the missing implementation of JVET-AE0102 and JVET-AG0100 encoder operations to the next version of ECM.

Regarding the normative algorithm for both non-CTC and CTC, cross checkers confirmed the results.

It was commented that JVET-AM0311 is a related contribution, but JVET-AM0311 modifies quantization center shift for a different non-CTC conditions, DQ off and RDOQ off, whereas this proposal focuses on quantization center shift modification for RDOQ on.

* For the proposed modifications under CTC, there are two main components: Apply quantization center shift to TSRC (which is currently not applied in ECM)
* Modify the quantization center shift table for RRC

For the CTC case, investigate in EE the two proposed modifications separately and in combination.

For the non-CTC case with DQ off and RDOQ on, investigate in EE the proposed method, report results for RRC and TSRC separately and in combination.

For the non-CTC case with both DQ off and RDOQ off, see notes under JVET-AM0311.

[JVET-AM0263](https://jvet-experts.org/doc_end_user/current_document.php?id=15930) Crosscheck of JVET-AM0068 (AHG12: On Shifting Quantization Center) [P. Nikitin (Qualcomm)] [late] [miss]

[JVET-AM0265](https://jvet-experts.org/doc_end_user/current_document.php?id=15932) Crosscheck of JVET-AM0068 (AHG12: On Shifting Quantization Center) [[M. Balcilar](mailto:muhammet.balcilar@interdigital.com), [F. Le Léannec (InterDigital)](mailto:fabrice.Leleannec@interdigital.com)] [late]

[JVET-AM0069](https://jvet-experts.org/doc_end_user/current_document.php?id=15716) Non-EE2: On Sign Prediction [Y. Zhang, L. Xu, Y. Yu, J. Gan, H. Yu, D. Wang (OPPO)]

This contribution proposes to include non-sign prediction coefficients in the calculation of hypotheses corresponding to the last two sign prediction coefficients. The modified hypotheses are used to calculate the boundary continuity for sign prediction. The method was implemented on top of ECM-17.0 and experimental results following CTC are summarized as follows:

AI: -0.01% (Y) -0.01% (U) 0.01% (V) 101.0% (EncT) 100.3% (DecT)

RA: -0.02% (Y) 0.02% (U) 0.06% (V) xx.0% (EncT) xx.0% (DecT)

LD: -0.09% (Y) 0.32% (U) 0.26% (V) 100.5% (EncT) 100.2% (DecT)

The number of inverse transforms needed for sign prediction is the same as ECM-17, which is 1.

It was commented that small gains were achieved in almost all classes and configurations. The added complexity seems to be manageable. Performance vs runtime increase is acceptable, except in AI case.

Investigate in EE. Further optimization to reduce encoder runtime is requested.

[JVET-AM0260](https://jvet-experts.org/doc_end_user/current_document.php?id=15927) Crosscheck of JVET-AM0069 (Non-EE2: On Sign Prediction) [K. Jia (Alibaba)] [late]

[JVET-AM0111](https://jvet-experts.org/doc_end_user/current_document.php?id=15758) AHG12: On Residual Sign Prediction [C. Hollmann, A. Filippov (TCL)]

In this contribution a modification to the residual sign prediction tool is proposed. The modification consists of two aspects. First, TUs with less than two significant coefficients in the sign prediction area do not apply RSP. Second, the context modelling of the RSP flag is adjusted and several new contexts are added. The method is reported to have the following impact in regard to compression efficiency and runtimes:

* AI: –0.01% / 0.08% / 0.05% (Y/U/V), 98.8% EncT, 98.0% DecT
* RA: 0.00% / 0.03% / 0.14% (Y/U/V), 98.9% EncT, 99.1% DecT

Aspect 1 of this proposal is aimed at complexity reduction (by restricting the use of RSP).

Aspect 2 of this proposal increases the number of CABAC contexts from 8 to 20.

Cross checker confirmed the performance results, but not the encoder runtime.

No LDB results were available from the proponent at the time of presentation. Cross checker reported that 0.07% luma gain and around 1% chroma loss and about 1% encoder runtime reduction can be achieved for class E in the LDB config,

Investigate in EE, the following tests should be performed:

* Aspect 1 only on top of next version of ECM
* Aspect 2 only on top of next version of ECM
* Retraining the current 8 contexts in RSP
* Both aspects in combination

[JVET-AM0317](https://jvet-experts.org/doc_end_user/current_document.php?id=15985) Crosscheck of JVET-AM0111 (AHG12: On Residual Sign Prediction) [Y. Zhang (OPPO)] [late]

[JVET-AM0311](https://jvet-experts.org/doc_end_user/current_document.php?id=15979) AHG12: On Shifting Quantization Center for simple quantization (DQ and RDOQ disabled) (JVET-AM0068 related) [M. Le Pendu, M. Balcilar, F. Le Léannec, K. Naser (InterDigital)] [late]

In contribution JVET-AM0068, it is proposed to apply quantization center shifting to both RRC and TSRC when DQ is not enabled, but with RDOQ enabled. In this contribution, it is further proposed to apply quantization center shifting to both RRC and TSRC in the simple quantization case, that is, when both DQ and RDOQ are disabled. The experimental results over ECM-17.0 (with both DQ and RDOQ disabled) are summarized as follows:

AI:

|  |  |  |  |
| --- | --- | --- | --- |
| Class B | -0.63% | -0.58% | -0.78% |
| Class C | -0.63% | -0.77% | -0.81% |
| Class E | -0.61% | -0.82% | -0.73% |

RA:

|  |  |  |  |
| --- | --- | --- | --- |
| Class B | -0.79% | -0.80% | -0.72% |
| Class C | -0.71% | -0.83% | -0.64% |

The bug fix on JVET-AE0102 and JVET-AG0100 encoder operations reported by the proponent of JVET-AM0068 had been extended to the scaler quantization-only case.

It was commented that it would be desirable to add the missing JVET-AE0102 and JVET-AG0100 encoder operations for the scale-quantization-only case, i.e. DQ off and RDOQ off, as well. However, it was commented that this software fix has not been cross checked.

It was suggested for the proponent to submit this fix as a merge request for software coordinators to confirm and integrate once confirmed.

Investigate in EE the proposed method, report results for TSRC and RRC separately and in combination.

It was noted that the normative part of the proposed changes in JVET-AM0068 and JVET-AM0311 are the same, and the EE tests would have different encoders but the same decoder.

It was further noted that in the current ECM, when DQ is off, sign prediction is turned off as a result.

#### Other (1)

Contributions in this area were discussed during 2020–2035 on Sunday 29 June 2025 (chaired by Y. Ye).

[JVET-AM0130](https://jvet-experts.org/doc_end_user/current_document.php?id=15777) Non-EE2: On partitioning optimization [G. Wang, C. Zhou, Z. Lv (vivo)]

This contribution proposes a partitioning optimization method in two main aspects. The first aspect applies a restriction on TT splitting to avoid the redundant partitioning structure when BT is combined with TT. Meanwhile, the CABAC contexts for split\_cu\_flag are changed based on this restriction to improve the coding efficient. The encoding complexity can be reduced by utilizing this method. The second aspect predicts the allowance of the split mode (No split) according to the minimum total depth obtained from a temporal area.

On top of ECM-17.0, the simulation results of the proposed method are:

AI: 0.00% 0.05% -0.04%, EncT: 97.9%, DecT: 100.3%.

RA: -0.01% -0.01% 0.06%, EncT: 100.3%, DecT: 99.0%.

It was commented that aspect 1 of this proposal can also be implemented as non-normative encoder only change.

Cross checker confirmed encoder runtime reduction of about 2% in AI for both aspect 1 and aspect 2.

The number of CABAC contexts for split\_cu\_flag is unchanged, and initialization value also unchanged.

Several experts expressed interest in this proposal, esp. aspect 1.

Investigate in EE. Test aspects 1 and 2 separately and in combination, also test aspect 1 as encoder-only change.

[JVET-AM0296](https://jvet-experts.org/doc_end_user/current_document.php?id=15964) Crosscheck of JVET-AM0130 (Non-EE2: On partitioning optimization) [Z. Deng (Bytedance)] [late]

### CTC for EE2/ECM and general ECM improvements (3)

Contributions in this area were discussed during 1240–1305 on Tuesday 1 July 2025 (chaired by JRO).

[JVET-AM0158](https://jvet-experts.org/doc_end_user/current_document.php?id=15805) [AHG3][AHG6] ECM software code quantity progress [T. Ikai (Sharp)]

ECM performance, encoding time, and decoding have been studied in AHG activities and contributions. However how ECM software code quantity increases have not been investigated. This contribution reports the progress of code quantity across ECM versions.

It is reported that

- ECM code quantity is 4x and 16x compared to VTM in software code lines and bytes, which are much larger than 2x and 2x in VTM vs HM ratio.

- ECM byte / lines ratio (a.k.a code density) is 4x compared to that of VTM and HM.

- Common part occupies large area of code quantity compared to Encoder and decoder part.

In the authors' view, the increase in code quantity and density of the new codec algorithm is inevitable, as prior knowledge of some decoder/video content is an important source of improvement in coding efficiency.

See also in 4.3

Contribution for information – no immediate action suggested.

It was also commented that some elements of ECM (such as NSPT) require large tables.

It was asked if all branches were included in the count? Naturally, in an exploration, the software grows larger than in a reference code for a standard.

[JVET-AM0216](https://jvet-experts.org/doc_end_user/current_document.php?id=15863) AHG12: Fixes for 12-bit internal bit depth in ECM [R. Yu, V. Seregin, M. Karczewicz (Qualcomm)]

The contribution reports that enabling 12-bit internal bit depth in ECM-17.0 result in a relatively large coding performance drop for chroma components compared to using 10-bit internal bit depth. The contribution claims that issues are identified to be related to some CCCM-based tools and proposes corresponding fixes to address those issues.

The fixes are reported to be implemented on top of ECM-17.0. When enabling 12-bit internal bit depth together with the proposed fixes, the BD-rate impact over ECM-17.0 with 12-bit internal bit depth is reported as follows:

AI: -0.02%, -0.42%, -0.34% for Y, U, V respectively

RA: 0.01%, -1.66%, -1.64% for Y, U, V respectively

LDB: -0.02%, -3.88%, -3.10% for Y, U, V respectively

The BD-rate impact over ECM-17.0 with 10-bit internal bit depth is reported as follows:

AI: -0.28%, 0.09%, 0.05% for Y, U, V respectively

RA: -0.57%, 0.06%, -0.07% for Y, U, V respectively

LDB: -0.70%, 0.13%, -0.33% for Y, U, V respectively

It is suggested to include the proposed fixes in the next version of ECM.

Decision(SW/BF): Adopt JVET-AM0216

[JVET-AM0273](https://jvet-experts.org/doc_end_user/current_document.php?id=15940) Crosscheck of JVET-AM0216 (AHG12: Fixes for 12-bit internal bit depth in ECM) [Y. Wang (Bytedance)] [late]

[JVET-AM0220](https://jvet-experts.org/doc_end_user/current_document.php?id=15867) AHG12: Fix on cabac\_init\_flag and Temporal Cabac Inheritance [B. Wang, R. Chernyak, Z. Xiang, S. Liu (Tencent)]

The current ECM doesn’t consider potential overlap of cabac initialization triggered from cabac\_init\_flag and temporal cabac inheritance. Thus, some redundant signaling overhead occurs at slice level when both coding tools are enabled. It is proposed to apply cabac\_init\_flag method only when the temporal inheritance is not possible.

With the proposed method, simulation results shows that consistent coding gain are achieved for RA and LDB configurations over ECM-17.0 by bitrate saving.

In version 2, the results are updated.

There are 5 QP points in test are replaced with anchor for RA classA1, 7 for class A2, 2 for LDB class B and 1 for LDB classTGM due to unfinished simulation. The replacement is noted in the attached excel sheet result.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access Main 10** | | | | | | |
|  | **Over ECM-17.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -0.001% | -0.001% | -0.001% | 100.0% | 99.9% | 100.0% | 100.1% |
| Class A2 | -0.001% | -0.001% | -0.001% | 99.8% | 99.8% | 100.0% | 100.0% |
| Class B | -0.003% | -0.003% | -0.003% | 100.5% | 99.8% | 100.0% | 100.0% |
| Class C | -0.006% | -0.006% | -0.006% | 99.9% | 100.5% | 100.0% | 100.0% |
| Class E |  |  |  |  |  |  |  |
| **Overall** | -0.003% | -0.003% | -0.003% | 100.1% | 100.0% | 100.0% | 100.0% |
| Class D | -0.023% | -0.023% | -0.023% | 99.9% | 100.3% | 100.0% | 100.0% |
| Class F | -0.006% | -0.006% | -0.006% | 100.2% | 100.1% | 100.0% | 100.0% |
| Class TGM | -0.004% | -0.004% | -0.004% | 100.4% | 100.5% | 100.0% | 100.1% |
|  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | |
|  | **Over ECM-17.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -0.003% | -0.003% | -0.003% | 99.9% | 99.7% | 100.2% | 99.9% |
| Class C | -0.005% | -0.005% | -0.005% | 99.7% | 102.7% | 100.0% | 100.0% |
| Class E | -0.017% | -0.017% | -0.017% | 100.3% | 100.4% | 100.0% | 99.9% |
| **Overall** | -0.007% | -0.007% | -0.007% | 99.9% | 100.9% | 100.1% | 99.9% |
| Class D | -0.015% | -0.014% | -0.015% | 98.7% | 98.9% | 100.1% | 100.0% |
| Class F | -0.012% | -0.012% | -0.012% | 99.8% | 101.0% | 100.0% | 100.1% |
| Class TGM | -0.003% | -0.003% | -0.003% | 99.9% | 98.4% | 100.1% | 100.3% |

Results are still incomplete (also for crosschecks).

It was commented that this is not really a bug fix, but rather a proposal trying to coding gain (which is minor). No action at this moment.

[JVET-AM0322](https://jvet-experts.org/doc_end_user/current_document.php?id=15990) Cross-check of JVET-AM0220 (AHG12: Fix on cabac\_init\_flag and Temporal Cabac Inheritance) [E. Ye (Qualcomm)] [late]

[JVET-AM0329](https://jvet-experts.org/doc_end_user/current_document.php?id=15997) Crosscheck of JVET-AM0220 (AHG12: Fix on cabac\_init\_flag and Temporal Cabac Inheritance) [[H.-J. Jhu](mailto:jhuhong-jheng@kwai.com), [X. Xiu (Kwai)](mailto:xiaoyuxiu@kwai.com)] [late]

# High-level syntax (HLS) and related proposals (71)

## AHG9: Aspects of SEI messages in VSEI, VVC, HEVC and AVC (0)

Contributions in this area were discussed during 1500–1600 on Thursday 26 June 2025 and 1230–1300 on Friday 27 June 2025 (chaired by J. Boyce).

[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 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*JVET-AM0189 also relates to the study of JVET-AL2006 VSEI*

This contribution proposes a modification of the semantics of a persistence flag in several SEI messages in VSEI v4 and VSEI v3 draft. The proposed modification applies to the following SEI messages:

(In VSEI v4)

1 Source picture timing information SEI message

2 Modality information SEI message

3 Text description information SEI message

4 AI usage restrictions SEI message

(In VSEI v3)

5 Image format metadata SEI message

6 Frame packing arrangement SEI message

7 Content colour volume SEI message

8 Equirectangular projection SEI message

9 Generalized cubemap projection SEI message

10 Sphere rotation SEI message

11 Region-wise packing SEI message

12 Omnidirectional viewport SEI message

13 Sample aspect ratio information SEI message

14 Display orientation SEI message

15 Colour transform information SEI message

A question is raised about making the proposed changes also in HEVC.

**Decision: Adopt** to VSEI and HEVC.

[JVET-AM0048](https://jvet-experts.org/doc_end_user/current_document.php?id=15695) AHG9/AHG2: Miscellaneous changes for HEVC [Y.-K. Wang, J. Xu (Bytedance)]

This contribution proposes the following changes for HEVC:

1. Changed the value range of pri\_region\_layer\_id[ i ] in bitstreams conforming to "this version of this Specification" from 0..55 to 0..62, as the value range 0..55 is good for VVC but not good for HEVC as in HEVC the corresponding value range of nuh\_layer\_id is 0..62.an asserted bug fix, in subclause G.11.1.3 (Multiview format range extensions profiles) in JVET-AL1006-v1, change the following (thanks to Alexis M. Tourapis for spotting the error):

* Otherwise (OpTid of the output operation point is less than vps\_max\_sub\_layer\_minus1), the conformance is indicated by sub\_layer\_profile\_idc[ OpTid ] being equal to 10 or sub\_layer\_profile\_**‌**compatibility\_flag[ OpTid ][ 10 ] being equal to 1, with the additional indications specified in Table H.4 for the flags associated with the index OpTid.

to the following (change the two instances of "10" to "14"):

* Otherwise (OpTid of the output operation point is less than vps\_max\_sub\_layer\_minus1), the conformance is indicated by sub\_layer\_profile\_idc[ OpTid ] being equal to 14 or sub\_layer\_profile\_**‌**compatibility\_flag[ OpTid ][ 14 ] being equal to 1, with the additional indications specified in Table H.4 for the flags associated with the index OpTid.

The detailed proposed text changes, marked relative to JVET-AL1006-v1, are included in an attachment to this contribution.

Decision: Adopt item 1 and item 2.

Further discussion 1745 – 1800 on Monday 30 June 2025.

The -v2 version of this contribution adds a third item.

As an asserted bug fix, in subclause F.7.4.3.1.1 (Video parameter set extension semantics), replace the following sentence:is a requirement of bitstream conformance that AuxId[ IdDirectRefLayer[ nuhLayerIdA ][ j ] ] for any values of nuhLayerIdA and j shall be equal to AuxId[ nuhLayerIdA ], when AuxId[ nuhLayerIdA ] is in the range of 0 to 2, inclusive.

with the following:

It is a requirement of bitstream conformance that AuxId[ IdDirectRefLayer[ nuhLayerIdA ][ j ] ] for any value of nuhLayerIdA for which NumDirectRefLayers[ nuhLayerIdA ] is greater than 0 and any value of j in the range of 0 to NumDirectRefLayers[ nuhLayerIdA ] − 1, inclusive, shall be equal to AuxId[ nuhLayerIdA ], when AuxId[ nuhLayerIdA ] is in the range of 0 to 2, inclusive.

Decision: Adopt item 3.

[JVET-AM0174](https://jvet-experts.org/doc_end_user/current_document.php?id=15821) AHG9: On general SEI payload constraints [Y. Sanchez, R. Skupin, T. M. Borges, K. Sühring, C. Hellge, T. Schierl (Fraunhofer HHI)]

Presented at 1230 on Friday 27 June 2025.

This contribution proposes to update the excluded payloadTypes from the constraint in section D.2.2 in VVC v4, which disallows multiple SEI messages with the same payloadType within an AU.

It was suggested that the text description SEI message should also be added to the list. In general, it seems like any SEI messages with an ID should be added to the list.

Decision: Adopt with addition of text description SEI (219).

## AHG9: Aspects related to VSEI version 4 (24)

General discussion during 1600–1615 on Thursday 26 June 2025 (chaired by J. Boyce).

VSEI v4 is intended for FDIS in October. 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 1530–1600 on Thursday 26 June 2025 (chaired by J. Boyce). Further discussion 1930 – 1945 on Friday 27 June 2025.

[JVET-AM0047](https://jvet-experts.org/doc_end_user/current_document.php?id=15694) AHG9: Miscellaneous changes for VSEI [Y.-K. Wang, J. Xu (Bytedance)]

*JVET-AM0047 also relates to modality information, digital signed content, and NNPFC SEI messages*

This contribution proposes the following changes for VSEI:

1. Since SEI messages in the VSEI spec already have an extension mechanism to add extension data to the end of any SEI message syntax, for the modality information SEI message the extension mechanism through the syntax elements mi\_modality\_type\_extension\_bits and mi\_reserved\_modality\_type\_extension is asserted to be redundant and is thus proposed to be removed.
2. When dsci\_vss\_implicit\_association\_mode\_flag is equal to 1, dscs\_verification\_substream\_id is inferred to be equal to MaxNumSubLrs \* LayerId + SubLrId. However, currently dscs\_verification\_substream\_id is coded as u(8), while it is asserted that a reasonably inferred value of dscs\_verification\_substream\_id can easily be greater than 255. Therefore, it is proposed to
   1. Change the value range of dsci\_num\_verification\_substreams\_minus1 from 0..255 to 0..65 535.
   2. Change the coding of dscs\_verification\_substream\_id and dscv\_verification\_substream\_id from u(8) to u(16).
   3. Add the following constraint: The value of dscv\_verification\_substream\_id shall be in the range of 0 to dsci\_num\_verification\_substreams\_minus1, inclusive. Note that such a constraint already exists for dscs\_verification\_substream\_id.
3. Since the semantics of the value 2 for nnpfc\_scan\_type\_idc is specified, as an asserted bug fix, change "The value of nnpfc\_scan\_type\_idc shall not be equal to 2." to be "The value of nnpfc\_scan\_type\_idc shall not be equal to 3."
4. Some asserted minor, purely editorial changes.

The detailed proposed text changes, marked relative to JVET-AL2006-v4, are included in an attachment to this contribution.

For aspect 1, it is noted that the modality information SEI message is new for VSEI v4.

Decision: Adopt item 1, item 3. Refer item 4 to editors.

Further discussion requested on item 2.

Further discussed 27 June 2025.

Side activity included discussion on items 2a and 2b. It was noted that JVET-AM0210 item 5 is related.

