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

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

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# Summary

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

For ISO/IEC purposes, JVET is alternatively designated ISO/IEC JTC 1/‌SC 29/‌WG 5, and this was the nineteenth meeting as WG 5. The JVET meeting was held under the chairmanship of Dr Jens-Rainer Ohm (RWTH Aachen/Germany). For rapid access to particular topics in this report, a subject categorization is found (with hyperlinks) in section 2.16 of this document. It is further noted that work items which had originally been conducted by the Joint Collaborative Team on Video Coding (JCT-VC) were continued in JVET as a single joint team, and explorations towards possible future need of standardization in the area of video coding are also conducted by JVET, as negotiated by the parent bodies.

The JVET meeting began at approximately 0500 UTC on Wednesday 26 March 2025. Meeting sessions were held on all days except the weekend days of Saturday and Sunday 29 and 30 March 2025, until the meeting was closed at approximately 0014 hours UTC on Saturday 5 April 2025. Approximately 473 people attended the JVET meeting, and approximately 210 input documents (not counting crosschecks, reports, and summary documents), 18 AHG reports, 2 EE summary reports, 1 BoG report(s), and no incoming liaison document(s) were discussed. The meeting took place in coordination with a meeting of various SC29 Working Groups and Advisory Groups – where WG 5 is representing the Joint Video Coding Team(s) and their activities from the perspective of the SC 29 parent body, under whose auspices this JVET meeting was held. The subject matter of the JVET meeting activities consisted of work on further development and maintenance of the twin-text video coding technology standards *Advanced Video Coding* (AVC), *High Efficiency Video Coding* (HEVC), *Versatile Video Coding* (VVC)*, Coding-independent Code Points (Video)* (CICP), and *Versatile Supplemental Enhancement Information Messages for Coded Video Bitstreams* (VSEI), as well as related technical reports, reference software and conformance testing packages. Further important goals were reviewing the results of the Exploration Experiment (EE) on Neural Network-based Video Coding, of the EE on Enhanced Compression beyond VVC capability, of other technical input on novel aspects of video coding technology, and to plan next steps for investigation of candidate technology towards further standard development.

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

a) JVET documents

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

b) documents produced as WG 5 documents only:

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

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

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

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

* 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:

* 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 18 “ad hoc groups” (AHGs) to progress the work on particular subject areas. At this meeting, 2 Exploration Experiments (EE) were defined. The next eight JVET meetings were planned for 26 June – 4 July 2025 under ISO/IEC JTC 1/‌SC 29 auspices in Daejeon, KR; during 3 – 12 October 2025 under ITU-T SG21 auspices in Geneva, CH; during 14 – 23 January 2026 under ISO/IEC JTC 1/‌SC 29 auspices, to be conducted as teleconference meeting; during 24 April – 1 May 2026 under ISO/IEC JTC 1/‌SC 29 auspices in Santa Eulària, ES; during 7 – 15 July 2026 under ITU-T SG21 auspices in Geneva, CH; during 14 – 23 October 2026 under ISO/IEC JTC 1/‌SC 29 auspices in Hangzhou, CN; during January 2027 under ISO/IEC JTC 1/‌SC 29 auspices, date and location t.b.d.; and during April 2027 under ITU-T SG21 auspices, date and location t.b.d.

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

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

# Administrative topics

## Organization

The ITU-T/ISO/IEC Joint Video Experts Team (JVET) is a group of video coding experts from the ITU-T Study Group 21 Visual Coding Experts Group (VCEG) and ISO/IEC JTC 1/‌SC 29/‌WG 5. The parent bodies of the JVET are ITU-T WP3/21 and ISO/IEC JTC 1/‌SC 29.