Decision: Adopt item 2c, constraint on value of dscv\_verification\_substream\_id

[JVET-AM0052](https://jvet-experts.org/doc_end_user/current_document.php?id=15699) AHG9: Editorial changes for VSEI [Y. He, S. Zhao, L. Kerofsky, M. Karczewicz (Qualcomm)]

This contribution proposes the following changes for VSEI.

1. Define Log2() function
2. Specify semantics of po\_num\_bits\_in\_prefix\_indication\_minus1[ i ] and po\_sei\_prefix\_data\_bit[ i ][ j ] without referencing SEI prefix indication SEI message

Decision (Ed): Adopt item 1.

Further discussion requested on Item 2.

See notes for JVET-AM0292.

[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 ] [Y.-K. Wang (Bytedance), Y. He (Qualcomm)] [late]

JVET-AM0052 item 2 proposes to specify the semantics of po\_num\_bits\_in\_prefix\_indication\_minus1[ i ] and po\_sei\_prefix\_data\_bit[ i ][ j ] without referencing the SEI prefix indication SEI message. It is asserted that the direction suggested by JVET-AM0052 item 2 is good (since the SPO SEI message has been moved from the VVC text to the VSEI text) while the concrete suggested changes are not (due to the wording difference between "the prefix indication for the i-th SEI message type" vs "i-th SEI prefix indication"). This contribution proposes to change the semantics of the two syntax elements as follows:

**~~po\_num\_bits\_in\_prefix\_indication\_minus1~~**~~[ i ] and~~ **~~po\_sei\_prefix\_data\_bit~~**~~[ i ][ j ], when present, have the same semantics as the num\_bits\_in\_prefix\_indication\_minus1[ i ] and sei\_prefix\_data\_bit[ i ][ j ] syntax elements of the SEI prefix indication SEI message, with prefix\_sei\_payload\_type replaced by po\_sei\_payload\_type[ i ].~~

**po\_num\_bits\_in\_prefix\_indication\_minus1**[ i ] plus 1 specifies the number of bits in the prefix indication for the i-th type of SEI message.

**po\_sei\_prefix\_data\_bit**[ i ][ j ] specifies the j-th bit of the the prefix indication for the i-th type of SEI message.

Decision (bug fix): Adopt.

[JVET-AM0191](https://jvet-experts.org/doc_end_user/current_document.php?id=15838) 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 VSEI v4 draft. The proposed modifications are as follows:

(Related to MI SEI messages)

1 Clarify the semantics related to MinWavelength and MaxWavelength.

(Related to PRI SEI messages)

2 Clarify the semantics of pri\_cancel\_flag.

3 Clarify the semantics of pri\_resampling\_width\_num\_minus1[ i ] and pri\_resampling\_width\_denom\_minus1[ i ].

(Related to DSCV SEI messages)

4 Move some constraints in the semantics of DSCV SEI message from VSEI v4 to AVC interface document.

Agreed on item 1, item 2, item 3.

For item 4, it was considered that it was better to keep the constraints in VSEI.

### SEI processing order and processing order nesting SEI messages (6+1)

Contributions in this area were discussed during 1600–1955 on Thursday 26 June 2025 (chaired by J. Boyce).

[JVET-AM0080](https://jvet-experts.org/doc_end_user/current_document.php?id=15727) AHG9: On the PON SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

This contribution proposes the following changes to the PON SEI message.

* Propose a constraint requiring that all PON-nested SEI messages indicated by a SPO SEI message be encapsulated within the same PON SEI message to simplify the parsing process
* Propose two options to ensure the uniqueness of the PON-nested SEI message type
  + Option 1: constrain the pon\_processing\_order value of a PON-nested SEI message type
  + Option 2: redefine and constrain the PON-nested SEI message type

It was remarked that in the current design, it is the encoder’s choice to include within a single SEI message or separate into multiple SEI messages. The encoder may prefer to separate them to avoid having a PON SEI message being too large.

The proponent remarked that the proposal is intended for TuC rather than VSEI v4. It was noted that it is not usual practice to impose additional constraints in an extension of an existing SEI message.

It was suggested that there may be use cases where the lack of a constraint may be useful.

[JVET-AM0081](https://jvet-experts.org/doc_end_user/current_document.php?id=15728) AHG9: On the PON dependency constraint [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

This contribution proposes the following constraint changes to the PON SEI message.

* Propose additional dependency constraints on the generalized cubemap projection, object mask information, modality information and AI usage restriction SEI messages.

Propose modifications on the existing dependency constraints.was remarked that the GCMP constraint is in the VVC interface text, because they do not apply to HEVC and AVC.The other 3 SEI messages are all new to VSEI v4.

Decision: Add the proposed constraints for object mask info, modality info, and AU usage restriction SEI messages.

It is proposed to modify the wording of constraints for consistency.

It was remarked that cancel flags have different characteristics for different SEI messages, especially for those using IDs.

Decision: Add the suggested wording for display orientation SEI.

[JVET-AM0082](https://jvet-experts.org/doc_end_user/current_document.php?id=15729) AHG9: On the PON nested FGC SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm), Y. Sanchez (Fraunhofer HHI), M. M. Hannuksela (Nokia)]

1. This contribution proposes the following 2 changes on PON-nested FGC SEI message to support both traditional and picture resolution adaptive film grain processing in a bitstream.Restrict the dependency constraint between the PON-nested FGC SEI message and non-PON-nested FGC SEI message to within a single processing chain.
2. Generalize the proposed restriction to apply to other PON SEI messages.
3. Constrain the processing order of FGC SEI messages to be the same within a SPO SEI message.

For item 1, it was remarked that “an associated SEI message” is not clear. Some clarification may be beneficial. Discussed about associated SEI message language on June 30 2025, during 17:10-17:15, chaired by S. Deshpande.

A note is proposed to be added.

Decision: It was agreed to make this change from v2.

It was suggested that a PON-nested thing shouldn’t affect a non-PON-nested thing.

For item 3, it was suggested to not be needed, as the wrapping flag can be used. It is encoder’s choice.

[JVET-AM0121](https://jvet-experts.org/doc_end_user/current_document.php?id=15768) AHG9: On the SEI processing order SEI message [M. M. Hannuksela, J. Boyce, F. Cricri (Nokia)]

Discussed during 1700–1855 on 26 June 2025 (chaired by S. Deshpande).

This contribution proposes the following items that are related to the SEI processing order (SPO) SEI message:

1. It is proposed to enable the packed regions information (PRI) SEI message in a processing chain defined by an SPO SEI message with the following changes:
   1. It is proposed to include the SEI message payload type of the PRI SEI message in SeiProcessingOrderSeiList and SpoProcessSeiList in HEVC and VVC.

Decision: Agreed

* 1. When a PRI SEI message is associated with a processing chain defined by an SPO SEI message, it is proposed that pri\_target\_pic\_params\_present\_flag shall be equal to 1. In other words, when a PRI SEI message is included in a processing chain, it is proposed that the PRI SEI message can only be used as a process.

Specification text option A includes the constraint in the semantics of the SPO SEI message, whereas specification text option B includes the constraint in the semantics of the PRI SEI message.

It was asserted by the proponents that the text changes would be less if it is required that pri\_target\_pic\_params\_present\_flag shall be equal to 1.

A use case where the pri\_target\_pic\_params\_present\_flag may be 0 in case of a stand-alone PRI SEI was described (ROI processing).

Decision: Agreed on Option A.

1. It is proposed to allow processing chains of a single entry by replacing po\_num\_sei\_messages\_minus2 with po\_num\_sei\_messages\_minus1.

The motivation is to enable the use of the processing order nesting (PON) SEI message for carrying SEI messages that are alternatives to each other and/or extend the SEI message payload relative to an earlier VSEI version. For example, with this change, film grain characteristics (FGC) SEI messages of different target resolutions can be included into different processing chains.

It was commented that the motivation for the current minus2 coding is that previous thinking was that SPOs with 2 or more SEIs only are meaningful, but the new use case modifies that previous understanding.

1. Decision: Agreed asserted clarifications relating to associating SEI messages with SEI message types are proposed:
   1. Conditions that specify when an SEI message is associated with the i-th SEI message type of an SPO SEI message are proposed.

It was asked if the list of changes to define this condition, as proposed are really necessary.

Discussed after offline discussion on 30 June 2025. Some existing specification text was identified which addresses this. So no action.

* 1. As an editorial change, it is proposed to use the phrase "an SEI message associated with the i-th SEI message type" consistently.

Decision: Agreed on item b (editorial).

1. It is proposed to disallow bitstreams with more than one SEI message associated with the same SEI message type for the same picture.

It was commented that there was a discussion of this at the previous meeting. It was commented that the proposed green highlighted text may be unnecessarily too restrictive. It was clarified by the proponent that the green highlight text change should be considered together with the yellow highlight association text.

Discussed after offline discussion together with item 3a above on 30 June 2025. After checking this constraint was not found existing in the current specification text. Some related text in the current specification was identified but was found to not be having a “shall” requirement. The offline suggestion was to add the proposed constraint or let the decoder handle it (which would need some text to be proposed).

Decision: Agreed on item 4.

1. The following changes related to the concept of the types of SEI messages are proposed:
   1. The concept of the "types of SEI messages" is proposed to be described to refer to entries of the SPO SEI message rather than SEI messages.
   2. It is proposed that types of SEI messages are different when processing order nesting is used for both and their processing order values differ. Specification text option A uses plain English, and option B refers to syntax elements.
   3. It is proposed that types of SEI messages are different when processing order nesting is used for one but not the other one. Specification text option A uses plain English, and option B refers to syntax elements.

Discussed further on 28 June 2025. See notes under JVET-AM0321.

1. It is proposed not to include byte alignment after the last SEI prefix.

It was commented that this breaks the aspect of carrying strings of “bytes” - only for the last prefix, and then it should also be considered to completely remove the byte alignment in the for loop.SEI prefix indication SEI message has similar alignment as in current VSEI v4 draft. Thus there was a preference to leave the current design as it is.

No action.

1. The following constraints related to po\_complexity\_info\_present\_flag are proposed:
   1. It is proposed that when no NNPFs are present in a processing chain, po\_complexity\_info\_present\_flag shall be equal to 0 in bitstreams conforming to this version of VSEI. Consequently, complexity could be indicated for any future neural-network-related SEI messages included in a processing chain.
   2. It is proposed that when no NNPFs are present in a processing chain and po\_complexity\_info\_present\_flag is equal to 1, decoders of this version of VSEI allow and ignore the complexity syntax elements.

Decision: Agreed to add the following constraint: When po\_sei\_payload\_type[ i ] is not equal to the payload type value of the NNPFA SEI message for any value of i in the range of 0 to po\_num\_sei\_messages\_minus2 + 1, inclusive, po\_complexity\_info\_present\_flag shall be equal to 0.

1. As an asserted clarification, it is proposed that po\_num\_parameters\_idc, po\_num\_kmac\_operations\_idc, and po\_total\_kilobyte\_size indicate the cumulative values of all the NNPFs that are included in the processing chain and activated by NNPFA SEI messages for any picture.

It was discussed whether it is intended/ better to indicate the property of the network or the bitstream.

Different people had different preferences regarding whether i) or ii) below should be the design intent.

1. the cumulative values of all the NNPFs that are included in the processing chain, or
2. the cumulative values of all the NNPFs that are included in the processing chain and activated by NNPFA SEI messages for any picture.

Discussed on 30 June 2025 during 15:20-15:25

Proponents prefer ii) above. Some other participant preferred i).

Decision: Delegate to the editors to ensure that the specification text implements option i)

1. editorial proposals are proposed:
   1. It is proposed to rename po\_num\_sei\_messages\_minus1 or po\_num\_sei\_messages\_minus2 (depending on the outcome of item 2) to po\_num\_sei\_msg\_types\_minus1 or po\_num\_sei\_msg\_types\_minus2, since it counts SEI message types rather than SEI messages.
   2. Both "type of SEI message" and "SEI message type" have been used in the text in their singular and plural forms. It is proposed to use only "SEI message type" consistently.

Delegated to the editors.

[JVET-AM0166](https://jvet-experts.org/doc_end_user/current_document.php?id=15813) AHG9: Miscellaneous aspects in VSEI v4 [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

*JVET-AM0166 also relates to the MI and PRI SEI messages*

This contribution proposes miscellaneous modifications that are asserted to provide improvement to some aspects of SEI messages in VSEI v4 draft. The proposed modifications are as follows:

(Related to SPO/PON SEI messages)

4. On prefix and suffix SEI messages in PON SEI

5. On prefix and suffix SEI messages in SPO SEI

Item 4 proposes that the following two constraints to be added into the current spec text:

1. A PON SEI message that is present the bistream as a prefix SEI message shall not contain a PON-nested SEI message that can be present in a bistream as suffix SEI message only.
2. A PON SEI message that is present the bistream as a suffix SEI message shall not contain a PON-nested SEI message that can be present in a bistream as prefix SEI message only.

It was suggested that the specific wording should mention NAL units, and that the constraint should be in the coding specification interfaces rather than VSEI.

Conditionally adopt item 4 subject to review of text, with constraint in the coding spec interface text.

Item 5 proposes to add the constraint such that an SEI message that can be a suffix SEI message only and is included in a processing chain shall not have processing order that is lower than another SEI message that can be a prefix SEI message only.the SEI message included in prefix vs. suffix only affects the coding order and doesn’t necessarily affect the processing order.

No action on item 5.

Further discussion at 1755 on Monday 30 June 2025.

Adoption of item 4 confirmed.

[JVET-AM0206](https://jvet-experts.org/doc_end_user/current_document.php?id=15853) AHG9: On signalling of sei payload type in SEI processing order SEI message [H. Tan, C. Kim, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

In the current design of SEI processing order (SPO) SEI message, payload type of SEI messages included in the processing chain is signalled using fixed length coding, that is, u(12). It is asserted that while it is currently enough to cover existing SEI messages included in VSEI and SEI messages that are included in the codecs that may use VSEI (e.g., AVC, HEVC, and VVC), it is asserted that the signalling design may not be future proof considering the number of bits for signalling payload type is not fixed in the codecs that currently may use VSEI and in the future codecs that may use the VSEI.

This contribution proposes to modify the signalling of payload type in SPO as follows:

**Option 1:** Modify the signalling of payload type of SEI included in SPO SEI message by using ue(v) and move it to the last syntax element in the for loop.

**Option 2:** Do the following modifications:

* Modify the signalling of payload type of SEI included in SPO SEI message from u(12) to u(11) and use the extra bit as a new flag to specify whether or not additional value to supplement the value of payload type.
* The flag is constrained to be equal to 0 for VSEI version 4.

It was noted that the number of SEI payload types allocated so far is less than 256, but more than 200.

It was suggested that 12 bits is sufficient for future generation codecs.

No action.

[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 [Y.-K. Wang (Bytedance), M. M. Hannuksela (Nokia), Y. He (Qualcomm)] [late]

Chaired by S. Deshpande on 28 June 2025 during 9:00-9:20

The bullet items 2 and 3 in JVET-AM0121 subclause 5.1 are assertedly describing use cases of SEI message types in different SPO entries being the same. In that case, it is asserted that there is no reason to only allow SEI message types in different SPO entries being the same when PON is involved, but rather, it should be allowed even when PON is not involved.

This contribution proposes an alternative set of text changes that address the same issues as JVET-AM0121 item 5 and JVET-AM0079 item 3. The concrete changes are included in the attachment to this contribution, with changes marked relative to JVET-AL2006-v4-ncm.

In the specification text markup the key technical change proposed is:

The SEI message types indicated in different entries of an SPO SEI message are typcially different from each other but some of them may also be the same.

There are also a number of editorial changes proposed.

Decision: Adopt

### NNPF SEI extensions (1)

Contributions in this area were discussed during 0900–1000 on Friday 27 June 2025 (chaired by J. Boyce).

[JVET-AM0113](https://jvet-experts.org/doc_end_user/current_document.php?id=15760) AHG9: Supporting pre-processing aware post processing in the NNPFC SEI message [M. Damghanian, M. Pettersson, R. Sjöberg (Ericsson)]

This contribution proposes to add support for pre-processing aware post-processing to the NNPFC SEI message. The proponents claim that this addition supports usage of the sandwiched codec architecture presented in JVET-AL0060. The followings are proposed for VSEI v4:

Proposal 1

* 1. To add a new nnpfc\_purpose entry in Table 20 for pre-processing aware post-processing, with the interpretation that the post-processing corresponds to an applied pre-processing.
  2. To add a new nnpfc\_purpose entry in Table 20 to indicate that the NNPF process is improving visual quality towards a quality metric.
  3. To add a new syntax element nnpfc\_quality\_metric\_idc where the values of the syntax element describe the type of quality metric the video resulting from the NNPF process is enhanced towards.

Proposal 2

* To add a new syntax element nnpfc\_decoded\_video\_distortion\_idc where the value of the syntax element specifies the level of distortion expected due to a pre-processing.

Is being proposed for VSEI v4.

It was suggested that there is not a backwards compatibility issue with making the proposed changes in a future version of VSEI.

It was noted that the EOI SEI message describes the decoded picture. It was suggested that the EOI could communicate that the decoded pictures was not suitable for human viewing, and use the existing NNPF SEI to indicate the post-filter operation.

It was commented that there may be advantages in having a single SEI message address the sandwich codec use case.

It was noted that NNPF already has a nnpfc\_for\_human\_viewing\_idc, but it describes the output of the NNPF process rather than the decoded picture.

The proposed wording for the purpose regarding pre-processing has been applied doesn’t seem specific to a sandwich codec, and could apply to other types of pre- and post-processing, e.g. downsampling and upsampling.

It was questioned if the proposal is adding signalling in the most appropriate location to address the described use case.

The sandwich coding use case is seen to be interesting.

Further study is encouraged.

### AI usage restrictions SEI message *(*3)

Contributions in this area were discussed during 1000–1015 on Friday 27 June 2025 (chaired by J. Boyce).

[JVET-AM0112](https://jvet-experts.org/doc_end_user/current_document.php?id=15759) AHG9: On AI usage restrictions SEI message [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

Chaired by S. Deshpande on 27 June 2025 during 10:00-11:00

The following changes are proposed to the AI usage restrictions SEI message in VSEI v4:

1. Add a value range for ue(v)-coded aur\_num\_restrictions\_minus1 from 0 to 255.

Decision: agreed

1. Add a restriction that the value of each aur\_restriction[ i ] shall be unique.

Decision: agreed

Add text that if aur\_restriction[ i ] is in the range of 4 to 255 not only aur\_restriction[ i ] shall be ignored but also aur\_context[ i ], if present.proposal 1 of JVET-AM0117. See notes there.

1. Remove the text “when the value of aur\_context[ i ] is greater than 15, decoders conforming to this version of this document shall ignore aur\_context[ i ]” and add a note saying that “Decoders conforming to this version of this document should only use the four least significant bits of aur\_context[ i ] and ignore bits of higher significance”.

Related to proposal 2 of JVET-AM0117. See notes there.

[JVET-AM0117](https://jvet-experts.org/doc_end_user/current_document.php?id=15764) AHG9: On the AI usage restrictions SEI message [M. M. Hannuksela, F. Cricri (Nokia), S. Wenger (Tencent), H. Tan (LGE) ]

Chaired by S. Deshpande on 27 June 2025 during 10:15-11:40

The following items related to the AI usage restrictions (AUR) SEI message are proposed:

1. It is proposed that when aur\_restriction[ i ] is equal to a reserved value, decoders conforming to VSEI version 4 shall interpret the i-th loop entry as if aur\_restriction[ i ] indicated "unusable for any AI application". Consequently, VSEI version 4 decoders interpret the AI usage restriction more strictly than, and hence comply with, what the semantics of a future VSEI version imply.

Related to proposal 3 of JVET-AM0112.

Decision: Agreed with proposal 1 (as the more safe approach compared to proposal 3 of JVET-AM0112).

1. It is proposed that when aur\_context[ i ] is equal to a reserved value, decoders conforming to VSEI version 4 shall ignore aur\_context[ i ] and interpret the i-th loop entry as if aur\_context\_present\_flag[ i ] were equal to 0 (indicating that aur\_restriction[ i ] applies regardless of the context).

Related to proposal 4 of JVET-AM0112.

It was commented that SEI message should not impose any requirements. It can express what an encoder wants but should not want decoder to do anything. There should be no concept of conforming to an SEI message by doing/ not doing something. SEI messages are preferences expressed by encoders. A new VSEI SEI should NOT define requirements on an existing standards decoder.

It was commented that in VSEI v1, v2 etc. some language regarding decoder behaviour has been used. It was suggested to avoid use of “decoder shall or shall not xxx” in VSEI.

Decision: Agreed with proposal 2 (as the more safe approach compared to proposal 4 of JVET-AM0112).

1. When an AUR SEI message type is included in an SPO SEI message, it is proposed to only allow the AUR SEI message at the end of the processing chain.

Decision: Agreed as a sensibility constraint.

1. In addition to already existing constraints that an AUR SEI message shall not contradict with processing chains specified by SEI processing order (SPO) SEI messages, it is proposed to require that an AUR SEI message shall not contradict with NNPF, GFV, and GFVE SEI messages that are not included in processing chains defined by SPO SEI messages.

It was suggested to add a definition of what “contradiction” means.

It was suggested to actually remove the constraint as we don’t usually specify encoder not to do “crazy” things.

Decision: agreed to remove the constraint.