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

It is further noted that the unabbreviated name of JVET was formerly known as “Joint Video *Exploration* Team”, but the parent bodies modified it when entering the phase of formal development of the *Versatile Video Coding* (VVC) and *Versatile Supplemental Enhancement Information Messages for Coded Video Bitstreams* (VSEI) standards, as well as associated conformance test sets, reference software, verification testing, and non-normative guidance information. Furthermore, starting from the twentieth meeting, work items which had originally been conducted by the Joint Collaborative Team on Video Coding (JCT-VC) were continued to be conducted in JVET as a single joint team, as negotiated by the parent bodies. This particularly consists of work on:

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

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

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

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

This report contains three important annexes, as follows:

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

## Meeting logistics

Information regarding logistics arrangements for the meeting had been provided via the email reflector [jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de) and at <http://wftp3.itu.int/av-arch/jvet-site/2025_03_AL_Virtual/>.

## Primary goals

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

a) JVET documents

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

b) documents produced as WG 5 documents only:

* WG 5 N 338 Request for ISO/IEC 23090-15 Conformance testing for VVC (3rd ed.)
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c) document forwarded by JVET and Q6/21 for ITU-T agreement:

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

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

## Documents and document handling considerations

### General

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

Document registration timestamps, initial upload timestamps, and final upload timestamps are listed in Annex A of this report.

The document registration and upload times and dates listed in Annex A and in headings for documents in this report are in Paris/Geneva time. Dates mentioned for purposes of describing events at the meeting follow the CEST timezone (local time in Geneva), except as otherwise noted.

Highlighting of recorded decisions in this report is practised as follows:

* Decisions made by the group that might affect the normative content of a future standard are identified in this report by prefixing the description of the decision with the string “Decision:”.
* Decisions that affect one of the various software packages but have no normative effect on text are marked by the string “Decision (SW):”.
* Decisions that fix a “bug” in one of the test model descriptions such as VTM, HM, etc. (an error, oversight, or messiness) or in the associated software package are marked by the string “Decision (BF):”.
* Decisions that are merely editorial without effect on the technical content of a draft standard are marked by the string "Decision (Ed.):". Such editorial decisions are merely suggestions to the editor, who has the discretion to determine the final action taken if their judgment differs.
* Other parenthetical comments may be used for describing the impact or motivation of a decision. Some decisions are recorded with the word “agreed” rather than “Decision:”, especially for work items under study, non-normative, editorial and planning matters.

This meeting report is based primarily on notes taken by the JVET chair. The preliminary notes were also circulated publicly by ftp and http during the meeting on a daily basis. It should be understood by the reader that 1) some notes may appear in abbreviated form, 2) summaries of the content of contributions are often based on abstracts provided by contributing proponents without an intent to imply endorsement of the views expressed therein, and 3) the depth of discussion of the content of the various contributions in this report is not uniform. Generally, the report is written to include as much information about the contributions and discussions as is feasible (in the interest of aiding study), although this approach may not result in the most polished output report. Expressions such as “X.XX%” indicate that the desired results were not available at the time the information was recorded.

### Late and incomplete document considerations

The formal deadline for registering and uploading non-administrative contributions had been announced as Wednesday, 19 March 2025. Any documents uploaded after 1159 hours Paris/Geneva time on Thursday 20 March 2025 were considered “officially late”, with a grace period of 12 hours (to accommodate those living in different time zones of the world). The deadline does not apply to AHG reports and other such reports which can only be produced after the availability of other input documents.

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

In many cases, contributions were also revised after the initial version was uploaded. The contribution document archive website retains publicly accessible prior versions in such cases. The timing of late document availability for contributions is generally noted in the section discussing each contribution in this report.

One suggestion to assist with the issue of late submissions has been to require the submitters of late contributions and late revisions to describe the characteristics of the late or revised (or missing) material at the beginning of discussion of the contribution. This has been agreed to be a helpful approach to be followed at the meeting.

The following technical design proposal contributions were registered and/or uploaded late:

* JVET-AL0183 (a proposal on intra mode derivation), uploaded 03-20,
* JVET-AL0187 (a proposal on LOP retraining), uploaded 03-24,
* JVET-AL0189 (a proposal on HOP retraining), uploaded 03-20,
* JVET-AL0190 (a proposal on VLOP retraining), uploaded 03-21,
* JVET-AL0195 (a proposal on IntraTMP merge list), uploaded 03-21,
* JVET-AL0241 (a proposal on IntraTMP sub-modes), uploaded 03-20,
* JVET-AL0243 (a proposal on hybrid NN/conventional codec), uploaded 03-21,
* JVET-AL0248 (a proposal on motion vector prediction), uploaded 03-21,
* JVET-AL0250 (a proposal on cross-component NNSR), uploaded 03-22,
* JVET-AL0275 (a proposal on clipping for CCALF), uploaded 03-25,
* JVET-AL0286 (a proposal on optical correction SEI), uploaded 03-25,
* JVET-AL0287 (a proposal on generated gerge candidates), uploaded 03-25,
* JVET-AL0288 (a proposal on FGC SEI refpic size), uploaded 03-26,
* JVET-AL0290 (a proposal on enhanced TIMD with NNIP), uploaded 03-25,
* JVET-AL0291 (a proposal on LOP5 description and implementation mismatch), uploaded 03-25,
* JVET-AL0292 (a proposal on NNPF characteristics in NNPFA), uploaded 03-25,
* JVET-AL0302 (a proposal on enhanced colour format information SEI), uploaded 03-26,
* JVET-AL0303 (a proposal on packed regions information SEI), uploaded 03-26,
* JVET-AL0308 (a proposal on layer ID syntax elements in VSEI TuC), uploaded 03-26,
* JVET-AL0310 (a proposal on resampling type for EOI SEI), uploaded 03-27,
* JVET-AL0317 (a proposal on CLVS and SEI messages in HEVC), uploaded 03-29,
* JVET-AL0320 (a proposal on CICP TuC for monochrome), uploaded 03-28,
* JVET-AL0321 (a proposal on XYB colour representation in CICP), uploaded 03-28,
* JVET-AL0326 (a proposal on error recovery SEI), uploaded 03-31,
* JVET-AL0333 (a proposal on interpolation filter switching), uploaded 04-01,
* JVET-AL0334 (a proposal on virtual intra prediction mode), uploaded 04-01,
* JVET-AL0335 (a proposal on VIPM selection for MTS), uploaded 04-01,
* JVET-AL0339 (a proposal on text for the FGC SEI message), uploaded 04-02,
* JVET-AL0341 (a proposal on NNPFA SEI message extension), uploaded 04-02.

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-AL0141 (a showcase on the implementation of display rectangles SEI), uploaded 03-29,
* JVET-AL0239 (a proposal of a new sequence in HD-SDR-LB), uploaded 03-24,
* JVET-AL0242 (a study on ECM performance under different MTT configurations), uploaded 03-20,
* JVET-AL0245 (a study on common test condition), uploaded 03-21,
* JVET-AL0247 (a study on Max Transform Size in ECM), uploaded 03-21,
* JVET-AL0265 (a report on SADL update), uploaded 03-24,
* JVET-AL0278 (an information on use case and requirements for NGVC), uploaded 03-25,
* JVET-AL0282 (a report on Film grain analysis improvement), uploaded 03-28,
* JVET-AL0289 (a study on multi-layer verification test plan), uploaded 03-26,
* JVET-AL0322 (an illustration on sequences selection), uploaded 03-28.

All cross-verification reports at this meeting were registered late, and/or uploaded late. In the interest of brevity, these are not specifically identified here. Initial upload times for each document are recorded in Annex A of this report.

The following contribution registrations were noted that were later cancelled, withdrawn, never provided, were cross-checks of a withdrawn contribution, or were registered in error: JVET-AL0088, JVET-AL0089, JVET-AL0090, JVET-AL0146, JVET-AL0163, JVET-AL0170, JVET-AL0172, JVET-AL0180, JVET-AL0267, and JVET-AL0318.