1. It is proposed to add aur\_sei\_exclusion\_flag in the AUR SEI message. When aur\_sei\_exclusion\_flag is equal to 1, it specifies that the AUR SEI message does not constrain SEI messages that imply AI processing. When equal to 0, the indicated AI usage restrictions also apply to AI processing implied by SEI messages (e.g., NNPF and GFV SEI messages), as specified in JVET-AL2006.

It was asked why this is proposed for VSEI v4. The answer was it is relaxing something which we should not do in a future version.

There was a support expressed to add this functionality in v4 including the proposed flag.

It was commented that “things that imply AI processing” is not clear.

It was asked to consider including the proposed flag inside the for loop instead of outside.

It was suggested not to signal the flag and specify a behavior similar to flag being always equal to 1. And specify a language like: If an NNPF SEI message is present the usage restriction flag does not prevent it from being applied.

Discussed after offline discussion on 30 June 2025 during 15:25-15:45

In the revision:

Two options are proposed:

* + 1. It is proposed to add aur\_sei\_exclusion\_flag in the AUR SEI message. When equal to 1, it specifies that AI processes indicated by NNPFC, NNPFA, GFV, and GFVE SEI messages in the bitstream are not subject to the indications of this SEI message. aur\_sei\_exclusion\_flag equal to 0 specifies that AI processes indicated by NNPFC, NNPFA, GFV, and GFVE SEI messages in the bitstream are subject to the indications of this SEI message.
    2. It is proposed to add aur\_sei\_exclusion\_flag[ i ] in the AUR SEI messge. When equal to 1, it specifies that AI processes indicated by NNPFC, NNPFA, GFV, and GFVE SEI messages in the bitstream are not subject to the indications by the values of aur\_restriction[ i ], aur\_context\_present\_flag[ i ], and aur\_context[ i ] (when present). aur\_sei\_exclusion\_flag[ i ] equal to 0 specifies that AI processes indicated by NNPFC, NNPFA, GFV, and GFVE SEI messages in the bitstream are subject to the indications by the values of aur\_restriction[ i ], aur\_context\_present\_flag[ i ], and aur\_context[ i ] (when present).

Option B is preferred by the proponents (new proponent added to v4 document version).

Option A was same as that discussed in the first presentation with some semantics rewording. Option B has the proposed flag inside the loop.

Decision: Agree on Option B.

[JVET-AM0152](https://jvet-experts.org/doc_end_user/current_document.php?id=15799) AHG9: AI usage restrictions for entities other than decoded pictures [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

The current AI-usage restrictions (AUR) SEI message specifies AI usage restrictions for decoded pictures but not necessarily other data in the picture unit (PU) associated with the AUR SEI message. It is asserted that limiting AUR SEI to provide AI usage restriction only for decoded picture means it would miss the chance to also provide AI usage restriction to other data in the PU that actually also usable for AI applications.

This contribution proposes the following modifications to the AUR SEI message:

1. Extend the scope of restriction information from decoded pictures to picture unit(s).
2. Define a flag to indicate whether the restriction applies only to decoded pictures or to picture unit(s).

A suggestion was made to revise the proposed language to refer to both picture unit and decoded picture.

There was support to make clear that the coded picture syntax elements are also subject to the usage restrictions.

It was questioned if the additional flexibility of the proposed flag is useful.

Decision: adopt proposal 1, with revision of the language to include both decoded pictures and picture units.

### Digitally signed content SEI messages (5+1)

Contributions in this area were discussed during 1630–1900 on Friday 27 June 2025 (chaired by J. Boyce).

[JVET-AM0118](https://jvet-experts.org/doc_end_user/current_document.php?id=15765) AHG9: Digital signing of selected SEI messages [M. M. Hannuksela, J. Boyce (Nokia)]

Chaired by S. Deshpande on 27 June 2025 during 15:00-:16:20

This contribution asserts that the capability to include selected SEI messages in the message digest together with VCL NAL units is desirable, since then both the content of the SEI messages as well as their association with the VCL NAL units can be verified.

The contribution proposes including the following aspects in VSEI version 4:

1. It is proposed to add SEI NAL units that include a DSCS SEI message with dscs\_id equal to dscIdVal and dscs\_verification\_substream\_id equal to dscSubstreamId in the verification substream for dsci\_id equal to dscIdVal and verification substream ID equal to dscIdVal.

It is proposed to allow signing of SEI messages that are carried in suffix SEI NAL units together with a DSCS SEI message.if this functionality is desirable: Yes, there is support for such a functionality from multiple participants.

Regarding if this functionality should be added in VSEI V4 or in a future version of VSEI: There was support to add the functionality to VSEI V4, if possible.

Joint discussion regarding JVET-AM0118 and JVET-AM0160 Option 2:

A non-proponent preferred JVET-AM0118 solution. It was commented by another non-proponent that the JVET-AM0118 solution has more flexibility and JVET-AM0160 option 2 does not provide full specification text.

It was asked why a flag is needed for JVET-AM0118 if it needs to be included together with DSCS SEI. It was commented that because in majority of the cases SEI messages will not be signed and so the flag is useful.

Decision: Adopt JVET-AM0118 in VSEI V4.

[JVET-AM0119](https://jvet-experts.org/doc_end_user/current_document.php?id=15766) AHG9: On start and end flags of digitally signed content [M. M. Hannuksela, J. Boyce (Nokia)]

Chaired by S. Deshpande on 27 June 2025 during 16:20-:16:50

It is asserted that the specification text related to dsci\_signed\_content\_start\_flag and dscv\_signed\_content\_end\_flag has the following problems:

1. The following issues are caused by the fact that dscv\_signed\_content\_flag is present only when dscv\_verification\_substream\_id is equal to 0:
   1. Signed content cannot end with an AU that has substream ID greater than 0. For example, if substreams correspond to temporal sublayers, signed content cannot end with an AU that has sublayer identifier greater than 0.
   2. It is unclear how to derive the variable signingStatus, which uses dscv\_signed\_content\_end\_flag when dscv\_signed\_content\_end\_flag is not present in the DSCV SEI message.
2. The integrity of the original content across a splice point is not protected or detectable by the DSC SEI messages:
   1. An attack can remove the signed content that follows the verification period with dscv\_signed\_content\_end\_flag equal to 1.
   2. An attack can reorder pieces of signed content starting with dsci\_signed\_content\_start\_flag equal to 1 and ending with dscv\_signed\_content\_end\_flag equal to 1.

The proposal introduces the following terms:

* A verification unit is a sequence of verification periods within which splicing would cause a failure of digital signature verification, while splicing can be done at the boundaries of a verification unit.
* A verification chain is a sequence of verification units from which no verification unit can be removed or reordered without causing a failure of digital signature verification. However, a verification chain may be intervened at a verification unit boundary by verification unit(s) of other verification chain(s).

The proposal extends the start and end signalling of verification periods so that verification units and verification chains are identified as follows:

1. dsci\_signed\_content\_start\_flag is replaced by the 2-bit dsci\_start\_idc, with the following values:

0: the beginning of a verification period that does not start a verification unit or a verification chain

1: the beginning of a verification period and the beginning of a verification unit that does not start of a verification chain

2: the beginning of a verification period, a verification unit, and a verification chain

1. dscv\_signed\_content\_end\_flag is replaced by the 2-bit dscv\_end\_idc, which is present without any gating condition and has the following values:

0: the end of a verification substream of a verification period that does not end a verification unit or a verification chain

1: the end of a verification substream of a verification period that ends of a verification unit and does not end a verification chain

2: the end of a verification substream of a verification period that ends of a verification unit and a verification chain

It was commented that this is more of an extension of functionality rather than a bug-fix.

It was commented that there are some open questions.

1. Can it be specified how much content can be added in between chains (number of chains, length of video)
2. How is the interaction of different dsc\_ids that are used in a same time in one chain vs. using dsc\_id to distinguish chains?
3. How is the removal of entire chain handled?

No support was expressed by anyone for the aspect of changing flags to idcs (mainly due to the lateness of adding functionality at this stage)

The “Limited Alternative” in section 4 was discussed as a possible solution for asserted bug-fix for the point #1 above.

JVET-AM0208 item 7 is related/ similar.

Decision: Adopt the Limited Alterative proposed in section 4 of JVET-AM0119.

[JVET-AM0164](https://jvet-experts.org/doc_end_user/current_document.php?id=15811) AHG9: On DSC SEI [K. Sühring, T. Hinz, Y. Sanchez, J. Pfaff, H. Schwarz, D. Marpe, T. Wiegand (Fraunhofer HHI)]

This contribution proposes several small corrections for DSC SEI messages:

1. increase the maximum allowed signature size for possible long signatures in post-quantum cryptography
2. add a constraint to better support sub-picture extraction based on scalable nesting SEI
3. move the dsci\_key\_source\_uri syntax element to the end of the DSCI SEI message for improved handling with trust manifeststs
4. allow DSC SEIs with different content within the same AU in VVC (this aspect to be discussed with JVET-AM0174)

Regarding item 2, it is noted that there are other contributions for subpicture signing for the TuC.

It was noted that the proposal places a constraint on external means.

Some additional study may be needed to confirm that the recommended constraint is sufficient.

Proponent may request a revisit of item 2 after review of the related TuC contributions.

For item 4, see notes for JVET-AM0174.

Decision: Adopt item 1 to increase signature length, item 3 to move the dsci\_key\_source\_uri syntax element

[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 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

Chaired by S. Deshpande on 28 June 2025 during 14:40-14:55

1. This contribution proposes modifications for implicit association mode in digitally-signed content (DSC) SEI messages in VSEI v4. Ensure the inferred value of verification substream ID is in the allowed range.
2. Clarify the semantic of the implicit association mode.
3. Add a constraint to avoid partial implicit association.

Item 1 was part of offline discussion. The offline discussion suggested adding a constraint rather than making any increase to the value range or length of id coding syntax element.It was commented that the existing following value range already implies this constraint:

The value of dscs\_verification\_substream\_id shall be in the range of 0 to dsci\_num\_verification\_substreams\_minus1, inclusive.

So no change is required.

Item 2 : It is suggested to add “with dscs\_id equal to dsci\_id”.

Decision: Agreed on item 2.

Item 3: Partial association is a feature and will be also useful/ needed for SEI signing. No action.

[JVET-AM0208](https://jvet-experts.org/doc_end_user/current_document.php?id=15855) AHG9: On aspects related to verification period in digitally-signed content SEI messages in VSEI v4 draft [H. Tan, J. Lee, J. Nam, C. Kim, J. Lim, S. Kim (LGE)]

Chaired by S. Deshpande on 28 June 2025 during 14:55-15:30

This contribution proposes changes that are asserted improve the clarity of the verification period concept in digitally-signed content (DSC) SEI messages. The proposed items include:

* Item 1: On signing only some PUs in a CVS
* Item 2: On verification period aligning with intra period
* Item 3: On repetition of DSCI SEI message within an AU
* Item 4: On consistency of signing method of verification system in a CVS
* Item 5: On the condition that marks the end of a verification period
* Item 6: On the presence of DSCI SEI message with all pictures in the CVS are intra picture

Item 7: On the constraint on the value of dsci\_signed\_content\_start\_flag see notes under JVET-AM0119.

Following questions are raised in the proposal for discussion:

1. When pictures in a CVS are signed by a verification system, is it allowed that not all pictures in the CVS are signed? It is not allowed, so item 1 does not need discussion.
2. The current definition of a verification period implies that every new DSCI SEI message starts a new verification period. Currently a DSCI SEI message can be present in any AU, not just an IRAP or GDR AU which means a verification period can start at any AU within a CVS and also can end at any AU as well. In authors’ assessment, the benefit of allowing such flexibility is not really clear. Should it better to constraint such that verification period shall only start from DSCI SEI message that is present in an IRAP AU or GDR AU? It was commented that the current flexibility is to support a use case of very long IRAP/ GDR intervals. Since that is the case, item 2 does not need discussion.
3. The current definition of verification period is ambiguous about whether repetition of DSCI SEI message, particularly DSCI SEI messages in the same AU, is allowed or not. On the other hand, the constraint about the presence of DSCI SEI message disallow repetition within an AU since it is constrained that there shall be at most one DSCI SEI message with a particular value of dsci\_id in an AU. In authors’ opinion, there is no good reason to disallow repetition within an AU and we normally allow repetition if there is no issue. Thus, this matter needs to be clarified.

It was commented that the current design is that signature cannot be verified if any packets are lost. It was not clear what is the use case for repetition, if not for error resilience (which is not supported).

Thus item 3 does not need discussion.

1. When pictures within a CVS are signed using a particular verification system, is it possible for the signing algorithm / method to change from one verification period to another verification period within the CVS?

It was commented that we need to consider which parameters should be limited (e.g. hash method), but some other parameters (e.g. number of substreams etc.) are not limited. It was commented to keep the design in SEI fully flexible and put any constraints in application/ system standards.

To keep the current flexibility, no need to discuss item 4.

Item 5: It was commented that current language mirrors language in our specifications for CVS.

Design intent is clear and the text is delegated to editors for consideration.

Item 6: Preference was not to add further restriction for all-intra coding. No action.

[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 [H. Tan, J. Lee, J. Nam, C. Kim, J. Lim, S. Kim (LGE)]

Chaired by S. Deshpande on 28 June 2025 during 15:30-15:45

This contribution proposes changes that are asserted improve various aspects for the design of digitally-signed content (DSC) SEI messages. The proposed items include:

* Item 1: On the presence of DSCV SEI messages:

It was commented that adoption of JVET-AM0119 (removal of conditional signaling) takes care of any asserted problem related to this.

It was confirmed that DSCV does not need be present only at the last AU.

Discussed again on 29 June 2025 during 9:45-9:55

It was commented that the proposed condition change only corresponds to “dscv\_signed\_content\_end\_flag shall be equal to 1” case.

Decision: It was agreed to make this change as it is editorial after the adoption of JVET-AM0119.

* Item 2: On restarting content signing when verification substream structure changes:

It was commented that an existing constraint already takes care of any issue related to the problem statement of this item.

* Item 3: On the need for DSCV SEI messages to be present for every verification period:

No support to relax the constraint.

* Item 4: On signalling of dscv\_signed\_content\_end\_flag:

Adoption of JVET-AM0119 (removal of conditional signaling) takes care of any asserted problem related to this.

* Item 5: On the number of verification substreams and signalling for this information

Item 5 doesn’t need to be discussed (as it is identical to another proposal. See notes under JVET-AM0047 item 2).

### Packed regions information SEI message *(*2+1)

Contributions in this area were discussed during 1230–1530 on Friday 27 June 2025 (chaired by J. Boyce).

[JVET-AM0075](https://jvet-experts.org/doc_end_user/current_document.php?id=15722) AHG9: On packed regions information SEI message [T. Chujoh, Z. Fan, R. Ishimoto, T. Ikai (Sharp)]

VSEI version 4 has reached the DAM stage on the ISO/IEC standardization process. This contribution reports the following editorial and technical problems for the packed regions information SEI message, which has been revised to draft 6 of VSEI version 4 at the March/April online meeting and proposes their solutions.

1. Two variable names BtDepthY and BtDepthC should be improved to BitDepthY and BitDepthC.
2. The interface variables for the PRI SEI message are defined using the syntax elements pri\_region\_layer\_id[ i ] and pri\_num\_regions\_minus1 before their definition. They should be specified without the SEI syntax element.
3. The syntax element pri\_use\_max\_dimensions\_flag does not explain its semantics. It should be explained why these arrays are used in calculations for the region parameters.

For item 1, these changes would make the interface text awkward (by having something like "The variable X is set equal to X").

For item 2, the first sentence was awkward “using each layer identifier value, layer\_Id, in AU, applied to this SEI message”. It would be possible to avoid the name of the specific syntax element. Item 2 is delegated to the editors.

It was noted that other locations in the spec refer to a syntax element before the syntax element is defined.

Agreed to item 3, which is editorial.

The editors are recommended to consider the naming of the bit depth interface variables.

[JVET-AM0166](https://jvet-experts.org/doc_end_user/current_document.php?id=15813) AHG9: Miscellaneous aspects in VSEI v4 [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

*JVET-AM0166 also relates to the SPO and MI SEI messages*

*(Related to PRI SEI message)*

3. On handling of persistence for PRI SEI

It is asserted that there is an issue with the the 3rd bullet in the PRI persistence semantics. This text is proposed for the 3rd bullet:

: – A picture in an AU associated with a ~~Another~~ packed regions information SEI message is output ~~present in an AU~~ that follows the current picture ~~AU~~ in output order.

It was suggested that the proposed text may have issues in a multi-layer case. This text was suggested to replace all 3 bullets:

pri\_persistence\_flag equal to 1 specifies that the packed regions information SEI message applies to the current AU and persists for all subsequent AUs in output order in the current CVS until the next AU, when present, that follows the current AU in output order and contains a packed regions information SEI message.

Agreed to modify the persistence language. Exact text delegated to the editors.

[JVET-AM0211](https://jvet-experts.org/doc_end_user/current_document.php?id=15858) AHG9: On the packed regions information SEI message [J. Xu, Y.-K. Wang (Bytedance)]

The following modifications for the packed regions information (PRI) SEI message are proposed in this contribution

1) Address a mismatch between the VSEI and VVC text on the interface of the PRI SEI message.

2) When pri\_target\_pic\_params\_present\_flag is equal to 0, do not signal resampling ratio related syntax elements, including pri\_num\_resampling\_ratios\_minus1, pri\_resampling\_width\_num\_minus1, pri\_resampling\_width\_denom\_minus1, pri\_fixed\_aspect\_ratio\_flag, pri\_resampling\_height\_num\_minus1, pri\_resampling\_height\_denom\_minus1 and pri\_resampling\_ratio\_idx.

3) Allow different chroma formats and bit depth values for different regions and add syntax elements to specify chroma format and bit depth values for the target picture.

Decision: Adopt item 1, option b.

Regarding item 2, it was remarked that the original design intent of the PRI SEI messages was to have the resampling information available as it indicates the size of a region in the source picture.

It was suggested that a note could added to clarify that.

Further discussion requested after text of a note is available.

Regarding item 3, allowing different chroma formats and bit depths for different regions was previous proposed, but use cases weren’t that required that flexibility weren’t clear. A particular use case is described with mixed screen content and natural content.

It was suggested that even mixed content can be coded as 4:4:4.

It was questioned if there is a constraint on consistent colour space.

This is proposed for VSEI v4. It was questioned whether it could be done as an extension in a future version.

Not sufficient support to do this for VSEI v4. Further discussion requested to consider if it could be structured as an extension and included in the TuC.

Further discussed at 1100 on Tuesday 1 July 2025.

Decision: adopt to VSEI v4 the language for item 2 in contribution -v2 : When pri\_target\_pic\_params\_present\_flag is equal to 0, the resampling ratio values indicate the resampling ratios of the regions from the source picture.

Decision: add item 3 to TuC to allow different chroma formats and bit depths, in an extension of the PRI SEI in the TuC.

### Source picture timing information SEI message (0)

Contributions in this area were discussed during 1710–1830 on Friday 27 June 2025 (chaired by J. Boyce).

[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 [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

*JVET-AM0165 also relates to the EOI, MI, TDI, and IFM messages*

(Related to SPTI SEI message)

1. On value range of spti\_source\_type in SPTI SEI

(Related to MI SEI message)

2. On value range of mi\_modality\_type in MI SEI

3. On reserved value of mi\_modality\_type in MI SEI

(Related to EOI SEI message)

4. On reserved value of eoi\_type in EOI SEI

5. On reserved value of eoi\_object\_based\_idc in EOI SEI

6. On reserved value of eoi\_privacy\_protection\_method\_idc in EOI SEI

7. On reserved value of eoi\_privacy\_info\_type in EOI SEI

(Related to IFM SEI message)

8. On reserved value of ifm\_type\_id[ i ] in IFM SEI

(Related to TDI SEI message)

9. On reserved value of tdi\_descr\_purpose in TDI SEI

10. On reserved value of tdi\_descr\_id in TDI SEI

Regarding item 1, in the current design of source picture timing information (SPTI) SEI message, the syntax element spti\_source\_type is defined using bitmask operations in the range of 0x01 to 0x80, which means there are 8 bits out of the 16 bits allocated for this signalling have been specified. However, the current semantics of spti\_source\_type specify that its value range is from 0 to 127, and the decoder is designed to ignore spti\_source\_type values from 128 to 255.

Item 2 is related to JVET-AM0047 item 1. No action.

Item 3 proposes typical language regarding reserve values, which was missing.

Item 4 clarifies the behavior of decoders regarding reserved values of eoi\_type.

Item 5 clarifies the behavior of decoders regarding reserved values of eoi\_object\_based\_idc.

Item 6 fixes a bug in the reserved range of values of eoi\_privacy\_protection\_method\_idc to be 65535 rather than 255, since the syntax element is u(16), and also clarifies the behavior of decoders regarding reserved values.

Item 7 clarifies the behavior of decoders regarding reserved values of eoi\_privacy\_info\_type

Item 8 proposes the following for ifm\_type\_id[ i ]:

When the value of ifm\_type\_id[ i ] is in the range of 7 to 255, inclusive, decoders conforming to this version of this document shall ignore all information for the i-th loop of the image format metadata~~ifm\_type\_id[ i ]~~.

It was suggested that the “i-th loop” language is imprecise.

The spirit of the proposal is to ignore the i-th entry, which is agreed. It was suggested to use “i-th image format metadata payload” .

Item 9 proposes the following text for tdi\_descr\_purpose : When the value of tdi\_descr\_purpose is in the range of 7 to 255, inclusive, d~~D~~ecoders conforming to this version of this document shall ignore the text description information SEI message.~~allow any value of text\_descr\_purpose in the range of 0 to 255, inclusive.~~

Item 10 proposes to reserve some values of tdi\_descr\_id.