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

“Placeholder” contribution documents that were basically empty of content, or lacking any results showing benefit for the proposed technology, and obviously uploaded with an intent to provide a more complete submission as a revision, had been agreed to be considered unacceptable and to be rejected in the document management system until a more complete version was available (which would then be counted as a late contribution if the update was after the document deadline). At the current meeting, this situation did apply to documents JVET-AL0183, and JVET-AL0195 which were initially empty of results and were flagged as late in the list above, based on the time of the first reasonable document upload.

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

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

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

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

### Outputs of the preceding meeting

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

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

The available output documents of the previous meeting and the software had been made available in a reasonably timely fashion.

## Attendance

The list of participants in the JVET meeting can be found in Annex B of this report.

The meeting was open to those qualified to participate either in ITU-T WP3/21 or ISO/IEC JTC 1/‌SC 29/‌WG 5 (including experts who had been personally invited as permitted by ITU-T or ISO/IEC policies).

Participants had been reminded of the need to be properly qualified to attend. Those seeking further information regarding qualifications to attend future meetings may contact the responsible coordinators.

It was further announced that it is necessary to register for the meeting through the ISO Meetings website for ISO/IEC experts, and through the Q6/21 rapporteur for ITU-T experts. The password for meeting access had been sent to registered participants via these channels. Links to the Zoom sessions (without the necessary password) were available in the posted meeting logistics information and the calendar of meeting sessions in the JVET web site.

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

* Use the “hand-raising” function to enter yourself in the queue to speak (unless otherwise instructed by the session chair). If you are dialed in by phone, request your queue position verbally. The online queue will be interleaved with the room queue, though it may not always be guaranteed that the sequence perfectly follows the sequence by which hand raising occurred.
* Stay muted unless you have something to say. People are muted by default when they join and need to unmute themselves to speak. The chair may mute anyone who is disrupting the proceedings (e.g. by forgetting they have a live microphone while chatting with their family or by causing bad noise or echo).
* Identify who you are and your affiliation when you begin speaking. The same applies for speakers in the room to let online participants know who is speaking.
* Use your full name and company/organization and country affiliation in your joining information, since the participation list of Zoom would also be used to compile the online part of attendance records.
* Turn on the chat window and watch for chair communication and side commentary there as well as by audio.
* Generally, do not use video for the teleconferencing calls in order to avoid overloading internet connections; enable only voice and screen sharing.
* Extensive use of screen sharing is encouraged, to enable participants to view the presented material and the meeting notes. At times, multiple sources of screen sharing may be enabled, so it may be necessary for participants to understand that this is happening and to understand how to select which shared screen they want to see.

## Agenda

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

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

The agenda was approved as suggested.

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

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

## ISO and IEC Code of Conduct reminders

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

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

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

These include points relating to:

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

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

## IPR policy reminder

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

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

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

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

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

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

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

## Software copyright disclaimer header reminder

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

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

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

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

## Communication practices

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

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

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

It was emphasized that reflector subscriptions and email sent to the reflector must use real names when subscribing and sending messages and subscribers must respond to inquiries regarding the nature of their interest in the work. The current number of subscribers on the JVET email list was 1292 (as of 25 March 2025). All discussions (including those on AVC, HEVC, VVC, CICP, etc.) shall be conducted on the JVET reflector rather than any of the old reflectors (including JVT, JCT-VC, and JCT-3V) which are retained for archiving purposes.

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

## Terminology

* **ACT**: Adaptive colour transform
* **AFF**: Adaptive frame-field
* **AI**: All-intra
* **AIF**: Adaptive interpolation filtering
* **ALF**: Adaptive loop filter
* **AMP**: Asymmetric motion partitioning – a motion prediction partitioning for which the sub-regions of a region are not equal in size (in HEVC, being N/2x2N and 3N/2x2N or 2NxN/2 and 2Nx3N/2 with 2N equal to 16 or 32 for the luma component)
* **AMVP**: Adaptive motion vector prediction
* **AMT or MTS**: Adaptive multi-core transform, or multiple transform selection
* **AMVR**: (Locally) adaptive motion vector resolution
* **APS**: Adaptation parameter set
* **ARC**: Adaptive resolution conversion (synonymous with DRC, and a form of RPR)
* **ARMC**: Adaptive re-ordering of merge candidates
* **ARSS**: Adaptive reference sample smoothing
* **ATM**: AVC-based multiview and 3D test model
* **ATMVP** or “subblock-based temporal merging candidates”: Alternative temporal motion vector prediction
* **AU**: Access unit
* **AUD**: Access unit delimiter
* **AVC**: Advanced video coding – the video coding standard formally published as ITU-T Recommendation H.264 and ISO/IEC 14496-10
* **BA**: Block adaptive
* **BC**: See CPR or IBC
* **BCW**: Biprediction with CU based weighting
* **BD**: Bjøntegaard-delta – a method for measuring percentage bit rate savings at equal PSNR or decibels of PSNR benefit at equal bit rate (e.g., as described in document VCEG-M33 of April 2001)
* **BDOF**: Bi-directional optical flow (formerly known as **BIO**)
* **BDPCM**: Block-wise DPCM
* **BL**: Base layer
* **BMS**: Benchmark set (no longer used), a former preliminary compilation of coding tools on top of VTM, which provide somewhat better compression performance, but are not deemed mature for standardzation
* **BoG**: Break-out group
* **BR**: Bit rate
* **BT**: Binary tree
* **BV**: Block vector (used for intra BC prediction)
* **CABAC**: Context-adaptive binary arithmetic coding
* **CBF**: Coded block flag(s)
* **CC**: May refer to context-coded, common (test) conditions, or cross-component
* **CCALF**: Cross-component ALF
* **CCLM**: Cross-component linear model
* **CCCM**: Cross-component convolutional model
* **CCP**: Cross-component prediction
* **CCSAO**:Cross-component SAO
* **CE**: Core Experiment – a coordinated experiment conducted toward assessment of coding technology
* **CG**: Coefficient group
* **CGS**: Colour gamut scalability (historically, coarse-grained scalability)
* **CIIP**: Combined inter/intra prediction
* **CL-RAS**: Cross-layer random-access skip
* **CPB**: Coded picture buffer
* **CPMV**: Control-point motion vector
* **CPMVP**: Control-point motion vector prediction (used in affine motion model)
* **CPR**: Current-picture referencing, also known as IBC – a technique by which sample values are predicted from other samples in the same picture by means of a displacement vector called a block vector, in a manner conceptually similar to motion-compensated prediction
* **CST**: Chroma separate tree
* **CTC**: Common test conditions
* **CVS**: Coded video sequence
* **DCI**: Decoder capability information
* **DCT**: Discrete cosine transform (sometimes used loosely to refer to other transforms with conceptually similar characteristics)
* **DCTIF**: DCT-derived interpolation filter
* **DF**: Deblocking filter
* **DIMD**: Decoder intra mode derivation
* **DMVR**: Decoder motion vector refinement
* **DoCR**: Disposition of comments report
* **DPB**: Decoded picture buffer
* **DPCM**: Differential pulse-code modulation
* **DPS**: Decoding parameter sets
* **DRC**: Dynamic resolution conversion (synonymous with ARC, and a form of RPR)
* **DT**: Decoding time
* **DQ**: Dependent quantization
* **ECS**: Entropy coding synchronization (typically synonymous with WPP)
* **EMT**: Explicit multiple-core transform
* **EOTF**: Electro-optical transfer function – a function that converts a representation value to a quantity of output light (e.g., light emitted by a display
* **EPB**: Emulation prevention byte (as in the emulation\_prevention\_byte syntax element)