It was suggested to remove the “with the tdi\_descr\_id” in the proposed text.

Decision (Bug fix): Adopt item 1 for SPTI, item 3 for modality reserved value, item 4 for eoi\_type, item 5 for eoi\_object\_based\_idc, item 6 for eoi\_privacy\_protection\_method\_idc, item 7 for eoi\_privacy\_info\_type, item 8 with replacing “i-th loop” with “i-th image format metadata payload”, item 9 or tdi\_descr\_purpose., item 10 with removing “with the tdi\_descr\_id” wording.

### Modality information SEI message (0+4)

Contributions in this area were discussed during 1900–1930 on Friday 27 June 2025 (chaired by J. Boyce).

[JVET-AM0166](https://jvet-experts.org/doc_end_user/current_document.php?id=15813) AHG9: Miscellaneous aspects in VSEI v4 [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

*JVET-AM0166 also relates to the SPO and PRI SEI messages*

This contribution proposes miscellaneous modifications that are asserted to provide improvement to some aspects of SEI messages in VSEI v4 draft. The proposed modifications are as follows:

(Related to MI SEI message)

1. On signaling of min and max wavelengths in MI SEI

2. On constraint for wavelength in MI SEI

Item 1 proposes modified semantics for min and max wavelength parameters. “when present” is added to semantics. It is suggested to remove the inference values when the syntax elements are not present.

It is noted that JVET-AM0191 also has modifications to the semantics.

Further discussion requested item 1 after proposal with suggestions above is combined with JVET-AM0191.

Item 2 proposes that the max value is constrained to be larger than the min value.

Decision: adopt item 2.

Further discussed 1750 – 1755 Monday 30 June 2025.

Decision: adopt item 1.

### Text description information SEI message (1+2)

Contributions in this area were discussed during 1830–1745 on Friday 27 June 2025 (chaired by J. Boyce).

[JVET-AM0098](https://jvet-experts.org/doc_end_user/current_document.php?id=15745) AHG9: On the TDI SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

This contribution proposes to add VSEI description to tdi\_descr\_purpose in text description information SEI message.

An example use case would be to indicate if an FGC SEI with resolution extension is present in the bitstream.

The existing manifest SEI message doesn’t include version numbers, but has a prefix.

It was noted that the FGC resolution is at the end of the SEI message, and would require the entire message to be in a prefix.

The usefulness for the use case for FGC SEI was questioned because the decoder wouldn’t know how to interpret the text, and the information is available within the FGC SEI message itself.

No action.

### Generative face video SEI (3)

Contributions in this area were discussed during 0900–1040 on Saturday 28 June 2025 (chaired by S. Deshpande).

[JVET-AM0091](https://jvet-experts.org/doc_end_user/current_document.php?id=15738) AHG9: On GFV SEI chroma key [J. Boyce, M. M. Hannuksela (Nokia)]

Chaired by S. Deshpande on 28 June 2025 during 9:20-9:55

Several problems are identified with the chroma key feature of the GFV SEI message, for which it is asserted that the current design does not sufficiently specify the intended behavior. This contribution proposes solutions to address the following identified problems:

1. Use of the chroma key feature for GFV cannot be disabled, because when chroma key parameters are not present, default values are inferred.

It was agreed that the current flag does not indicate that the recommended face generation process perform chroma keying and that this is a bug.

1. Chroma key parameter persistence is not specified. Chroma key parameters are signaled in a base picture, but do not persist to the drive and fusion pictures. As currently specified, default chroma key parameter values are always inferred for drive and fusion pictures.

It was agreed that the design intent is to use the parameters from base picture in this case.

1. No signalling mechanism to identify coded background pictures used for chroma keying.

It was asked why base picture cannot be background picture.

It was answered by proponent that when using chroma keying that will be the case.

It was commented that the design intent is broader than background picture.

It was asked if a use case of video chat which uses virtual background via external means is supported.

It was agreed that every fusion picture is not a background picture. It was suggested that a note could be added to identify a fusion picture which is a background picture.

1. Unnecessary signaling of separate presence flags for chroma key value colour components and for chroma key upper and lower thresholds.

It was commented that the design intent is: to signal only 1, 2 or 3 colour components when chroma key information is present.

If chroma key information is not present, and no parameters are signalled they are inferred as default values.

1. Missing constraint on chroma key thresholds can lead to negative alpha values or division by zero.

A new signaling option and adding constraint(s) option are proposed.

It was commented that the threshold signaling may not be needed and can be removed.

It was commented that the thresholds may allow using conventional alpha blending.

It was suggested that when thresholds are not signalled they should be considered undefined instead of inferring default values for them.

1. GFV process using chroma keying is not well described.

It is agreed that the current notes do not sufficiently describe the process.

Discussed again on 1 July 2025 chaired by S. Deshpande during 11:55-12:15. Further discussion requested. See notes under JVET-AM0334.

[JVET-AM0327](https://jvet-experts.org/doc_end_user/current_document.php?id=15995) AHG9: On GFV SEI [[S. McCarthy](mailto:sean.mccarthy@dolby.com), [P. Yin](mailto:pyin@dolby.com), [G. J. Sullivan (Dolby)](mailto:gary.sullivan@dolby.com)] [late]

Chaired by S. Deshpande on 30 June 2025 during 16:40-17:10

It is asserted that the clarity of the current draft of the generative face video (GFV) SEI messages could be improved, particularly with respect to fusion pictures and chroma key information.

Version 2 of this contribution incorporates additional editorial aspects, additional technical aspects, including the addition of a syntax element, and corresponding revisions to the attached specification text.

Editorial aspects:

* *Aspect 1*: Reword the introduction to clarify the definitions of base picture, fusion picture, driving picture, and chroma key information
* *Aspect 2*: Clarify the persistence of syntax elements specified for base pictures.
* *Aspect 3*: Rename the syntax element gfv\_drive\_pic\_fusion\_flag to gfv\_fusion\_pic\_flag and simplify the corresponding semantics
* *Aspect 4*: Simplify the semantics for gfv\_chroma\_key\_info\_present\_flag
* *Aspect 5*: Simplify and clarify Note 3 pertaining to the use of chroma key information for alpha blending
* *Aspect 6*: Clarify the persistence of fusion pictures
* *Aspect 7*: Rename the variables inputDriveY, inputDriveCr, and inputDriveCb to inputFusionY, inputFusionCr, and inputFusionCb, respectively, to clarify that these variables correspond to a fusion picture.
* *Aspect 8*: minor improvements to the specification text
* *Aspect 9*: Correct missing brackets and tabs in the syntax table.

Technical aspects:

* *Aspect 1*: Replace the syntax elements gfv\_chroma\_key\_thr\_present\_flag[ i ] and gfv\_chroma\_key\_thr\_value[ i ] and associated semantics with syntax elements gfv\_chroma\_key\_thr\_lower and gfv\_chroma\_key\_thr\_upper\_delta\_minus1 and associated semantics as proposed in JVET-AM0091.
* *Aspect 2*: Add missing aspects of the process used to generate a video picture when gfv\_chroma\_key\_info\_present\_flag is equal to 1
* *Aspect 3*: Added several constraints as proposed in JVET-AM0091.
* *Aspect 4*: Add syntax element gfv\_base\_pic\_no\_display\_flag to enable a base picture to not be displayed when chroma key information is used for background replacement, for example.

It was commented that the proposed updates completely remove alpha blending.

V3 attachment was discussed.

Regarding proposed NOTE 2, it was asked which entity determines the usage of chroma keying as per the example.

There are some other technical change which may not be summarized above.

Also in v3 syntax table an opening brace was unintentionally removed.

Due the the lateness of the document more time was requested for study.

It was suggested that some offline activity should be considered by the proponents of this document and JVET-AM0091 authors.

Discussed again 1 July 2025 chaired by S. Deshpande during 11:55-12:10. Further discussion requested. See notes under JVET-AM0334.

[JVET-AM0334](https://jvet-experts.org/doc_end_user/current_document.php?id=16002) AHG9: Common specification text for GFV SEI message [J. Boyce, M. M. Hannuksela (Nokia), S. McCarthy, P. Yin, G. J. Sullivan (Dolby), J. Chen, Y. Ye, B. Chen (Alibaba)] [late]

General discussion

It is noted that there is a ballot comment in AVC that SEI message names should be uniquely searchable. GFV and GFVE are not unique. It is suggested to change the name of the GFVE SEI message and its syntax elements. This can be left to the editors or contributions to the next meeting can make suggestions.

Discussed on 1 July 2025 chaired by S. Deshpande during 11:55-12:10

This contribution proposes common specification text for the generative face video SEI message. The proposed modifications are intended for VSEI v4.

The attached specification text incorporates editorial bug fixes and improvements for clarity, persistence, and constraints. The text also specifies syntax element, gfv\_chroma\_key\_purpose\_idc.

It was suggested that note 3 conditions on chroma key purpose idc should be delegated to the editors.

Base picture, driving picture and fusion pictures are mutually exclusive (i.e. a picture can be only of one of those types).

The syntax and semantics were reviewed. Some further editorial changes may be necessary.

Decision: Adopt to VSEI v4.

### Other (1)

Contributions in this area were discussed during 0900–1040 on Saturday 28 June 2025 (chaired by J. Boyce).

[JVETAM0126](https://jvet-experts.org/doc_end_user/current_document.php?id=15773) AHG9: Temporal quality indication for EOI SEI message [J. Chen, Y. Ye, B. Chen (Alibaba)]

It is proposed to add an indicator in the encoder optimization information (EOI) SEI message when the value of eoi\_type indicates temporal quality optimization has been applied. The proposed indicator can be used to indicate how the quality of a picture associated with the SEI message has fluctuated due to temporal quality optimization. It is asserted that such information could be useful at the decoder side for some applications to improve temporal quality consistency.

In version 3, an additional option to simplify the proposed semantics is provided.

JVET-AL0101 was suggested to be related.It was noted that the quality metric SEI in TuC can signal per picture quality. The contribution is describing a purpose.

It was questioned why this contribution is being proposed for VSEI v4.

The proposed option 1 semantics relate to human viewing, for which there is an existing eoi\_for\_human\_viewing\_idc syntax element. Option 2 does not mention human viewing.

A GFV use case was mentioned, but it might apply to other use cases.

It was noted that the current EOI SEI message is aimed more at CLVS properties, although has a persistence flag. This contribution uses the persistence, so only needs to signaled when the picture quality changes.

It was suggested that a flag may be sufficient rather than indicator.

Contribution AM0113 is related but specifically addresses NNPF.

Decision: Add option 2 to TuC, but move the syntax into the extension. A revision to the document with the syntax in the extension to be uploaded.

## AHG9: Extensions of SEI messages in VSEI (2)

Contributions in this area were discussed during 1100–1145 on Saturday 28 June 2025 (chaired by J. Boyce).

[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 [J. Boyce, M. M. Hannuksela (Nokia)]

Chaired by S. Deshpande on 28 June 2025 during 11:00-11:25

This contribution proposes to extend the SDI SEI message to signal the layer index of the described layer for confidence auxiliary layers, e.g., auxiliary layers of type AUX\_CONFIDENCE. Support for confidence auxiliary layers was added to the VSEI TuC based on contribution JVET-AL0092. A use case is described for which explicit signalling of the described layer ID of the confidence layer is needed to avoid incorrect inference of the described layer ID.

The proposal is summarized as follows:

* Add an extension to the SDI SEI message to support signalling of the sdi\_described\_layer\_idx[ i ] syntax element for auxiliary layers of type AUX\_CONFIDENCE
* When the SDI extension is not present, define an inference value of sdi\_described\_layer\_idx[ i ]
* Place a constraint on the primary picture associated with the confidence layer

Related notes from JVET-AL0092:

“There was support to add AUX\_CONFIDENCE value to SDI SEI in TuC, but not the proposed SEI at this time.

Regarding SEI message, for future it was requested to provide some convincing practical use case. Regarding confidence value range it was commented that it may not have much practical real-world usage and that it could be easily derived.”

AUX\_CONFIDENCE value was added to SDI SEI in TuC at the previous meeting.

A use case was presented. Regarding the use case it was asked if the last two layers could be swapped to then just need the inference and not signaling. Currently there is no inference specified either.

It was asked if the semantics of sdi\_associated\_primary\_layer\_idx[ i ][ j ] can be modified to allow it to point to an auxiliary layer (instead of only primary layer). This may have a backward compatibility issue, which should be checked.

It was asked if the confidence map is only for depth. That was just an example provided.

It was pointed that the extra syntax may repeat the same layer ID twice in the SEI if the association is to a primary layer. It was suggested to avoid repetition in this case.

Existing SEI allows multiple associated primary layers.

It was asked if such association be also supported for other kinds of auxiliary layers than confidence auxiliary layers.

The proposal is for TuC.

Decision: Agreed to add it into TuC.

[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 [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

Extension of the shutter interval information SEI message is proposed to signal details of rolling shutter cameras. Rolling shutter cameras are commonly used in consumer, automotive and autonomous vehicle applications. When either the object or the camera exhibits fast motion, the image may be distorted by rolling shutter artifacts. It is asserted that these artifacts degrade many uses of such an imager in areas such as bifocal stereo, multi-sensor fusion or 3D scene reconstruction. Details of the subframe capture timing may be used to improve the performance of these applications. The extension includes the follow syntax elements to describe rolling shutter capture.

1. A syntax element, sii\_rolling\_shutter\_scan\_order, describes the direction of scan, top-to-bottom, bottom-to-top, left-to-right, or right-to-left.
2. A syntax element, sii\_num\_units\_in\_rolling\_shutter\_scan\_interval, describes the duration of the scan in units already used in the SII message.
3. A syntax element, sii\_num\_units\_in\_rolling\_shutter\_scan\_delay, describes the delay of the scan in units already used in the SII message.

The existing shutter interval SEI message assumes a global shutter.

It was noted that rolling shutter cameras are common, but often processing is often done to correct for that before doing video encoding. Some applications, such as depth estimation, may prefer to operate on content where rolling shutter correction had not been done.

Rolling Cameras typically roll top to bottom, but the camera may be rotated relative to the scene it is capturing.

It was questioned if the scan delay syntax element is needed.

It was questioned why the scan interval and delay are signaled for each temporal sublayer as it would be expected to be consistent.

There is some support for adding to the TuC.

Decision: Conditionally adopt to the TuC, subject to revised text being provided in a new version of the contribution that removes the scan delay syntax element and separate sublayer signaling of the scan interval.

Further discussed on 1 July 2025. Adoption confirmed.

[JVET-AM0324](https://jvet-experts.org/doc_end_user/current_document.php?id=15992) Correction to the Alpha Channel Information SEI message processing order [D. Podborski, A.M. Tourapis (Apple)] [late]

This contribution identifies a potential issue with regards to the order of operations specified for simultaneous use of the alpha\_channel\_incr\_flag and alpha\_channel\_clip\_flag syntax elements in the Alpha Channel Information SEI message of the HEVC specification. The currently specified order seems to produce alpha values outside the intended range and may result in issues when alpha is applied. A normative correction reversing the order of operations is proposed.

It is noted that other changes are planned for the alpha channel information SEI message.

It is agreed that the current behavior is questionable.

Decision: Adopt to VSEI v4 and HEVC.

Further study encouraged to see if AVC has the same problem.

## AHG9: Aspects on SEI messages in TuC for VSEI (30)

### NNPF SEI messages *(*2)

Contributions in this area were discussed during 1145–1300 on Saturday 28 June 2025 (chaired by J. Boyce).

[JVET-AM0087](https://jvet-experts.org/doc_end_user/current_document.php?id=15734) AHG9: Comments on VSEI TuC [S. Deshpande (Sharp)]

Following modification is proposed related to NNPF signaling in VSEI Technologies under Consideration (TuC) document:

In Neural-network post-filter characteristics SEI in VSEI TuC it is proposed to signal the syntax elements nnpfc\_num\_aux\_layers\_minus1 and nnpfc\_layer\_target\_id[ i ] using ue(v) coding instead of u(6).

Decision: adopt to TuC.

[JVET-AM0173](https://jvet-experts.org/doc_end_user/current_document.php?id=15820) AHG9: NNPFA SEI message extension for multi-purpose NNPFs [C.-H. Demarty, E. François, A. Ak (InterDigital), M. Hannuskela, F. Cricri (Nokia)]

Chaired by S. Deshpande on 28 June 2025 during 15:45-16:xx

This contribution builds upon contributions JVET-AL0076-v2, JVET-AL292-v2 and JVET-AL341-v1 (not presented). This contribution proposes changes to avoid the need to define multiple NNPFs and NNPF cascades, which have been proved to lead to lower accuracy, by enabling the adaptive use of NNPF models that include several purposes. In the contribution, it is proposed to enable skipping a particular purpose among multiple purposes of the NNPF, when less purposes are desired. Additionally, defining a multipurpose NNPF allows to save both memory and computational resources.

This contribution starts with listing the benefits of multipurpose NNPF against NNPF cascades. It also proposes examples of multipurpose NNPFs with different architecture types.

It is proposed to add the support of multipurpose NNPFs into the VSEI TuC. The proposed specification text includes the following items:

1. nnpfa\_target\_purposes\_present\_flag, indicating if nnpfa\_target\_purposes\_idc is present.
2. nnpfa\_target\_purposes\_idc indicating a bit-field where the enabled bits are a subset of the enabled bits in nnpfc\_purpose; thus, a subset of the NNPFC-indicated purposes can be indicated in an NNPFA SEI message.
3. nnpfPurpose is set equal to nnpfa\_target\_purposes\_idc (if present) or nnpfc\_purpose (otherwise). The purpose-dependent variables (ChromaUpsamplingFlag, ResolutionResamplingFlag, etc.) are derived from nnpfc\_purpose for NNPFC SEI message syntax parsing and from nnpfPurpose for constraints and NNPF operation.
4. A bit of nnpfc\_auxiliary\_inp\_idc, namely nnpfc\_auxiliary\_inp\_idc & 8, is defined to indicate that a purpose is input to the NNPF as a part of the input tensor.
   1. When nnpfc\_auxiliary\_inp\_idc & 8 is equal to 0, nnpfa\_target\_purposes\_present\_flag shall be equal to 0. Since legacy VSEI decoders would not process NNPFs with nnpfc\_auxiliary\_inp\_idc & 8 greater than 0, they would not parse NNPFA SEI messages with the new syntax elements present and hence legacy compatibility is not compromised.
   2. The purpose is included in the input tensor as an additional matrix, similarly to the strength control value (QP), the text prompt, and the seed value.
5. Additional syntax elements in the NNPFA SEI message are defined that are updates of their corresponding syntax elements in the NNPFC SEI message, following the skipping of a particular purpose.

A question was asked about backward compatibility and it was described as provided via nnpfc\_auxiliary\_inp\_idc & 8.

It was asked if this proposal also supports previous backbone and tail architecture. It was commented that the goal of that proposal and this one is not the same.

It was asked if the join filter with multiple purposes can be used for selective filtering of only some of the purposes.

It was commented that considering previous meeting there are 3 or 4 possible proposals and approaches and some understanding of their relationship will be useful. It was commented that this proposal is similar to JVET-AL0341.

Some people expressed needing more time to study.

Following comments were made via zoom chat feature:

The changes are a lot, making the NNPFC/NNPFA design much more complicated. Lots of NNPFC paramters get added to the NNPFA SEI message. For the claimed benefits, the encoder can send another NNPFC SEI message with the reduced purpose combination. Compared to this alternative that does not need any change to the design, the proposed approach only saves some bits of the another NNPFC SEI message, while spending a lot more bits for the NNPFA SEI messages. And note that NNFPC is typically sequence-level while NNPFA is typically much more frequent. Therefore, my opinion is that the group should not take an action on this proposal.

Discussed again on 1 July 2025 chaired by S. Deshpande during 12:10-12:40

Some clarifying figures were added in v3.

After offline discussions, the proponents suggested to only consider addition of section 4.4 in TuC with nnpfPurpose replaced by nnpfc\_purpose.

Decision: Agree to add section 4.4 to TuC as modified above [add a note saying alternative approaches e.g. URI should be considered for this functionality].

### Constituent rectangles SEI (2)

Contributions in this area were discussed during 1150–1300 on Saturday 28 June 2025 (chaired by J. Boyce).

[JVET-AM0092](https://jvet-experts.org/doc_end_user/current_document.php?id=15739) AHG9: Editorial changes on the CR SEI message [Y. He, S. Zhao, L. Kerofsky, M. Karczewicz (Qualcomm)]

This contribution proposes the following editorial changes to the CR SEI message in TuC.

1. Replace cr\_rect\_id\_present\_flag with cr\_rect\_id\_enable\_flag to condition the cr\_rect\_id\_len\_minus1 as cr\_rect\_id\_present\_flag is not defined prior to this condition
2. Correct the loop variable used to signal the rectangle syntax elements and remove a redundant condition
3. Update cr\_enhanced\_chroma\_format\_enabled\_flag semantic as the cr\_group\_enhanced\_chroma\_format\_idc[ i ] syntax element may not present even when cr\_enhanced\_chroma\_format\_enabled\_flag equal to 1
4. Add missed layer index and replace total number of rectangles with the layer based number of rectangles in the enhanced colour format group constraint
5. Add missed layer index variable and replace total number of rectangles with the layer based number of rectangles in the associated ID constraint
6. Replace obsolete cr\_group\_444\_flag[ i ] with “cr\_group\_enhanced\_chroma\_format\_idc[ i ] equal to 2” in the semantics

Decision: Agreed item 1, item 2, item 3, item 6.