* **ECM**: Enhanced compression model – a software codebase for future video coding exploration
* **ECV**: Extended Colour Volume (up to WCG)
* **EIP**: Extrapolation based intra prediction
* **EL**: Enhancement layer
* **EOS**: End of (coded video) sequence
* **ET**: Encoding time
* **FRUC**: Frame rate up conversion (pattern matched motion vector derivation)
* **GCI**: General constraints information
* **GDR**: Gradual decoding refresh
* **GFV**: Generative face video
* **GLM**: Gradient linear model
* **GOP**: Group of pictures (somewhat ambiguous)
* **GPM**: Geometry partitioning mode
* **GRA**: Gradual random access
* **HBD**: High bit depth
* **HDR**: High dynamic range
* **HEVC**: High Efficiency Video Coding – the video coding standard developed and extended by the JCT-VC, formalized by ITU-T as Rec. ITU-T H.265 and by ISO/IEC as ISO/IEC 23008-2
* **HLS**: High-level syntax
* **HM**: HEVC Test Model – a video coding design containing selected coding tools that conforms to the HEVC standard design (possibly with under-development extensions) – now also used especially in reference to the (non-normative) encoder algorithms (see WD and TM)
* **HMVP**: History based motion vector prediction
* **HOP**: High-complexity operating point for neural network-based filter.
* **HRD**: Hypothetical reference decoder
* **HTM**: HEVC-based multiview and 3D test model (developed by JCT-3V)
* **HyGT**: Hyper-cube Givens transform (a type of NSST)
* **IBC** (also **Intra BC**): Intra block copy, also known as CPR – a technique by which sample values are predicted from other samples in the same picture by means of a displacement vector called a block vector, in a manner conceptually similar to motion-compensated prediction
* **IBDI**: Internal bit-depth increase – a technique by which lower bit-depth (8 bits per sample) source video is encoded using higher bit-depth signal processing, ordinarily including higher bit-depth reference picture storage (ordinarily 12 bits per sample)
* **IBF**: Intra boundary filtering
* **ILP**: Inter-layer prediction (in scalable coding)
* **ILRP**: Inter-layer reference picture
* **IPCM**: Intra pulse-code modulation (similar in spirit to IPCM in AVC and HEVC)
* **IRAP**: Intra random access picture
* **ISP**: Intra subblock partitioning
* **JCCR**: Joint coding of chroma residuals
* **JCT-3V**: Joint collaborative team on 3D video (for AVC and HEVC)
* **JCT-VC**: Joint collaborative team on video coding (for HEVC)
* **JEM**: Joint exploration model – a software codebase previously used for video coding exploration
* **JM**: Joint model – the primary software codebase that has been developed for the AVC standard
* **JSVM**: Joint scalable video model – another software codebase that has been developed for the AVC standard, which includes support for scalable video coding extensions
* **JVET**: Joint video experts team (initially for VVC, later expanded)
* **JVT**: Joint video team (for AVC)
* **KLT**: Karhunen-Loève transform
* **LB** or **LDB**: Low-delay B – the variant of the LD conditions that uses B pictures
* **LD**: Low delay – one of two sets of coding conditions designed to enable interactive real-time communication, with less emphasis on ease of random access (contrast with RA). Typically refers to LB, although also applies to LP
* **LFNST**: Low-frequency non-separable transform
* **LIC**: Local illumination compensation
* **LM**: Linear model
* **LMCS**: Luma mapping with chroma scaling (formerly sometimes called “in-loop reshaping”)
* **LOP**: Low-complexity operating point for neural network-based filter.
* **LP** or **LDP**: Low delay P – the variant of the LD conditions that uses P frames
* **LUT**: Look-up table
* **LTRP**: Long-term reference picture
* **MANE**: Media-aware network element
* **MC**: Motion compensation
* **MCP**: Motion compensated prediction
* **MCTF**: Motion compensated temporal pre-filtering
* **MDNSST**: Mode dependent non-separable secondary transform
* **MIP**: Matrix-based intra prediction
* **MMLM**: Multi-model (cross component) linear mode
* **MMVD**: Merge with MVD
* **MPEG**: Moving picture experts group (an alliance of working groups and advisory groups in ISO/IEC JTC 1/‌SC 29, one of the two parent bodies of the JVET)
* **MPM**: Most probable mode (in intra prediction)
* **MRL**: Multiple reference line intra prediction
* **MV**: Motion vector
* **MVD**: Motion vector difference
* **NAL**: Network abstraction layer
* **NNPF**: Neural network post filter
* **NNVC**: Neural network-based video coding (experimental software package)
* **NSQT**: Non-square quadtree
* **NSPT**: Non-separable primary transform
* **NSST**: Non-separable secondary transform
* **NUH**: NAL unit header
* **NUT**: NAL unit type (as in AVC and HEVC)
* **OBMC**: Overlapped block motion compensation (e.g., as in H.263 Annex F)
* **OETF**: Opto-electronic transfer function – a function that converts to input light (e.g., light input to a camera) to a representation value
* **OLS**: Output layer set
* **OOTF**: Optical-to-optical transfer function – a function that converts input light (e.g. l,ight input to a camera) to output light (e.g., light emitted by a display)
* **ONNX**: Open Neural Network Exchange – a format used to convert code from common neural network software packages into SADL code
* **operation point**: A temporal subset of an OLS
* **PDPC**: Position-dependent (intra) prediction combination
* **PERP**: Padded equirectangular projection (a 360° projection format)
* **PH**: Picture header
* **PHEC**: Padded hybrid equiangular cubemap (a 360° projection format)
* **PMMVD**: Pattern-matched motion vector derivation
* **POC**: Picture order count
* **PoR**: Plan of record
* **PROF**: Prediction refinement with optical flow
* **PPS**: Picture parameter set
* **PTL**: Profile/tier/level combination
* **QM**: Quantization matrix
* **QP**: Quantization parameter (sometimes conflated with quantization step size)
* **QT**: Quadtree
* **RA**: Random access – a set of coding conditions designed to enable relatively-frequent random access points in the coded video data, with less emphasis on minimization of delay (contrast with LD)
* **RADL**: Random-access decodable leading (type of picture)
* **RASL**: Random-access skipped leading (type of picture)
* **R-D**: Rate-distortion
* **RDO**: Rate-distortion optimization
* **RDOQ**: Rate-distortion optimized quantization
* **RDPCM**: Residual DPCM
* **ROI**: Region of interest
* **ROT**: Rotation operation for low-frequency transform coefficients
* **RPL**: Reference picture list
* **RPLM**: Reference picture list modification
* **RPR**: Reference picture resampling (e.g., as in H.263 Annex P), a special case of which is also known as ARC or DRC
* **RPS**: Reference picture set
* **RQT**: Residual quadtree
* **RRU**: Reduced-resolution update (e.g. as in H.263 Annex Q)
* **RVM**: Rate variation measure
* **SADL**: Small adhoc deep learning librar
* **SAO**: Sample-adaptive offset
* **SBT**: Subblock transform
* **SbTMVP**: Subblock based temporal motion vector prediction
* **SCIPU**: Smallest chroma intra prediction unit
* **SD**: Slice data; alternatively, standard-definition
* **SDH**: Sign data hiding
* **SDT**: Signal-dependent transform
* **SE**: Syntax element
* **SEI**: Supplemental enhancement information
* **SH**: Slice header
* **SHM**: Scalable HM
* **SHVC**: Scalable high efficiency video coding
* **SIF**: Switchable (motion) interpolation filter
* **SIMD**: Single instruction, multiple data
* **SMVD**: Symmetric MVD
* **SPO**: SEI processing order
* **SPS**: Sequence parameter set
* **SR**: Super-resolution
* **STMVP**: Spatial-temporal motion vector prediction
* **STRP**: Short-term reference picture
* **STSA**: Step-wise temporal sublayer access
* **TBA/TBD/TBP**: To be announced/determined/presented/public
* **TGM**: Text and graphics with motion – a category of content that primarily contains rendered text and graphics with motion, mixed with a relatively small amount of camera-captured content
* **TIMD**: Template-based intra mode derivation
* **TM**: Template matching
* **TMVP**: Temporal motion vector prediction
* **TS**: Transform skip
* **TSRC**: Transform skip residual coding