Regarding item 4. it is expected that the chroma components would be in separate layers, so should not make the change to restrict within a layer.

Regarding item 5, the design intent is for the ID numbering space to be common to all layers, so should not make this change.

It was suggested for editors to check the text to ensure that there isn’t overlay of the CR ID across layers.

[JVET-AM0093](https://jvet-experts.org/doc_end_user/current_document.php?id=15740) AHG9: On the CR SEI message [Y. He, S. Zhao, L. Kerofsky, M. Karczewicz (Qualcomm)]

This contribution proposes the following changes to the constituent rectangle (CR) SEI message in TuC.

1. Add value range of cr\_num\_group
2. Add constraint to avoid an empty CR SEI message
3. Add constraint to avoid an empty CR group
4. Propose CR purpose syntax element to ensure future proof extensibility
5. Add a condition to avoid signaling cr\_rect\_id when the rectangle is empty
6. Change CR group ID to group index
7. Add syntax element of the layer index of the associated rectangle in case the current rectangle and the associated rectangle are at the different layer
8. Propose to add CR\_Y rectangle as the primary rectangle

Items 2 and 3 seem unnecessary.

Regarding item 4, the proposal to add a purpose overlaps with the signaled cr\_rect\_type\_idc[ ] per CR, but provides the info at the beginning of the SEI message.

Regarding item 5, allowing signaling of ID for empty rectangles was adopted in JVET-AG0075 item 4.

Regarding item 7, is unnecessary because the CR ID numbering space is common across layers.

Further study on item 5. Consider if other SEI messages like DOI SEI that reference CR IDs have a constraint that referenced CRs shall not be empty.

Decision: Agreed item 1, item 6, item 8.

### Display rectangles SEI (2)

Contributions in this area were discussed during 1230–1300 on Saturday 28 June 2025 (chaired by J. Boyce).

[JVET-AM0095](https://jvet-experts.org/doc_end_user/current_document.php?id=15742) AHG9: On the DR SEI message [Y. He, S. Zhao, L. Kerofsky, M. Karczewicz (Qualcomm)]

This contribution proposes the following changes to the display rectangle SEI message in TuC.

1. Modify the DR update constraints to be based on the initial DR SEI message instead of previous DR SEI message
2. Constrain the uniqueness of the rectangle ID, dr\_assigned\_rect\_id and dr\_rect\_id.
3. Constrain dr\_rect\_id[ i ] to match one of the dr\_assigned\_rect\_id for the DR update processing
4. Propose a flag to infer the dr\_assigned\_rect\_id from the rectangle index when applicable.
5. Modify the semantics to clarify the width and height are in the units of luma samples.

Regarding item 2, dr\_assigned\_rect\_id was proposed in JVET-AL0099, and is related to partial updates.

Regarding item 4, byte alignment seems unnecessary.

Decision: Agreed on item 1, item 2, item 3, from item 4 add dr\_assigned\_rect\_id\_present\_flag, item 5.

[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 [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

Chaired by S. Deshpande on 28 June 2025 during 12:45-13:00

Some display rectangles applications may use display rectangles that have the same display aspect ratios as the cropped decoded picture, to zoom into specific regions while using the same display device. For such a use case, the current DR SEI includes signalling of unnecessary syntax elements. It is proposed to update the design to reduce bitrate for this use case.

It was asked if dr\_fill\_method\_present\_flag[ i ] can be set to 0. It can be, so this proposal can save 1 bit per DR.

Decision: Adopt to TuC.

### SEI processing order and processing order nesting SEI messages (2)

Contributions in this area were discussed during 1625–1710 on Saturday 28 June 2025 (chaired by J. Boyce).

[JVET-AM0079](https://jvet-experts.org/doc_end_user/current_document.php?id=15726) AHG9: On the SPO SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

Item 3 discussed further on 28 June 2025. See notes under JVET-AM0321.

This contribution proposes the following changes to the SPO SEI message.

* Add “critical process” in VSEI Table 24 and replace “root processes” with “critical processes” in the TuC accordingly to maintain consistency.
* Add a flag to enable inference of the complexity of the critical processes complexity from that of the processing chain when applicable.
* Modify the constraint of the syntax element po\_sei\_prefix\_flag to avoid potential ambiguity.

Suggest to editors to use the “critical process” naming.

It was noted that the flag may not be needed because it is known by the decoder whether or not the NNPF is in the critical process.

An encoder may avoid double signalling of the complexity parameters with the po\_critical\_complexity\_info\_present\_flag.

No action on this aspect.

For the 3rd aspect, see the notes in JVET-AM0321.

[JVET-AM0155](https://jvet-experts.org/doc_end_user/current_document.php?id=15802) AHG9: On the SPO SEI message complexity signaling [Y. Gao, P. Wu, S. Xie, Y. Bai, C. Huang (ZTE)]

This contribution proposes to signal the the complexity information of one or more key processes, where a key process is defined as the sub-chain including at least one NNPF process associated with a NNPF SEI message with index i*,* and the sum of po\_sei\_importance\_flag[ i ] and po\_sei\_processing\_degree\_flag[ i ] is greater than or equal to 1.

It was suggested that an alternative may be for an encoder to include in a prefix SEI information about complexity of the different chains. This alternative would have some additional bit count because other non-complexity related syntax elements would be included in the prefix, and would require some additional work by the decoder. This approach would not require any change to the existing design.It was suggested that the key process name is confusing and rename to make it more clear that it is NNPF related.

Decision: add to TuC. Editors to consider the renaming “key process”.

### Encoder optimization information SEI message (2)

Contributions in this area were discussed during 1730–1820 on Saturday 28 June 2025 (chaired by J. Boyce).

[JVET-AM0179](https://jvet-experts.org/doc_end_user/current_document.php?id=15826) AHG9: Depth-aware optimization for Encoder optimization information SEI message [G. Teniou, S. Wenger, A. Hinds (Tencent)]

This document proposes a new eoi\_type associated to depth-aware encoding optimization. The corresponding metadata is meant to guide the decoder in selecting appropriate filters, apply background removal or activate specific player adaptations such as local backlight modulation, semantic segmentation…

A potential use case described was when depth was available to the encoder which was used to preserve the foreground. The proponent said that the decoder might use the information about the source of the depth in an immersive use case.

Editors should check the TuC to remove unnecessary yellow highlights.

It was noted that the EOI SEI already has an object based optimization type, and suggested that depth-based processing may be expressed using that eoi type.

It was suggested that the proposed wording of the EoiDepthAwareFlag could be better described and more concise.

It was questioned why the decoder would benefit from the information regarding the depth source type and the depth-aware encoding method used.

It was noted that the depth map presence, bit depth, and resolution are already available elsewhere, and there is no information provided of which layer contains the depth.

It was noted that many of the existing optimizations in EOI were studied in AHG8.

It was noted that the signalled information doesn’t describe what depth range is prioritized, e.g. foreground vs background.

It was suggested that having some more information such as a metric to indicate for example what QP was used to code foreground vs background. Quality and sharpness information may be useful for the rendering side.

It is unclear how a receiving system would make use of the signalled information.

Further study encouraged to make more clear the intended use cases and ensure that the signaled information would be used by the receiving system to address the use cases.

### Digitally signed content messages (4)

Contributions in this area were discussed during 1820–2000 on Saturday 28 June 2025 (chaired by J. Boyce).

[JVET-AM0156](https://jvet-experts.org/doc_end_user/current_document.php?id=15803) AHG9: On Digitally Signing a SEI message [Y. Gao, P. Wu, Y. Bai, S. Xie, C. Huang (ZTE)]

This contribution proposes the following changes related to optimize the functionality of digitally signing a SEI message.

Adding a flag(sei\_digital\_signature\_initialization\_present\_flag) to specify whether the digital signing initialization related syntax elements are present in the SEI message that requires digital signature verification.

It was noted that JVET-AM0118 was decided to be included in VSEI v4.

Signing of SEI messages has been resolved and there is no interest of the group to further study signing of SEI messages.

[JVET-AM0160](https://jvet-experts.org/doc_end_user/current_document.php?id=15807) AHG9: On including SEI messages in the digitally signed content [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

Chaired by S. Deshpande on 27 June 2025 during 15:50-16:20

This contribution proposes modification to the digitally signed content (DSC) SEI messages to enable inclusion of NAL units containing SEI messages in the content signing. Two options are presented and proposed to be included in the VSEI TuC:

Option 1: optionally include SEI NAL units in the authentication process.

Option 2: signal a list of payloadtype of SEI messages that are included for content signing and specify constraints to handle cases of multiple SEI messages in one SEI RBSP, SEI messages in nesting SEI messages (e.g., scalable nesting SEI message, processing order nesting SEI message).

Regarding option 1 it was pointed out that signing all SEI NAL units will have the problem that it will also include DSCV SEI. The discussion was thus focused on Option 2.

It was commented that in Option 2 the specification text regarding how the message digest is created is not provided.

Option 2 was discussed together with JVET-AM0118. See notes under JVET-AM0118.

[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 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

This contribution proposes two modifications on digitally-signed content (DSC) SEI messages for subpicture support in TuC of VSEI. The proposed modifications are as follows:

1, Clarify the conditions for subpicture signing to work.

2. Add a new mode for subpicture support.

The proposed constraints are as follows:

It is constrained that the value of dsci\_xxxx\_mode\_flag\* shall be equal to 0, when one or more of the following conditions is true for any SPS in the current verification period:

– sps\_num\_subpics\_minus1 is equal to 0.

– For any i in the range of 0 to sps\_num\_subpics\_minus1, inclusive, sps\_subpic\_treated\_as\_pic\_flag[ i ] is equal to 0.

It was commented that it may be useful to sign a group of subpictures rather than individual subpictures, and hence the proposed restriction on sps\_subpic\_treated\_as\_pic\_flag[ i ] would be problematic.

A concern was raised about the proposed constraint related to sps\_num\_subpics\_minus1 could be problematic for sub-bitstream extraction because parameters sets are included in the verification substream for pictures but not included in the verification substream for subpictures.

Further study encouraged for proposal 1. It was noted that the TuC has multiple options for DSC and it is encouraged to study tradeoffs between the options so that we can reduce the options retained in the TuC.

Decision: add proposal 2 as an additional option in the TuC.

It is encouraged to bring contributions to the next meeting to converge on a single solution to be included in the TuC.

The editors are encouraged to clearly mark/name the options in the TuC.

An AHG9 mandate should be added to study and reduce options in the TuC.

[JVET-AM0205](https://jvet-experts.org/doc_end_user/current_document.php?id=15852) AHG9: Digitally signed content: use of Picture ID for overlay area exclusion [I. Sodagar, C. Fersch, S. McCarthy (Dolby Labs)]

This contribution proposes additional syntax and semantics for the digitally signed content SEI messages included in JVET-AL2006 (Additional SEI messages for VSEI version 4 (Draft 6)). Specifically, this contribution proposes adding signalling exclusion of subpictures in a video stream for media authentication.

It is proposed to allow signing of a group of subpictures that are a subset of the subpictures.

It was suggested that excluding a region of the picture from the digital signature violates the design intent of the DSC SEI messages because only a portion of the picture is trustworthy.

It is suggested that the display overlay information SEI message in the TuC could potentially be used in combination with the current DSC design to address the overlay use case mentioned in the contribution.

It was suggested that the scalable nesting SEI message can be used for subpicture signing.

It was noted that the subpicture design in the TuC includes signing for all subpictures in the picture, but may be signed separately. This contribution proposes excluding some subpictures of the picture from signing, which is different in terms of trustworthiness.

### Film grain regions characteristics SEI message (2+2)

Contributions in this area were discussed during 0900–1020 on Sunday 29 June 2025 (chaired by J. Boyce).

[JVET-AM0085](https://jvet-experts.org/doc_end_user/current_document.php?id=15732) AHG9/AHG13: On Film Grain Regions Characteristics SEI message [S. Deshpande, J. Samuelsson-Allendes (Sharp)]

This contribution relates to the film grain regions characteristics (FGRC) SEI message, which is included in the Technologies under consideration for future extensions of VSEI. It is proposed to signal width and height of the picture that the parameters in the FGRC SEI message apply to.

It was questioned why there isn’t a presence flag for the width and height parameters.

It was questioned if there should be an ID.

It is noted the JVET-AM0230 is similar but includes a presence flag.

There is support for signaling the width and height in the FGRC SEI.

An alternative was suggested to use the value 0 in the width and height to indicate to use an inferred value instead of a presence flag.

It was questioned if chroma subsampling alignment should be required.

The width and height parameters could be signalled either at the beginning or end of the SEI message.

There was a suggestion to add a note about how to handle the cropping window.

The cropping window issue is relevant for the FGC SEI in VSEI v4. There was concern about backwards compatibility if a change were to be made. Further study encouraged. This topic may be revisited this meeting if requested.

Decision: Add to TuC with the addition of a presence flag with semantics from JVET-AL0339/JVET-AM0230. A revised version of the contribution to be uploaded.

[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 [S. Xie, W. Niu, P. Wu, Y. Gao, C. Huang (ZTE)]

*JVET-AM0124 also relates to software for SEI messages*

The document of “Technologies under consideration for future extensions of VSEI (version 8)” (JVET-AL2032) has been finalized in May 2025. In the document, the Film Grain Regions Characteristics (FGRC) SEI message design has been stabilized and the texts, relating to FGRC SEI message, have been fully integrated. During our FGRC SEI message software implementation process, one typo in the document of JVET-AL2032 has been identified. In this meeting contribution, we propose to correct this identified typo, and we also would like to request a merge process on FGRC SEI message interface software integration.

Decision: Adopt the modified syntax table condition to the TuC.

Regarding the software, there is a TuC branch for adoptions to the TuC. When SEI messages are moved to a WD, they can be moved to the main VTM SW.

The software update is noted, and can be put into a merge request for the TuC branch.

[JVET-AM0168](https://jvet-experts.org/doc_end_user/current_document.php?id=15815) [AHG9/AHG13] Implementation in VTM TuC of the film grain regions characteristics SEI message [F. Urban, E. François, P. de Lagrange (InterDigital), G. Teniou (Tencent)]

*JVET-AM0168 also relates to software for SEI messages*

This contribution provides a status of the VTM software implementation of the Film Grain Regions Characteristics (FGR) SEI message, defined in the VSEI TuC. It states that the single model version (one model per picture), aligned with the TuC specification JVET-AG2032, is available in a branch of the VTM TuC git repository. It also states that the interest of the FGR SEI message, in single model version, has been demonstrated by showcases in JVET-AH0212. It is proposed to include the FGR SEI message in the WD of the next VSEI specification version (v5), when this version is initiated.

It is proposed:

1. to agree to include the FGR SEI message in the first version of the WD VSEI v5 specification when created,
2. to decide which of the single model version (as defined in JVET-AG2032) or the multi-model version (as documented in JVET-AL2032) is to be moved to v5
   * Such a decision should depend on both the availability of the software implementation and the confirmed interest from the group

It is noted that there is not yet a WD for VSEI v5. Decisions on including SEI messages into v5 will wait until that work has started.

[JVET-AM0230](https://jvet-experts.org/doc_end_user/current_document.php?id=15877) AHG9/AHG13: Reference picture resolution for the FGR SEI message [E. François, P. de Lagrange, F. Urban (InterDigital)]

See notes under JVET-AM0085.

### Lens optical correction SEI message (2)

Contributions in this area were discussed during 1020–1145 on Sunday 29 June 2025 (chaired by J. Boyce).

[JVET-AM0101](https://jvet-experts.org/doc_end_user/current_document.php?id=15748) AHG9: On Lens Optical Correction SEI message [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

This contribution proposes the following changes to the LOC SEI message to increase clarity and resolve some typos

1. Add syntax elements for resolution at which LOC is indicated. This is needed to convert the optical center, specified in LOC as a fraction of picture resolution, to a pixel value.
2. Add data length of loc\_focal\_parameters\_present\_flag. Corrects an omission.
3. Add independent focal lengths for horizontal and vertical dimensions to support pixel aspect ratios which are not one or when the focal lengths are estimated and not identical
4. Define the normalization process used in converting pixel coordinates into normalized coordinates used by the distortion models. Camera calibration offsets values by the optical center than scales by the focal length. The defined normalization uses the focal length expressed in units of pixels rather than in mm.
5. Modified semantics of loc\_tca\_model\_id correcting a naming typo.

The semantics refer to pixels, but should probably refer to luma samples.

It was suggested that it could be optional to send one vs two focal length parameters, when the x and y are equal.

JVET-AM0181 was noted as also having some similar information signalled for a different SEI message, and has an option to signal either one or two focal length parameters.

The existing design expressed focal length in millimeters. This contribution proposes using samples and explicitly signals the source picture width and height, and defines a normalization process using those parameters.

There is an error in the normalization process of local\_pic\_width\_in\_luma\_samples.

The proposed focal signaling is in samples which are integers, so can’t have fractional samples. Is that prevision sufficient?

Proponent said that many applications of interest provide focal length data in pixel units.

It is suggested the link between the sensor and processing domain is not clear.

Further discussion requested.

Further discussed 1115 Tuesday 1 July 2025.

Decision (editorial): Add editorial bug fixes from items 2 and 5 from the -v2 of the contribution.

[JVET-AM0102](https://jvet-experts.org/doc_end_user/current_document.php?id=15749) AHG9: Additional models for the LOC SEI message [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

This contribution proposes the following changes to LOC SEI message to support two additional radial distortion models commonly used in automotive and computer vision applications, the Woodscape distortion model and the Brown-Conrady model. These changes are in addition to the changes proposed in the LOC document JVET-AM0101.

1. Use separate flags for presence of focal length and focal center parameters as the Woodscape model does not use focal length while focal center parameters are used in both models.
2. Add syntax and semantics needed for the Woodscape distortion model.
3. Add syntax and semantics needed for the Brown-Conrady distortion model.
4. Modify semantics of loc\_tca\_model\_id to support the new models.

The proponent indicates that the Woodscape and Brown-Conrady models are commonly used in training data for autonomous driving. Today, JSON files are used with still images.

The new models are fisheye, which the other models described in the LOC are not.

There is a fisheye SEI already in HEVC that has quite different syntax element than the proposal. It was targeting a 360 video use case.

It was suggested to rename the Woodscape model.

The proponent says that there is no need to add a normative reference for equations, as they are included in the semantics.

Decision: add to TuC.

### Display overlays information SEI message (3)

Contributions in this area were discussed during 1145–1250 on Sunday 29 June 2025 (chaired by XXX).

[JVET-AM0094](https://jvet-experts.org/doc_end_user/current_document.php?id=15741) AHG9: On the DOI SEI message [Y. He, S. Zhao, L. Kerofsky, M. Karczewicz (Qualcomm)]

This contribution proposes the following changes to the display overlay information SEI message in TuC.

1. Constrain the position and size of overlay picture and the associated alpha component
2. Constrain the resampling display overlay size that the value of (doi\_width\_minus1[ i ] + 1) ÷ (CodedOverlayWidth[ i ]) shall be in the range of 1 ÷ 16 to 16, inclusive; and the value of (doi\_height\_minus1[ i ] + 1) ÷ (CodedOverlayHeight[ i ]) shall be in the range of 1 ÷ 16 to 16, inclusive.
3. Constrain the target picture size that the value of TargetPicWidth shall be greater than 0 and TargetPicWidth % TargetPicSubWidthC shall be equal to 0, and the value of TargetPicHeight shall be greater than 0 and TargetPicHeight % TargetPicSubHeightC shall be equal to 0.
4. Constrain the referencing constituent rectangle to avoid an empty display overlay
5. Propose various editorial changes
6. Propose to use CR index instead of CR ID for alpha component of the i-th display overlay, and change doi\_alpha\_partition\_id[ i ] to doi\_alpha\_partition\_idx[ i ], to be consistent with the texture component of the i-th display overlay doi\_partition\_idx[ i ]

Regarding item 2, unclear that a restriction is needed.

Regarding item 3, the restriction is overly constraining if the composition process is done in 4:4:4.

Agreed item 1, item 4, item 5, item 6.

[JVET-AM0147](https://jvet-experts.org/doc_end_user/current_document.php?id=15794) AHG9: On applying display overlays on display rectangles [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

Chaired by S. Deshpande on 29 June 2025 during 12:00-12:15

Display Overlay Information (DOI) SEI currently supports application to display overlays based on picture, subpicture, constituent rectangles and explicitly signalled partitions. For applications leveraging display rectangles to enable multi-views experience extracting the view from a single cropped decoded picture, application of overlay on display rectangles is complicated. It is proposed to make application of display overlays simple, by supporting display rectangles as a new type of partition for DOI SEI.

Support was expressed for this use case and proposal.

Decision: Adopt to TuC.

[JVET-AM0180](https://jvet-experts.org/doc_end_user/current_document.php?id=15827) AHG9: Overlay purpose indicator for Display overlays information SEI message [G. Teniou, S. Wenger, A. Hinds (Tencent)]

This document proposes to include an indicator of intended semantic purpose of the i-th display overlay. This allows decoders and applications to make informed decisions about how to process, prioritize, or present each overlay.

It is noted that even the background layer is considered a display overlay, and there is no proposed purpose that would be suitable for it.

Is proposed with u(4), but ue(v) may be more suitable as value 0 will require fewer bits.

As proposed, a single purpose is signalled. A bit mask could potentially be used to indicate multiple purposes.

Use cases for overlays include logo, scores, stock tickers.

It was suggested that text could be signalled rather an index to a table of purposes, but that is seen as being harder for a receiver to interpret.

It was suggested to put the purpose earlier in the syntax.

It was suggested that it may be useful to signal importance of a display overlay.

It was suggested that it would be useful to have signalling of an overall purpose of the SEI message.

There were a number of comments related to the DOI design generally rather than the specific proposal in this contribution.

* It was suggested to check the DOI design enables layers to have different frame rates, which is unrelated to this proposal.
* It was asked if there is a limit on the target picture width and height.
* It was suggested that there should maybe be a restriction on colour primaries
* It was suggested that the alpha application process should be more clearly defined

Decision: add to TuC.

### Picture segment information SEI message (2)

Contributions in this area were discussed during 1425–1500 on Sunday 29 June 2025 (chaired by J. Boyce).

[JVET-AM0097](https://jvet-experts.org/doc_end_user/current_document.php?id=15744) AHG9: On the PSI SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

This contribution proposes 2 bug fixes.

1. A correction to the derivation of quantAuxLuma, quantAuxCr and quantAuxCb to avoid negative bit shifts
2. Modify the condition used to signa psi\_type\_id by replacing MinValue with MaxValue

It is agreed that the derivation should be changed. It was suggested to add an if condition which applies to all 3 assignments rather than using the ? : operator.

There may be additional places where a negative shift may occur.

For item 1, it is agreed that there is a bug. A new version of the contribution to be uploaded which uses an if condition, and also fixes other locations where a negative shift may occur.

Agreed for items 1 and 2, with editorial changes as noted above.

[JVET-AM0192](https://jvet-experts.org/doc_end_user/current_document.php?id=15839) AHG9: On picture segmentation SEI message in TuC of VSEI [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

This contribution proposes modifications for picture segmentation information (PSI) SEI message in TuC of VSEI. The proposed modifications are as follows:

1 Change the allowed value range of psi\_shift\_operator.

2 Modify the syntax and semantics to signal shifted values.

3 Make psi\_min\_value and psi\_max\_value optional.

4 Change psi\_values\_cnt to psi\_values\_cnt\_minus1.

5 Ensure uniqueness of type identifier.

Regarding item 2, it was suggested to rename the psi\_min\_value and psi\_max\_value syntax element names to indicate that they are quantized.

Regarding item 5, it was suggested that some use cases may want to assign two values to the same type identifier and such a restriction would be too limiting.

Agreed to item 1, item 2, item 4.

### Danmu information SEI message (3)

Contributions in this area were discussed during 1500–1700 on Sunday 29 June 2025 (chaired by J. Boyce).

[JVET-AM0154](https://jvet-experts.org/doc_end_user/current_document.php?id=15801) AHG9: On danmu information SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

This contribution proposes modifications that are asserted to provide improvements to certain aspects of the Danmu Information (DI) SEI message in technologies under consideration for future extensions of VSEI. The proposed modifications can be summarized as follows:

1. Add signalling about the source (e.g., general user, AI, etc.) and category (e.g., general comment, notice, etc.) of danmu comments.
2. Add an additional display type for danmu comment. The proposed additional display types are: left, right, scrolling from top to bottom, and scrolling from bottom to top.

For item 1, the usefulness of having the source information was questioned.

JVET-AM0182 has a proposal related to item 2.

Some comments were made about the general danmu SEI design:

* The interaction with display orientation should be considered
* It may be useful to provide more specific location

Decision: add item 2 to TuC

[JVET-AM0161](https://jvet-experts.org/doc_end_user/current_document.php?id=15808) AHG9: On display timing in the danmu information SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

This contribution proposes modifications to improve the design and flexibility of display timing in the Danmu Information (DI) SEI message in technologies under consideration for future extensions of VSEI. The proposed modifications can be summarized as follows:

1. Modify the inferred value of the di\_end\_delta\_poc

2. Modify the signaling of duration-related syntax elements to be optional.

3. Clarify the relationship between the display period and the persistence of the DI SEI message

1. On the semantics of di\_start\_delta\_poc[ i ]

2. On the semantics of di\_end\_delta\_poc[ i ]

4. Support clock-based timing information in the DI SEI message

For item 1, see notes in JVET-AM0182.

Regarding item 2, the following note is suggested to not be a note but described as applying when di\_duration\_present\_flag is equal to 0

Note: When di\_duration\_present\_flag is equal to 0, the duration of the danmu is determined by external means not specified in this document.

A concern was suggested that item 2 removes the ability to determine the speed.

Further discussion requested item 2.

Agree on Item 3 option 2.

Item 4 proposes two options to use clock-based timing, which raises the question if the systems layer is a more appropriate place to describe Danmu information.

It is noted that it requires more bits to signal clock-based information than to signal delta POC values. u(32) is proposed.

No action on Item 4.

Further discussed at 1120 on 1 July 2025.

It is unclear how the speed of a Danmu is determined. Different platforms may offer different flexibility. Further study on this aspect.

[JVET-AM0182](https://jvet-experts.org/doc_end_user/current_document.php?id=15829) AHG9: On the Danmu SEI message [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

This proposal introduces the following changes to the Danmu SEI message in the current VSEI Tuc:

1. Propose a syntax element to specify Danmu background colour
2. Propose a syntax element to specify Danmu display type
3. Propose a syntax element to specify Danmu font type
4. Propose a syntax element to specify Danmu transparency level
5. Propose a syntax element to specify Danmu font size.
6. Correct the inference of di\_end\_delta\_poc syntax when it is not present

Item 2 includes display type idc values 5 and 6 that are similar to table entries proposed in JVET-AM0154.

It was suggested that the proposed display type idc value 7 is underspecified as it doesn’t indicate what direction the danmu will move.

For item 2, see notes for JVET-AM0154.

It was questioned if font size would vary for individual messages.

In the proposal, the new syntax elements are signaled for each message, which may be wasteful.

It was suggested that there should be an unspecified font type.

The font\_type\_idc[ i ] syntax element can be used to indicate open file format, but does not provide any syntax to indicate the actual font used (e.g. Times New Roman, Arial, etc.)

Further study on font type is encouraged.

For the signaling of background color, there is no option for transparent background.

In some systems, the viewer can select the transparency value, rather than having the transparency being associated with individual danmu messages.

It was questioned if the transparency is performed in the linear or non-linear domain.

What is the interaction between background color and transparency? Does it apply to the background or to the font or to the composited font + background?

Further study encouraged on items 1, 3, 4, and 5.

JVET-AM0161 Item 1 is related to Item 6.

Agreed to item 6.

### Other (4)

Contributions in this area were discussed during 1720–1820 on Sunday 29 June 2025 (chaired by J. Boyce).

[JVET-AM0086](https://jvet-experts.org/doc_end_user/current_document.php?id=15733) AHG9: On Photosensitive Content Information Signaling [S. Deshpande (Sharp)]

This contribution relates to the Photosensitive Content Information SEI message, which is included in the Technologies under consideration for future extensions of VSEI. It is proposed to optionally signal more detailed information regarding the content with respect to the specific categories/ guidelines specified in ISO 9241-391 and ISO/ IEC 40500:2012 standards in the Photosensitive Content Information SEI message.

Decision: add to TuC.

[JVET-AM0096](https://jvet-experts.org/doc_end_user/current_document.php?id=15743) AHG9: On the QM SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

This contribution proposes the following changes.

1. Modifies the processing order constraint between the QM SEI message and the corresponding post-processing SEI message to align with the SPO processing order constraint.
2. Add sign syntax element to support negative metric gain value.

Agreed to item 1.

For item 2, it was suggested that a new syntax element is not needed, but the sign could be determined based on the qm\_metric\_increasing\_flag[ i ] syntax element. The semantics would need to be updated.

Decision: update the semantics to indicate the sign based on qm\_metric\_increasing\_flag[ i ]. A new version of the contribution to be uploaded to reflect.

[JVET-AM0099](https://jvet-experts.org/doc_end_user/current_document.php?id=15746) AHG9: On the BRI SEI message [Y. He, L. Kerofsky, S. Zhao, M. Karczewicz (Qualcomm)]

This contribution proposes the following changes to the bitdepth range information SEI message in TuC.

1. Constrain the referencing constituent rectangle to avoid empty range
2. Change bri\_num\_ranges\_minus1 to bri\_num\_ranges\_minus2

Agreed to item 1.

Regarding item 2, it was noted that the original design intent was to allow a single range. No action on item 2.

[JVET-AM0108](https://jvet-experts.org/doc_end_user/current_document.php?id=15755) AHG9: On colour mapping information SEI message [J. Samuelsson-Allendes, S. Deshpande (Sharp)]

Colour Mapping Information (CMI) SEI message is a new SEI message included in the Technologies under Consideration (TuC) document for VSEI (JVET-AL2032). The CMI SEI message provides information to enable colour mapping of decoded picture luma samples to RGB samples. In the current version of the CMI SEI message, a piecewise linear mapping function can be signalled. It is asserted that this works well for mapping functions such as “Jet” but it is asserted that this is inefficient for smooth continuous mapping functions such as “Turbo” and “Viridis”. This contribution proposes the following changes to the CMI SEI message:

1. Add an alternative signalling method using fixed point polynomial coefficients
2. Add the possibility of signalling a text string to identify the intended colour mapping function
3. Use minus1 signalling for the anchor point delta when signalled with uniform spacing
4. Make the following minor edits to the existing semantics:
   1. Fix the semantics of cmi\_num\_bits\_minus8 to use correct names of other syntax elements
   2. Add a constraint that anchor points are signalled in increasing order
   3. Remove leftover sentence referring to ColourMap codepoint in CICP
   4. Add missing cmi\_ prefix to colour\_map\_id
   5. Remove hanging "if( a >= 0 )"
   6. Add handling of when decSample <= cmi\_anchor\_point\_x[ 0 ]
   7. Remove the [c] part for cmi\_anchor\_point\_x

Version 2 of the contribution includes a few minor fixes compared to the first version of the contribution.

It was suggested that 32 bits per coefficient may be too high. It was suggested to include a flag to switch between 16 and 32 bits.

It was suggested to rename the SEI message colour map SEI.

Agreed to add item 1.

It was suggested that same common maps could be predefined in a table. This is a possible alternative to item 2.

It was suggested that if a text string was added, a language tag may be added.

It was suggested that the semantic of cmi\_colour\_map\_name should avoid including “function intended to be applied to the decoded picture.”

Agreed to add item 2, item 3, item 4.

## Additional SEI message aspects (6)

Contributions in this area were discussed during 1820–2000 on Sunday 29 June 2025 and 1400–1545 on Monday 30 June 2025 (chaired by J. Boyce).

[JVET-AM0083](https://jvet-experts.org/doc_end_user/current_document.php?id=15730) AHG9: Auxiliary sampling alignment and transformation information SEI [V. Zakharchenko, J. Boyce, D. Rusanovskyy, M. M. Hannuksela (Nokia)]

Chaired by S. Deshpande on 29 June 2025 during xx-xx

An auxiliary sampling alignment information SEI message has been proposed during the 38th JVET meeting that provide the subsampling information parameters aligning an auxiliary picture sample values associated with primary picture and auxiliary picture offset with respect to the primary picture. The SEI message proposed in JVET-AL0224 supports a variety of auxiliary picture types, subsampling types, and grid alignment types associated with the primary picture by providing syntax elements to describe grid and alignment process and describes position of the auxiliary image and a primary picture.

The auxiliary subsampling info SEI message is aimed at use cases where depth or other auxiliary pictures are subsampled to reduce bitrate or sample rate and/or are cropped relative to the primary picture, such as for computer gaming content. This contribution extends the proposed SEI with support of geometric conversion for multiple camera systems.

It was asked if rather than signaling a relation between a primary and auxiliary picture, a design where each picture provides the required information for itself which could be used for mapping between different pictures has been considered.

The design assumes that the image has been already rectified.

The affine transform proposed is in 2D.

A question was asked about precision and use of certain bit widths used for syntax elements.

The slide deck shown (which was slightly updated compared to v3 version) will be uploaded.

It was asked if there are two auxiliary pictures, the relation between them is not necessarily clear from the information signaled.

It was asked if the simple alignment method uses the hor, ver centered flag syntax elements. It is used.

There is support to add this.

Decision: Add to tuC

[JVET-AM0103](https://jvet-experts.org/doc_end_user/current_document.php?id=15750) AHG9: Camera Extrinsic Information SEI message [L. Kerofsky, Y. He, S. Zhao, M. Karczewicz (Qualcomm)]

The camera extrinsic information (CEI) SEI message is proposed to address automotive and robotics applications. Information about the orientation and location of a camera in a world coordinate system is provided. The coordinate system is signalled. Three different methods are in common use to describe orientation in 3D space. The first method (Euler angles), roll, pitch and yaw are used in the sphere rotation SEI message. In a second method, a 3x3 rotation matrix is used to describe camera orientation. The third method to represent a rotation using unit quaternions is commonly used in automotive, robotics, and computer graphics applications. A rotation corresponds to a unit quaternion. In addition to orientation, the translation of a camera is specified by a length three vector in the coordinate system signalled.

The CEI SEI message signals the following elements

1. Coordinate system indicator either ISO 8855 automotive centric system or a camera centric coordinate system.
2. Rotation format indicator specifying either a unit quaternion, a3x3 rotation matrix or three Euler angles.
3. Syntax related to the signaled rotation format.
4. A translation vector of length three indicating the translation relative to the origin of the indicated coordinate system.

Three different rotation methods are proposed to be supported in the SEI. It was questioned if it is necessary to have all three methods.

The table for cei\_coordinate\_system\_idc has an entry “camera centric” that needs further description.

The graphics rendering info SEI in TuC signals parameters for the coordinate system – orientation, and right vs. left handed.

The MAI SEI message uses the upper left corner of the image as the origin.

JVET-AM0181 is related.

It would be beneficial to use common terminology where possible.

[JVET-AM0153](https://jvet-experts.org/doc_end_user/current_document.php?id=15800) AHG9: Loss recovery information SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

This contribution presents a further study on the Loss Recovery Information (LRI) SEI message, which was initially proposed at 38th meeting. This contribution proposes the following modifications:

1. Introducing lri\_target\_delta\_poc to signal the temporal relation between the recovery and target pictures, enabling their temporal separation and enhancing resilience against burst loss.
2. Relocating the LRI SEI message to the recovery picture to ensure signaling robustness.

The redundant information is signaled in a later coded picture, which might limit its usefulness in low latency applications.

Which picture is the SEI message associated with – the normal picture or the recovery picture? Answer: the recovery picture.

It was suggested that the test conditions were cherry picked in the showcase in terms of the loss locations.

It was suggested that loss resiliency is of most interest for low latency applications.

An alternative was suggested that more frequent intra updates could be used, which could have bitrate overhead similar to what the recovery layer would require.

No action.

[JVET-AM0181](https://jvet-experts.org/doc_end_user/current_document.php?id=15828) AHG9: Proposed new SEI message on localization and mapping [G. Teniou, S. Wenger, A. Hinds, J. Ricard (Tencent), Louis Kerofsky, Yong He, Shuai Zhao (Qualcomm) ]

This document proposes a new SEI message designed to support the 3d model creation from 2d video streams. The proposed SEI message conveys essential metadata such as camera intrinsic (focal length, principal point…) parameters and camera extrinsic (position and orientation) parameters. This metadata is crucial for algorithms that create 3d models such as 3d Gaussian Splatting (3DGS) and to assist the rendering process.

The radial distortion aspect of this SEI message is a subset of what is provided in the Lens optical correction (LOC) SEI.

It was questioned why 3dmr\_camera\_id is included in the intrinsic parameters.

The focal length is expressed in pixels, which should be for the capture resolution, which may not be the same as the coded picture.

This condition is problematic for future extensibility: if( 3dmr\_camera\_model ! = 1 )

It was suggested that gaussian splat coding may benefit from having the same information, so there should be some coordination.

Differences between JVET-AM0103 and this contribution:

* presence of the intrinsic parameters in this contribution
* the coordinate system in JVET-AM0103
* depth range
* more models for the extrinsic parameters is JVET-AM0103

There is some support for the providing a solution for this use case.

Further discussion requested after side activity to try to merge JVET-AM0103 and JVET-AM0181.

Further discussed at 1135 on 1 July 2025.

The message is renamed localization and mapping SEI in the -v2 version of the contribution and co-authors were added.

There is a problem with the syntax table in terms of repeating the same syntax element name in multiple locations in the table, including lam\_focal\_length\_x\_times100.

There is still some question if it necessary to include several options (quaternions, Euler angles, matrix coefficients) for the rotation. It is noted that the graphics rendering info SEI contained some of the information. If multiple SEI messages have the same representation, an effort should be made to align the language between them.

The camera centric entry of lam\_coordinate\_system\_idc is not fully described.

A -v3 version of the contribution to be provided that avoids repeating syntax elements in the table, and that fixes the table alignment issues.

Decision: add to the TuC.

[JVET-AM0184](https://jvet-experts.org/doc_end_user/current_document.php?id=15831) AHG9: Picture Reference Degree SEI Message [S. Zhao, Y. He, L. Kerofsky, M. Karczewicz (Qualcomm)]

This document is to propose the picture reference degree SEI message which provides a mechanism for encoders to specify the degree to which the current picture serves as a reference for subsequent pictures in decoding order. The proposed SEI message reflects actual reference usage based on the encoder’s reference picture lists and rate distortion optimization.

The proposed picture reference degree SEI message provides support on the decoder-side’s error concealment and system-level error resilience. By identifying reference-critical frames, it can provide more efficient media transmission feedback in real-time transport system.

It was noted that the reference picture list contains information indicating which picture are reference pictures.

The SEI message describes how often future coded pictures reference the current picture. This would require some type of two pass coding to know this information about future coded pictures.

The proponent suggested that a receiver might use this information to decided whether to send an FIR or retransmission request to the encoder.

The spare picture SEI message in AVC is an alternative approach. Perhaps it could be added to VSEI.

It was suggested that loss resiliency is of most interest for low latency applications.

No action.

[JVET-AM0212](https://jvet-experts.org/doc_end_user/current_document.php?id=15859) AHG9: Gaussian splatting information SEI message [D. Wang, J. Xu, L. Zhang, Y.-K. Wang, S. Jiao (Bytedance)

*JVET-AM0212 also relates to software for SEI messages*

It is asserted that using exitsiting image/video codec to compress 3DGS data has been widely acknownledged. In this contribution, a Gaussian splatting SEI message is specified to support such a usage. A showcase is presented to demonstrate the usage of this Gaussian splatting information SEI message.

In -v2 of this contribution, some typos are fixed and a slide deck is attached.

16 bit data is separated into low and high bit rate ranges for coding using a 10-bit codec.

Each gaussian has 59 attributes, which are coded as image data. The pixel rate may be quite large.

Different scaling ratios may be used for different attributes.

The showcase used low delay config. It split the attribute data in 4 layers.

The quantized attributes are organized into four layers:

* ​​posH​​: 3-channel, resolution (3W)×H
* ​​posL​​: 3-channel, resolution (3W)×H
* ​​multiAtt​​: 11-channel, resolution (6W)×(2H)
* ​​shN​​: 45-channel, resolution (6W)×(8H)

Different QPs were used for the layers.

It was questioned what profile/level would be required to code 3DGS data structure as described by this SEI message.

It was questioned if low level coding tools would be beneficial for this type of video data.

A PSNR vs bitrate graph was shown. The PSNR was calculated on rendered images over 3 viewports, comparing to the rendered images without video compression.questioned if the PSNR saturates at higher bitrates.

A coordination meeting with WG4 and WG7 is planned.

If technical work on this topic were to proceed, a CTC would need to be defined.

Monochrome content is coded using luma, with mid-gray for the chroma samples.

Request that proponents upload a revision of the document that includes the picture dimensions of the 4 layers used in the showcase. The sample rate can also be provided.

It was questioned if MIV could be used for coding the 3DGS data. It is noted that have been proposals to use V3C in MPEG contributions m73255, m73256, m73257, and m73258.

It was asked if subject testing has been done, especially considering potential temporal artifacts.

## SEI Software and showcases (3+1)

Contributions in this area were discussed during 1545–1600 on Monday 30 June 2025 (chaired by XXX).

[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 [S. Xie, W. Niu, P. Wu, Y. Gao, C. Huang (ZTE)]

See notes in section 6.4.7.

[JVET-AM0168](https://jvet-experts.org/doc_end_user/current_document.php?id=15815) [AHG9/AHG13] Implementation in VTM TuC of the film grain regions characteristics SEI message [F. Urban, E. François, P. de Lagrange (InterDigital), G. Teniou (Tencent)]

*JVET-AM0124 and JVET-AM0168 also relate to the film grain regions characteristics SEI message*

See notes in section 6.4.7.

[JVET-AM0162](https://jvet-experts.org/doc_end_user/current_document.php?id=15809) AHG9: Software implementation of attenuation map information metadata in the Green Metadata SEI message [C.-H. Demarty, F. Urban, E. François, F. Aumont (InterDigital)]

*JVET-AM0162 also relates to the study of SEI messages in VVC, HEVC, and AVC*

In the amendment 2 of the 23001-11 Energy-Efficient Media Consumption (Green Metadata) edition 3 specification [1], new attenuation map information metadata for the reduction of the power consumption at the display side is specified. This new metadata is inserted in the Green Metadata SEI message as a new metadata type.

This contribution informs of the updated implementation of the Green Metadata SEI message including this new type in the VTM software.

In version v2, it is noted that the updated implementation has been merged in the master branch of the VTM software.

It is useful to get this update because this messages was not developed in JVET.

[JVET-AM0212](https://jvet-experts.org/doc_end_user/current_document.php?id=15859) AHG9: Gaussian splatting information SEI message D. Wang, J. Xu, L. Zhang, Y.-K. Wang, S. Jiao (Bytedance)

*JVET- AM0212 also relates to identifying potential needs for new SEI messages*

See notes in section 6.5.

## Non-SEI HLS aspects (0)

Kept as template for future use.

# Plenary meetings, joint meetings, BoG reports, and liaison communications (update)

## General

The following topics were discussed in JVET plenary Monday 30 June 1300–1400:

* Status of last meeting’s output documents
  + All WG 5 documents now available in MPEG dms and ISO documents sites
  + JVET-AM2020 still missing
  + Ballot on CD 23090-15 (not uploaded yet to dms): [m73679](https://dms.mpeg.expert/doc_end_user/current_document.php?id=100280&id_meeting=203) – Iole Moccagatta will review when available and report back (revisit).
  + Ballot on DIS 23090-16: Only editorial comments – submit DIS as final standard. Next edition including new SEI messages could be started as CD in October or at a later meeting. DoCR to accept ISO editor comments, plus recommendation to proceed to publication.
* Liaison communication – none so far
* Scheduling for the remaining week (further detail on scheduling is recorded in section 2.12)
  + CfE preparation
  + Joint review of 4.x topics
* Joint meetings
  + Monday 1700–1800 with AG 5: CfE dry-run (see notes under JVET-AM0323)
  + Tuesday 1300-1400: AG 5 & WG 4: Multi-layer test (includes LCEVC, SHVC, VVC)
  + Wednesday 1615–1645 with WG 4, WG 7: Gaussian splat coding
  + Thursday 1400–1600 with VCEG, WG 2, AG 5: Next generation video coding, CfE
* Standards progression and outputs
  + DoCR preparation 14496-10 CDAM1 (Karsten), 23090-15 3e CD (Iole), 23090-16 2e DIS (Frank)
  + White paper VSEI/VVC – to be presented in AG 3 meeting Thursday afternoon
* Review status from tracks and discussion on potential open issues

### Review of documents at plenary level

List of adoptions from HLS was presented Wednesday 2 July 1150 by Jill Boyce:

**Summary of HLS adoptions**

VSEI v4:

* Mostly small editorial improvements, additions of constraints, clarifications, and bug fixes
* New feature: DSC SEIs support for signing of SEI messages
* More significant bug fixes: GFV chroma key

HEVC:

* Editorial improvements and bug fixes

TuC:

* New features, editorial improvements, additions of constraints, clarifications, and bug fixes of existing SEI messages in TuC
* Extensions to existing SEI messages in VSEI v3
* New SEI messages:
  + Auxiliary sampling alignment and transformation information SEI
  + Localization and mapping SEI

**Adoptions List**

**VSEI v4**

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) HG9: Common specification text for GFV SEI message

**HEVC**

* [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-AM0048](https://jvet-experts.org/doc_end_user/current_document.php?id=15695) AHG9/AHG2: Miscellaneous changes for HEVC
* [JVET-AM0324](https://jvet-experts.org/doc_end_user/current_document.php?id=15992) Correction to the Alpha Channel Information SEI message processing order

**TuC**

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 Signaling

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 signaling

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

At a high level, the list of reommendations for adoptions was agreed by the JVET plenary. For further details about the precise integration in editing the documents, refer to the notes in section 6. It was commented that for some of the SEI messages in TuC, more clarification about use cases or demonstrating showcases and duplication with existing SEI concepts may be desirable.

## MPEG information sharing meetings

Information sharing sessions with other WGs and AGs of the MPEG community were held on Monday 31 March 0500–0800, Wednesday 2 April 0500–0600, and Friday 4 April 2100–2300.

The status and plans for the work in the MPEG WGs and AGs was reviewed at these information sharing sessions.

## Joint meetings

### Joint sessions 1615-1645 Thursday 2 July on Gaussian splat coding: MPEG WG 4 / Video, MPEG WG 5 / JVET, MPEG WG 7 / 3D Graphics and Haptics

chaired by JRO, LY, MP

notes taken by JRO

SEI message had been reviewed in HLS. There were open questions about the amount of data and amount of syntax elements, and there was no expertise to assess technically what the benefit would be in terms of compression, or how complicated the reconstruction of the 3D data.

The assessment would require experimentation, which should not be done independent from the testing conditions used in WG 4/7 JEEs, and also compared against methods investigated there.

It was further commented that, if SEI messages would be needed in the context of using a video compression standard in the context of Gaussian splat coding, JVET would be glad to help the other WGs to reserve a certain number space for that purpose, such that there would be no confusion with other SEI messages developed for VSEI.

On the other hand, it was questioned if an SEI message is the best way of transporting information that is necessary for correct interpretation of a decoder output. SEI messages are also often dropped by decoders.

A presentation of JVET-AM0212 was given.

It was commented that very similar methods of mapping GS into a video are investigated in the JEE. What would the benefit be of defining it as SEI message. It was answered that this would allow usage of existing standards, and fast time to market.

It was suggested that the proponents of JVET-AM0212 should participate in the JEE, and if the method is assessed to be appropriate in terms of performance, systems concept and implementability, JVET would be happy to help in defining it as fast as possible.

### Joint session 1400-1600 Thursday 3 July on next generation video standardization: MPEG WG 2 / Requirements, MPEG WG 5 / JVET and VCEG (ITU-T Q6/21)

(chaired by …)

(notes taken by …)

## BoGs (2)

[JVET-AM0333](https://jvet-experts.org/doc_end_user/current_document.php?id=16001) BoG report on Tool Complexity Analysis [X. Li, E. Alshina, F. Bossen]

This document contains the report of the BoG on tool complexity analysis. The BoG met on 6/30 Tuesday 2:00pm –3:35pm KST.

Mandates

To further discuss criteria and instruments to analyse complexity of tools, based on the ideas in JVET-AM0042, JVET-AM0044, JVET-AM0125, JVET-AM0227, and JVET-AM0295. In this context, it should also considered what aspects would need improvement compared to previous CFP documents.

Recommendations

* Test both Valgrind and J0090 methods with up to 5 bitstreams (VTM LDB vs VTM LDP) and check the consistency of the results. Different compilers should be used in Valgrind tests. Four volunteers identified: Samsung, Google, Huawei, and Tencent.\
* Regarding runtime/RDO, no action is recommended for now. The RDO information may be further studied/considered after CfP.
* The proponent of JVET-AM0227 will further study it in the context of AHG7 bitstreams

Discussions

Agenda

* Proposals
  + JVET-AM0042: Report of AHG7 conference call on Assessment Perspectives of Codec/Coding Tools
  + JVET-AM0044: AHG7: Summary on the Tool Analysis in Earlier Proposals/Reports
  + JVET-AM0125: AHG17: Analysis on encoding time and mode cost test for draft CfE sequences
  + JVET-AM0227: AhG7: On bin to bit ratio in ECM
  + JVET-AM0295: [AHG7] External memory bandwidth evaluation
  + JVET-AM0194: To be presented
* Tool analysis
  + Memory bandwidth
  + Runtime/RDO
  + Throughput analysis

BoGDiscussions

Memorybandwidth

It was commented it would be great to test both (valgrind and J0090) and check the difference, and crosscheck.

It was commented that valgrind can provide results for different platforms, such as for PC/arm/power PC.

It was commented that valgrind may show different results with different compilers

Note: The commercial tool is for the video codec chip design

Volunteers to test valgrind (up to 5 bitstreams by VTM and ECM): Samsung, Google, Huawei, Tencent. Agreed

List of streams to be tested, version of valgrind to be decided within the scope of AhG7.

It was commented that valgrind settings could be found JVET-AM0295/JVET-G0061

It was commented that J0090 may not capture all the tools (most of new tools) in ECM.

It was commented that the test may be made on VTM only, VTM CTC as anchor and VTM with some tools disabled (such as LDB vs LDP) as test. Agreed

Runtime**/**RDO

It was commented that some processing may not be captured by the trace.

It was asked how to use this information to evaluate the complexity.

It was commented that RD number does give useful information, but is not a full picture of the encoding complexity.

It was commented the ratio between encoding and decoding runtime may be misleading due to different optimizations.

It was commented the term RDO may also be misleading, as full RDO and partial RDO are different.

It was commented the RDO number may not be easy to define for template matching search process.

It was commented that whether transform/inv-transform is considered in full/partial RDO is not clear.

It was commented that loop filter RDO is different from block mode RDO.

It was commented that the RDO information is useful for test model.

Recommendation: No action for now. The RDO information may be further studied/considered after CfP.

CABACenginethroughputanalysis

Two candidates: CE5 test bed (<https://vcgit.hhi.fraunhofer.de/JVET-L-CE5/VVCSoftware_VTM.git>, branch CE5.2) and JVET-AM0227

It was commented that it might be too early to study this as we don’t know what kind of entropy engine we will have.

It was commented that JVET-AM0227 was asked to clarify whether the numbers are all from residuals or other syntaxes. The proponent of JVET-AM0227 would like to further study this, e.g., with some of AHG7 group off test bitstreams.

CE5 test bed may not need to be excise for now.

Recommendation: The proponent of JVET-AM0227 will further study this in the context of AHG7 bitstreams

JVET**-**AM0194

This document cites several prior contributions regarding a need for complexity reduction and proposes specific actions JVET could undertake to aid in evaluation of parallelization potential on a per-tool basis for both existing and new tools, in a next-generation video codec.

It was asked for whether any action recommended. The proponent expressed that this was for information.

It was commented that specific proposals are welcome.

It was commented CPU+GPU solution is interesting. But how to measure it is not very clear. Can CPU runtime and GPU runtime be added directly? Maybe yes.

It was commented that some chips provide unified memory to avoid transfer latency.

It was commented it may be interesting to measure the difference between two rate-distortion-complexity surface to get an overall number.

It was commented that some small difference in one dimension may not be captured by the surface method.

The recommendations of the BoG above were agreed in JVET plenary Wed. 2 July morning.

No further discussion had been conducted in the BoG on detailed criteria of tool analysis. It was suggested to perform such study in the next AHG period, by picking one or two tools from each group of the ECM study that appear to be critical in complexity aspects such as memory bandwidth, number of operations, local dependency (e.g. processing cycles needed before the next block can be processed), etc., and bring such analysis as input, such that further discussion can be conducted on this basis.

[JVET-AM0336](https://jvet-experts.org/doc_end_user/current_document.php?id=16004) Report of BoG on draft CfE refinements [F. Bossen]

The BoG on draft CfE refinements met on July 1, 2025 from 1600 until approximately 1915 KST. This report includes notes from the meeting as well as recommendations. A revised CfE document that includes recommended changes is attached.

1. **Introduction**

Mandates of the BoG are:

* Refine CfE in terms of which data to collect for the cases of improved compression (based on JVET-AM0049) and constrained runtime (based on 125, 200, 225, 237)
* Discuss how to combine and evaluate runtime data, and how to describe that in the CfE
* Discuss HDR metrics (related to first point)
* Discuss whether it makes sense to include ECM in reduced runtime test (considering information from 125, 269, 332)
* Update timelines in CfE

Recommendations of the BoG are marked as “Recommendation:” below.

1. **Presentations**

***JVET-AM0125: AHG17: Analysis on encoding time and mode cost test for draft CfE sequences, [Y. Tokumo](mailto:tokumo.yasuaki@mail.sharp), [S. Hong](mailto:hong.sujun@mail.sharp), [T. Ikai (Sharp)](mailto:ikai.tomohiro@mail.sharp) (Appendix)***

Data in the appendix of JVET-AM0125 shows encoder run time ratios between ECM and VTM. Ratios at the lowest rate point significantly higher.

The authors then proposed to report two summary run times:

* Geomean of all rates
* Geomean of R4 rates

Concern was expressed about using only R4: uses only 25% of data. A summary should include all data. See further discussion on run time aggregation in Section 3.

***JVET-AM0287: [AHG17] On HDR coding and metrics, [D. Rusanovskyy (Nokia)](mailto:dmytro.rusanovskyy@nokia.com), [E. François (InterDigital)](mailto:edouard.francois@interdigital.com)***

* Contribution reviews JVET-AL2026 (Draft CfE) text’s aspects related to coding efficiency evaluation for HDR content.
  + [1] Draft Joint Call for Evidence on video compression with capability beyond VVC, JVET-AL2026.
  + [2] VTM and HM common test conditions and evaluation procedures for HDR/WCG video, JVET-AC2021
* Contributions proposes:
  + Change HDR tests categorization from resolution (4K/8K) to transfer characteristics (BT.2100 PQ/HLG)
  + Incorporate in CfE clarification text on compile and run-time settings for deriving of HDR metrics.
  + Evaluate need for PSNRL100/DeltaE100 HDR metrics reporting in the view of observed redundancy in additional to the weighted PSNR.

Document in CfE document the HDR metrics used for CfE

Item 1

It is proposed to change HRC/HRU categories to group sequences by transfer function (HLG/PQ).

Some concern was expressed about doing this, as it seems unnecessary. It was suggested that results could be summarized by transfer function with the current naming scheme.

Recommendation: when evaluating results of CfE, generate summaries by TF in addition to summary by category but keep current categories and naming.

Item 2

It is proposed to add details on how to compute HDR metrics in the CfE document as Annexes A, B, and C.

It was commented that including this information is useful.

The proposed Annex B describes metrics.

Do not include metric description as such information is not necessary to submit a response. Reference to another document would be preferred. Agreed. No action necessary.

The proposed Annexes A and C describe HDRtools usage for computing HDR metrics. Annex A describes usage of HDRtools in VTM/ECM and annex C describes usage as a standalone tool.

It was commented that HDRtools versions in Annexes A and C should be aligned to 0.23.

Recommendation: include annex C (describing use of HDRtools as a standalone tool) in CfE document.

Recommendation: describe usage of HDRtools with ECM in appropriate document (e.g., update to AI2017).

Item 3

It is suggested to consider removal of PSNR L100 and DE100 metrics in CfE data submissions as their correlation to wPSNR is high.

Some support to remove these metrics. It was noted that they could always be computed on submitted raw video files (decoded bitstreams) if the need arises.

Recommendation: remove PSNR L100 and DE100 and keep wPSNR for HDR sequences.

Item 4

It is proposed to include per sequence configuration files for CfE sequences in VTM/ECM software packages.

Recommendation: include per sequence configuration files for CfE sequences in VTM and ECM repositories. Each configuration file to include HDR-related parameters as appropriate.

E. François volunteered to submit merge requests.

Recommendation: add note about these configuration files in CfE document, and mention inclusion of HDR parameters in sequence configurations.

***JVET-AM0332: AHG17/AHG7 Test Results of AHG7 Group1-5 off with Smaller Partition Depth, [X. Li (Google)](mailto:xlxiangli@google.com)***

In this contribution, the test results of AHG7 group1-5 off with smaller partition depth are reported.

CTC conditions were applied, and ECM version 17.0 was. This was not yet tested under CfE conditions.

Recommendation: include configuration as additional reduced runtime point for ECM in CfE document.

Samsung volunteered to generate bitstreams.

It was remarked that there may be ECM configurations that achieve a better trade-off between encoder run time and BD-rate savings. Groups 1-5 were not defined with encoder run time in mind.



1. **Further discussions**

Encoder/decoder run times should be measured on a CPU (single thread). Responses may include additional information, e.g., run time on GPU, multithreaded, etc.

Recommendation: Add Annex to CfE document with CSV format for submitting data (see below).

Recommendation: remove NNVC point from CfE in section 3.

Recommendation: define aggregation of run times as in updated CfE document

Recommendation: approve timeline and miscellaneous modifications in attached updated CfE document

1. **Data submission format**

Data should be submitted in CSV format.

|  |  |
| --- | --- |
| Column name | Description |
| Sequence | Sequence name, e.g., SRU1 |
| Rate point | Rate point, e.g., R1 |
| Bitrate | Bitrate in kbps |
| PSNR Y | “JVET” PSNR. Refer to TR. Add to Annex C. |
| PSNR U |  |
| PSNR V |  |
| SSIM Y | MS-SSIM. Add to Annex C. |
| SSIM U |  |
| SSIM V |  |
| WPSNR Y | Weighted PSNR as described in Annex C. |
| WPSNR U |  |
| WPSNR V |  |
| EncT | Encoder run time in seconds as measured on CPU in single thread mode |
| DecT | Decoder run time in seconds as measured on CPU in single thread mode |
| relative EncT | Encoder time relative to anchor in % (e.g., 100% if runtime is equal to anchor) |
| relative DecT | Decoder time relative to anchor in % |
| peak Enc Memory | Peak memory use in Kb. Add note with example from VTM/ECM |
| peak Dec Memory | Peak memory use in Kb |

The first line in the CSV file should contain the name of the columns. For example:

Sequence;Rate point;bitrate;PSNR Y;PSNR U;PSNR V;SSIM Y;SSIM U;SSIM V;WPSNR Y;WPSNR U;WPSNR V;EncT;DecT;relative EncT;relative DecT;peak Enc Memory;peak Dec Memory

From discussion in JVET plenary Wednesday 2 July morning:

* Revisit: The CfE should solicit contributions to as many content categories as possible, but not necessary for all.
* It was reported that HDRtools requires 10 bit, and also VTM/ECM converts 8 bit internally to 10 bit, and ideally a proponents’ decoder would output 10 bit yuv for visual testing – another solution would be to provide 8 bit sequences also as 10 bit versions – would need update of the md5 sums, and might also have some implications on computation of PSNR. It was later confirmed by the maintainer of HDRtools that indeed HDRtools is able to handle 8 bit input, but requires same bit depth of the items compared, such that it is necessary to convert a 10-bit output of a decoder to 8 bit output. The best solution would be that HDRtools is modified such that it is able to compare an 8-bit input against a 10-bit decoder output and computes metrics exactly the same way as VTM/ECM. This way, it is irrelevant which bit depth a proponent’s decoder outputs, if it is 8 bit it is not a big deal converting it to 10 bit for viewing. Mathias, Frank and Alexis to coordinate the update of HDRtools. Revisit: CfE document needs modification that 10 bit output is preferable instead of saying it shall be same as input, plus update of HDRtools annex (if needed).
* Clarify DCR or ACR (see note under JVET-AM0323)
* All recommendations from the BoG report are agreed
* Further review/refinement of the CfE draft later

## 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 17.0 software (including all adoptions) was planned to be available 3 weeks after the meeting (25 April).

The NNVC 13.0 codebase software was planned to be available 3 weeks after the meeting (25 April).

VTM23.9 software will be released 1 week after the meeting. Additional versions will be released as appropriate (e.g. for integration and updates of SEI messages included in JVET-AL2006 by the current meeting).

Updates on top of HM18.0 and JM19.1 software will be released as appropriate (e.g., integration and updates of SEI messages included in JVET-AL1006 and JVET-AL1017 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-AM2023.

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-AM2024.

Initial versions of these documents were presented and approved.

## Drafting of specification text, encoder algorithm descriptions, and software

The following agreement has been established: the editorial team has the discretion to not integrate recorded adoptions for which the available text is grossly inadequate (and cannot be fixed with a reasonable degree of effort), if such a situation hypothetically arises. In such an event, the text would record the intent expressed by the committee without including a full integration of the available inadequate text.

## Plans for improved efficiency and contribution consideration

The group considered it important to have the full design of proposals documented to enable proper study.

Adoptions need to be based on properly drafted working draft text (on normative elements) and HM/VTM encoder algorithm descriptions – relative to the existing drafts. Proposal contributions should also provide a software implementation (or at least such software should be made available for study and testing by other participants at the meeting, and software must be made available to cross-checkers in EEs).

Suggestions for future meetings included the following generally-supported principles:

* Normative contributions (relating to changes in bitstream/decoder) shall include draft specification text
* Proposals shall contain all details relevant for understanding and be self-contained. In cases where the document is a follow-up of a previous contribution, the overall concept and the novelties should be highlighted at minimum
* Coding tool and encoder optimization proposals shall contain Excel sheets that allow assessment on a per-sequence basis
* Algorithm description text is strongly encouraged for non-normative contributions that are intended to be included in model description documents (VTM, ECM, etc.), and that is required for inclusion in TR drafts.
* Early upload deadline to enable substantial study prior to the meeting
* Using a clock timer to ensure efficient proposal presentations (5 min) and discussions (not exercised currently)

As general guidance, it was suggested to avoid usage of company names in document titles, software modules etc., and not to describe a technology by using a company name.

## General issues for experiments

It was emphasized that those rules which had been set up or refined during the 12th JVET meeting should be observed. In particular, for some CEs of some previous meetings, results were available late, and some changes in the experimental setup had not been sufficiently discussed on the JVET reflector.

Group coordinated experiments have been planned as follows:

* “Core experiments” (CEs) are the coordinated experiments on coding tools which are deemed to be interesting but require more investigation and could potentially become part of a draft standard by the next meeting or in the near future.
* “Exploration experiments” (EEs) are also coordinated experiments. These are conducted on technology which is not foreseen to become part of a draft standard in the near future. The investigating methodology for assessment of such technology can also be an important part of an EE. (Further general rules for EEs, as far as deviating from the CE rules below, should be discussed in a future meeting. For the current meeting, procedures as described in the EE description document are deemed to be sufficient.)
* A CE is a test of a specific fully described technology in a specific agreed way. It is not a forum for thinking of new ideas (like an AHG). The CE coordinators are responsible for making sure that the CE description is complete and correct and has adequate detail. Reflector discussions about CE description clarity and other aspects of CE plans are encouraged.
* A description of each experiment is to be approved at the meeting at which the experiment plan is established. This should include the issues that were raised by other experts when the tool was presented, e.g., interference with other tools, contribution of different elements that are part of a package, etc. The experiment description document should provide the names of individual people, not just company names.
* Software for tools investigated in a CE will be provided in one or more separate branches of the software repository. Each CE will have a “fork” of the software, and within the CE there may be multiple branches established by the CE coordinator. The software coordinator will help coordinate the creation of these forks and branches and their naming. All JVET members will have read access to the CE software branches (using shared read-only credentials as described below).
* During the experiment, revisions of the experiment plans can be made, but not substantial changes to the proposed technology. Withdrawing parts of experiments that were intended to show the individual benefits of a tool or parts of a tool is strongly discouraged. Combination tests may not be considered in such cases. Any changes made to individual tools in a combination shall be documented.
* The CE description must match the CE testing that is done. The CE description needs to be revised if there has been some change of plans.
* The CE summary report must describe any changes that were made in the process of finalizing the CE.
* By the next meeting it is expected that at least one independent cross-checker will report a detailed analysis of each proposed feature that has been tested and confirm that the implementation is correct. Commentary on the potential benefits and disadvantages of the proposed technology in cross-checking reports is highly encouraged. Having multiple cross-checking reports is also highly encouraged (especially if the cross-checking involves more than confirmation of correct test results). The reports of cross-checking activities may (and generally should) be integrated into the CE report rather than submitted as separate documents.
* It is mandatory to report encoder optimizations made for the benefit of a tool, and if an equivalent optimization could be applied on the anchor, a comparison against the improved anchor shall be provided.
* A new proposal can be included in a CE based on group decision, regardless if an independent party has already performed a cross-check in the meeting when it was first proposed.

It is possible to define sub-experiments within particular CEs, for example designated as CEX.a, CEX.b, etc., where X is the basic CE number.

As a general rule, it was agreed that each CE should be run under the same testing conditions using one software codebase, which should be based on the group test model software codebase. An experiment is not to be established as a CE unless there is access given to the participants in (any part of) the CE to the software used to perform the experiments.

The general agreed common conditions for single-layer coding efficiency experiments for SDR video are described in the prior output document JVET-T2010.

Experiment descriptions should be written in a way such that it is understood as a JVET output document (written from an objective “third party perspective”, not a proponent perspective – e.g., not referring to methods as “improved”, “optimized”, “enhanced”, etc.). The experiment descriptions should generally not express opinions or suggest conclusions – rather, they should just describe what technology will be tested, how it will be tested, who will participate, etc. Responsibilities for contributions to CE work should identify individuals in addition to company names.

CE descriptions contain a basic description of the technology under test, but should not contain excessively verbose descriptions of a technology (at least not unless the technology is not adequately documented elsewhere). Instead, the CE descriptions should refer to the relevant proposal contributions for any necessary further detail. However, the complete detail of what technology will be tested must be available – either in the CE description itself or in documents that are referenced in the CE description that are also available in the JVET document archive.

Any technology must have at least one cross-check partner to establish a CE – a single proponent is not enough. It is highly desirable have more than just one proponent and one cross-checker.

The CE development workflow 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

The ad hoc groups established to progress work on particular subject areas until the next meeting are described in the table below. The discussion list for all of these ad hoc groups was agreed to be the main JVET reflector ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de)).

Chairs of AHGs were asked to send draft mandates to JRO before XXXX on X 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 XXday X July 2025 at XXXX–XXXX.

|  |  |  |
| --- | --- | --- |
| **Title and Email Reflector** | **Chairs** | **Mtg** |
| **Project Management (AHG1)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Coordinate overall JVET interim efforts. * Supervise AHG and experiment studies. * Report on project status to JVET reflector. * Provide a report to the next meeting on project coordination status. * Supervise processing and delivery of output documents | J.-R. Ohm (chair), G. J. Sullivan (vice‑chair) | N |
| **Draft text and test model algorithm description editing (AHG2)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Produce and finalize draft text outputs of the meeting (JVET-AL1006, JVET-AL1017, JVET-AL2005 and JVET-AL2006). * Collect reports of errata for the VVC, VSEI, HEVC, AVC, CICP, and the published related technical reports and produce the JVET-AL1004 errata output collection. * Coordinate with the test model software development AhG to address issues relating to mismatches between software and text. * Collect and consider errata reports on the texts. | B. Bross, C. Rosewarne (co-chairs), F. Bossen, A. Browne, S. Kim, S. Liu, J.‑R. Ohm, G. J. Sullivan, A. Tourapis, Y.-K. Wang, Y. Ye (vice‑chairs) | N |
| **Test model software development (AHG3)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Coordinate development of test models (VTM, HM, SCM, SHM, HTM, MFC, MFCD, JM, JSVM, JMVM, 3DV-ATM, 360Lib, and HDRTools) software and associated configuration files. * Produce documentation of software usage for distribution with the software. * Enable software support for recently standardized additional SEI messages (for both VTM and HM), and SEI messages in TuC (the latter in a separate branch of VTM). * Discuss and make recommendations on the software development process. * Perform comparative tests of test model behaviour using common test conditions, including HDR, high bit depth and high bit rate. * Suggest configuration files for additional testing of tools. * Investigate how to minimize the number of separate codebases maintained for group reference software. * Coordinate with AHG on Draft text and test model algorithm description editing (AHG2) to identify any mismatches between software and text, and make further updates and cleanups to the software as appropriate. * Prepare drafts of merged and updated CTC documents for HM and VTM, as applicable. | F. Bossen, X. Li, K. Sühring (co-chairs), E. François, Y. He, K. Sharman, V. Seregin, A. Tourapis (vice‑chairs) | N |
| **Test material and visual assessment (AHG4)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Consider plans for additional verification testing of VVC capability, particularly target conducting tests for VVC multi-layer features, and update the test plan accordingly. * Maintain the video sequence test material database for testing the VVC and HEVC standards and potential future extensions, as well as exploration activities. * Study coding performance and characteristics of available and proposed video test material. * Identify and recommend appropriate test material for testing the VVC standard and potential future extensions, as well as exploration activities. * Identify and characterize missing types of video material, solicit contributions, collect, and make available a variety of video sequence test material, in coordination with other AHGs, as appropriate. * Maintain and update the directory structure for the test sequence repository, as necessary. * Collect information about test sequences that have been made available by other organizations. * Prepare and conduct expert viewing for purposes of subjective quality evaluation. * Coordinate with AG 5 in studying and developing further methods of subjective quality evaluation, e.g. based on crowd sourcing, 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) on multi-layer testing |
| **Conformance testing (AHG5)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study CD of VVC conformance 3rd edition and suggest improvements to JVET-AK2028, as appropriate. * Study the draft conformance bitstreams for new HEVC multiview profiles in JVET-AI1008, and further develop related conformance bitstreams. * Coordinate with AHG3 on implementation of the new HEVC multiview profiles. * Study the requirements of VVC, HEVC, and AVC conformance testing to ensure interoperability. * Maintain and update the conformance bitstream database, and contribute to report problems, and suggest actions to resolve these. * Study additional testing methodologies to fulfil the needs for VVC conformance testing. | I. Moccagatta (chair), F. Bossen, T. Ikai, S. Iwamura, H.-J. Jhu, K. Kawamura, P. de Lagrange, S. Paluri, K. Sühring, Y. Yu (vice‑chairs) | N |
| **ECM software development (AHG6)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Coordinate development of the ECM software and associated configuration files. * Produce documentation of software usage for distribution with the software. * Prepare and deliver ECM-17.0 software version (and potential updates), corresponding VTM anchor, and the reference configuration encodings according to the ECM common test conditions. * Investigate encoder speedup and other software optimization such as reduction of memory consumption. * Coordinate with ECM algorithm description editors to identify any mismatches between software and text, make further updates and cleanups to the software as appropriate. | V. Seregin (chair), J. Chen, R. Chernyak, F. Le Léannec, K. Zhang (vice-chairs) | N |
| **ECM tool assessment (AHG7)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Investigate methodology of tool assessment, such as the aspects of memory access and bandwidth, number of maximum processing cycles, block decoding dependencies, number of context coded bins, pipeline and parallelization. * Coordinate with AHG6 on resolving tool-off test related software issues (missing tool controls and software bugs). * Prepare configuration files and generate bitstreams and results of tool-on/tool-off testing. * Prepare reporting of tool assessment results. * Coordinate with AHG17 to collect simulation results on non-CTC sequences (e.g., those used in previous verification tests), and identify a set of non-CTC sequences that would be appropriate for additional testing. * Develop methodology of more reliable runtime measurement. | X. Li (chair), L.-F. Chen, Z. Deng, J. Gan, E. François, R. Ishimoto, H.-J. Jhu, J. Lainema, X. Li, J. Pardo, A. Stein, H. Wang (vice‑chairs) | Y (tel., 2 weeks notice) |
| **Optimization of encoders and receiving systems for machine analysis of coded video content (AHG8)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Solicit and study non-normative encoder and receiving systems technologies that enhance performance of machine analysis tasks on coded video content. * Identify and collect test materials that are suitable to be used by JVET for machine analysis tasks. * Discuss improvements on the evaluation framework, including evaluation procedures and methodologies. * Coordinate software development and experiments on optimization of encoders and receiving systems for machine analysis of coded video content, including combinations of proposed technologies. * Maintain the software implementation examples and develop tool combination examples in the repository, including sufficient documentation in terms of operation and performance. * Evaluate proposed technologies and their suitability for machine analysis applications. * Propose improvements to JVET-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-AL1006, JVET-AL1017, JVET-AL2005, and JVET-AL2006, identify any issues and propose solutions as appropriate. * Study JVET-AL2032, 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 an interface to NNVC software branch allowing to perform evaluation tests for end-to-end optimized AI coded reference pictures. | E. Alshina, F. Galpin, S. Liu, A. Segall (co-chairs), J. Li, Y. Li, R.-L. Liao, M. Santamaria, T. Shao, M. Wien, P. Wu (vice chairs) | Y (tel., 2 weeks notice), first on April 25, second on May 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 ECM17 algorithm description JVET-AL2025. * 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-AL2024 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-13.0 software version (and potential updates), and provide reference configuration encodings according to the NNVC common test conditions as described in JVET-AJ2016. Study the impact of the addition of new dataset on the already integrated models. * Investigate and bridge coding performance of NNVC VTM anchor compared to the latest VTM version and/or VTM anchor in ECM software. * Investigate combinations of tools included in the NNVC software, prepare and release anchor data for all configurations of the software, including anchors for High and Low Operation Point (HOP/LOP) and Very Low Operation Point (VLOP) configurations. * Study and maintain the SADL (Small Adhoc Deep-Learning Library). Identify gaps in functionality and develop improvements as needed. * Coordinate with NNVC algorithm and software description (JVET-AL2019) 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 April 25, second on May 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-AL2006. | 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))   * Finalize the draft CfE JVET-AL2026. * Prepare encoded bitstreams for the test sequences and encoder configurations defined in the draft CfE . * Make preparations for subjective viewing in dry-run of CfE at the next meeting. | J.-R. Ohm, M. Wien (co-chairs), M. Abdoli, E. Alshina, V. Baroncini, J. Chen, R. Chernyak, Z. Deng, P. de Lagrange, L. Li, D. Rusanovskyy (vice chairs) | Y   * tel., 2 weeks notice, first on April 15, 14 UTC |
| **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 XXX) in order to make it easy to reference.

# Output documents (update)

The following documents were agreed to be produced or endorsed as outputs of the meeting. Names recorded below indicate the editors responsible for the document production. Where applicable, dates of planned finalization and corresponding parent-body document numbers are also noted.

It was reminded that in cases where the JVET document is also made available as a WG 5 output document, a separate version under the WG 5 document header should be generated. This version should be sent to GJS and JRO for upload.

The list of JVET ad hoc groups was also issued as a WG 5 output document WG 5 N XXX, as noted in section 9.

[JVET-AM1000](https://jvet-experts.org/doc_end_user/current_document.php?id=15673) Meeting Report of the 39th JVET Meeting [J.-R. Ohm] [WG 5 N 344] (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.

New? [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] (2025-05-31, near next meeting)

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=14261) Future CICP extensions (draft 1) [E. Thomas, A. Tourapis]

Including updates from JVET-AM0089 and JVET-AM0335. Clarify about editors, and clarify if E. Thomas would be coauthor of JVET-AM0335.

[JVET-AM1006](https://jvet-experts.org/doc_end_user/current_document.php?id=15675) HEVC additional profiles and SEI messages (Draft 3) [Y.-K. Wang, B. Bross, S. Deshpande, G. J. Sullivan, A. Tourapis] (2025-XX-XX)

Primary editor: Y.-K. Wang.

Editorial improvements and bug fixes agreed at this meeting:

* [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-AM0048](https://jvet-experts.org/doc_end_user/current_document.php?id=15695) AHG9/AHG2: Miscellaneous changes for HEVC
* [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]

Remains valid – not updated: [JVET-AI1008](https://jvet-experts.org/doc_end_user/current_document.php?id=14609) Conformance testing for HEVC multiview extended and monochrome profiles [I. Moccagatta, S. Paluri, A. Tourapis, Y.-K. Wang]

Y.-K. Wang to be replaced by T. Fu in the next version.

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=15676) Support for additional SEI messages in AVC (Draft 2) [B. Bross, J. Boyce, G. J. Sullivan, Y.-K. Wang] [WG 5 DAM N XXX] (2025-XX-XX)

Primary editor: B. Bross

A DoC WG 5 N XXX on the CDAM was reviewed and approved on XXday XX July at XXXX-XXXX.

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=15677) HEVC with extensions and corrections (Draft 2) [G. J. Sullivan, Y.-K. Wang] (2025-XX-XX)

Primary editor: Y.-K. Wang.

To prepare the next edition of H.265 –changes made in 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=15678) Additions and corrections for VVC version 4 (Draft 13) [G. J. Sullivan, B. Bross, M. M. Hannuksela, Y.-K. Wang] (2025XX-XX)

Changes agreed at this meeting:

* 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.

[JVET-AM2006](https://jvet-experts.org/doc_end_user/current_document.php?id=15679) Additional SEI messages for VSEI version 4 (Draft 6) [J. Boyce, J. Chen, S. Deshpande, M. M. Hannuksela, S. McCarthy, G. J. Sullivan, H. Tan, Y.-K. Wang] (2025-XX-XX)

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) HG9: 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.

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).

New version? 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 XXX on the DIS was reviewed and approved on XXday XX July at XXXX-XXXX. The text will be submitted for publication as IS with editorial improvements requested by ISO editor.

Primary editor: F. Bossen.

[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.

New version? Remains valid – not updated: [JVET-AC2011](https://jvet-experts.org/doc_end_user/current_document.php?id=12575) VTM and HM common test conditions and evaluation procedures for HDR/WCG video [A. Segall, E. François, W. Husak, S. Iwamura, D. Rusanovskyy]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-U2012](https://jvet-experts.org/doc_end_user/current_document.php?id=10681) JVET common test conditions and evaluation procedures for 360° video [Y. He, J. Boyce, K. Choi, J.-L. Lin]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-T2013](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10546) VTM common test conditions and software reference configurations for non-4:2:0 colour formats [Y.-H. Chao, Y.-C. Sun, J. Xu, X. Xu]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-Q2014](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9683) JVET common test conditions and software reference configurations for lossless, near lossless, and mixed lossy/lossless coding [T.-C. Ma, A. Nalci, T. Nguyen]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-Q2015](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9684) JVET functionality confirmation test conditions for reference picture resampling [J. Luo, V. Seregin]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-AJ2016](https://jvet-experts.org/doc_end_user/current_document.php?id=14998) Common test conditions and evaluation procedures for neural network-based video coding technology [E. Alshina, F. Galpin, R.-L. Liao, S. Liu, A. Segall]

Remains valid – not updated: [JVET-AI2017](https://jvet-experts.org/doc_end_user/current_document.php?id=14615) Common test conditions and evaluation procedures for enhanced compression tool testing [M. Karczewicz, Y. Ye]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-AA2018](https://jvet-experts.org/doc_end_user/current_document.php?id=11949) Common test conditions for high bit depth and high bit rate video coding [A. Browne, T. Ikai, D. Rusanovskyy, X. Xiu, Y. Yu]

Links to test sequences need to be updated due to the change of the content server.

[JVET-AM2019](https://jvet-experts.org/doc_end_user/current_document.php?id=15681) 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] (2025-06-15)

New elements in text and software from notes elsewhere in this report:

* … .

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

New version? [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] (2025-06-15)

….

New version? Remains valid – not updated: [JVET-AJ2021](https://jvet-experts.org/doc_end_user/current_document.php?id=15001) Verification test plan for VVC multilayer coding (update 5) [O. Chubach, P. de Lagrange, M. Wien]

Remains valid – not updated: [JVET-AJ2022](https://jvet-experts.org/doc_end_user/current_document.php?id=15002) Plan for subjective quality testing of the FGC SEI message (update 4) [P. de Lagrange, W. Husak, M. Radosavljević, M. Wien]

[JVET-AM2023](https://jvet-experts.org/doc_end_user/current_document.php?id=15671) 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 XXXX-XXXX on XXday XX July.

This round of EE1 tests includes:

* + *…*

[JVET-AM2024](https://jvet-experts.org/doc_end_user/current_document.php?id=15672) Exploration experiment on enhanced compression beyond VVC capability (EE2) [V. Seregin, D. Bugdayci 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 XXXX-XXXX on XXday XX July.

This round of EE2 tests will include:



[JVET-AM2025](https://jvet-experts.org/doc_end_user/current_document.php?id=15683) Algorithm description of Enhanced Compression Model 18 (ECM 18) [M. Coban, R.-L. Liao, K. Naser, J. Ström, L. Zhang] (2025-XX-XX)

New elements from notes elsewhere in this report:

* …

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

**[JVET-AM2026](https://jvet-experts.org/doc_end_user/current_document.php?id=15684) Joint Call for Evidence on video compression with capability beyond VVC [J.-R. Ohm, M. Wien] [WG 5 N XXX] (2025-07-04)**

was reviewed and approved at XXXX-XXXX on XXday XX July.

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]

New version? 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 XXX was issued integrating additional corrected bitstreams (as per JVET-AM0005) together with the valid previous bitstreams as an attachment.

A DoC WG 5 N XXX on the DIS was reviewed and approved on XXday XX July at XXXX-XXXX.

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.

A DoC WG 5 N 353 on the CDTR was reviewed and approved on Friday 04 April at 0600-0615.

Request for public availability to be done when ITU-T version is submitted.

The ISO secretariat needs to be informed to create a URL for the software, and the software attachment needs to be prepared and submitted. This shall include software supporting all combinations that are indicated as relevant in the list.

New elements from notes elsewhere in this report:

* Updates in table for tool combinations, see notes under JVET-AL0152

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

Remains valid – not updated: [JVET-AI2031](https://jvet-experts.org/doc_end_user/current_document.php?id=14623) Common test conditions for optimization of encoders and receiving systems for machine analysis of coded video content [S. Liu, C. Hollmann]

[JVET-AM2032](https://jvet-experts.org/doc_end_user/current_document.php?id=15687) 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-XX-XX)

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 Signaling

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 signaling

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)

New version? Remains valid – not updated: [JVET-AK2038](https://jvet-experts.org/doc_end_user/current_document.php?id=15344) Draft white paper on VSEI [J. Boyce, S. McCarthy, S. Deshpande, G. J. Sullivan, Y. Sanchez, Y.-K. Wang] [ AG 3 Nxxx] (2025-03-21)

Was presented to AG 3 in the next meeting (with possible editorial improvements), 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 Friday 4 July.

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 3 – 12 October 2025, 40th meeting under ITU-T SG21 auspices in Geneva, CH, to be conducted as hybrid meeting (starting Friday 3 Oct. afternoon for opening and AHG reports only,
* During 14 – 23 January 2026, 41st meeting under ISO/IEC JTC 1/‌SC 29 auspices, to be conducted as teleconference meeting,
* During 24 April – 1 May 2026, 42nd meeting under ISO/IEC JTC 1/‌SC 29 auspices in Santa Eulària, ES, to be conducted as hybrid meeting,
* During 7 – 15 July 2026, 43rd meeting under ITU-T SG21 auspices in Geneva, CH, to be conducted as hybrid meeting,
* During 14 – 23 October 2026, 44th meeting under ISO/IEC JTC 1/‌SC 29 auspices in Hangzhou, CN, to be conducted as hybrid meeting,
* During January 2027, 45th meeting under ISO/IEC JTC 1/‌SC 29 auspices 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, 47th meeting under ISO/IEC JTC 1/‌SC 29 auspices in Shenzhen, CN, to be conducted as hybrid meeting,
* During January 2028, 48th meeting under ITU-T SG21 auspices, date and location t.b.d.

The agreed document deadline for the 40th JVET meeting was planned to be Friday 26 Sept. 2025.

Thank Samsung for displays …

Thank XXX for playout equipment …

Thank Mathias and others …

Thank meeting host and staff …

Marius Preda was thanked for the service of managing and assistance in maintaining the document site jvet-experts.org. Institut Mines-Télécom was thanked for hosting the site.

The 39th JVET meeting was closed at approximately XXXX hours KST on Friday 04 July 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 thirty-ninth 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. xx

# Annex B2 to JVET report: List of meeting participants attending remotely

The remote participants of the thirty-ninth 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. xx

# Annex C to JVET report: Recommendations of the 20th 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**