* **TT**: Ternary tree
* **UGC**: User-generated content
* **UWP**: Unequal weight prediction
* **VCEG**: Visual coding experts group (ITU-T Q.6/21, the relevant rapporteur group in ITU-T WP3/21, which is one of the two parent bodies of the JVET)
* **VCM**: Video coding for machines
* **VPS**: Video parameter set – a parameter set that describes the overall characteristics of a coded video sequence – conceptually sitting above the SPS in the syntax hierarchy
* **VQA**: Visual quality assessment
* **VT**: Verification testing
* **VTM**: VVC Test Model
* **VUI**: Video usability information
* **VVC**: Versatile Video Coding
* **WCG**: Wide colour gamut
* **WG**: Working group, a group of technical experts (usually used to refer to the WGs of ISO/IEC JTC 1/SC 29).
* **WPP**: Wavefront parallel processing (usually synonymous with ECS)
* Block and unit names in HEVC:
  + **CTB**: Coding tree block (luma or chroma) – unless the format is monochrome, there are three CTBs per CTU.
  + **CTU**: Coding tree unit (containing both luma and chroma, synonymous with LCU), with a size of 16x16, 32x32, or 64x64 for the luma component.
  + **CB**: Coding block (luma or chroma), a luma or chroma block in a CU.
  + **CU**: Coding unit (containing both luma and chroma), the level at which the prediction mode, such as intra versus inter, is determined in HEVC, with a size of 2Nx2N for 2N equal to 8, 16, 32, or 64 for luma.
  + **PB**: Prediction block (luma or chroma), a luma or chroma block of a PU, the level at which the prediction information is conveyed or the level at which the prediction process is performed in HEVC.
  + **PU**: Prediction unit (containing both luma and chroma), the level of the prediction control syntax within a CU, with eight shape possibilities in HEVC:
    - **2Nx2N**: Having the full width and height of the CU.
    - **2NxN (or Nx2N)**: Having two areas that each have the full width and half the height of the CU (or having two areas that each have half the width and the full height of the CU).
    - **NxN**: Having four areas that each have half the width and half the height of the CU, with N equal to 4, 8, 16, or 32 for intra-predicted luma and N equal to 8, 16, or 32 for inter-predicted luma – a case only used when 2N×2N is the minimum CU size.
    - **N/2x2N** paired with **3N/2x2N** or **2NxN/2** paired with **2Nx3N/2**: Having two areas that are different in size – cases referred to as AMP, with 2N equal to 16 or 32 for the luma component.
  + **TB**: Transform block (luma or chroma), a luma or chroma block of a TU, with a size of 4x4, 8x8, 16x16, or 32x32.
  + **TU**: Transform unit (containing both luma and chroma), the level of the residual transform (or transform skip or palette coding) segmentation within a CU (which, when using inter prediction in HEVC, may sometimes span across multiple PU regions).
* Block and unit names in VVC:
  + **CTB**: Coding tree block (luma or chroma) – there are three CTBs per CTU in a P or B slice or in an I slice that uses a single tree, and one CTB per luma CTU and two CTBs per chroma CTU in an I slice that uses separate trees.
  + **CTU**: Coding tree unit (synonymous with LCU, containing both luma and chroma in a P or B slice or in an I slice that uses a single tree, containing only luma or only chroma in an I slice that uses separate trees), with a size of 16x16, 32x32, 64x64, or 128x128 for the luma component.
  + **CB**: Coding block, a luma or chroma block in a CU.
  + **CU**: Coding unit (containing both luma and chroma in P/B slice, containing only luma or chroma in I slice), a leaf node of a QTBT. It’s the level at which the prediction process and residual transform are performed in JEM. A CU can be square or rectangle shape.
  + **PB**: Prediction block, a luma or chroma block of a PU.
  + **PU**: Prediction unit, has the same size as a CU in the VVC context.
  + **TB**: Transform block, a luma or chroma block of a TU.
  + **TU**: Transform unit, has the same size as a CU in the VVC context.

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

* MPEG-2 | H.262 (the video coding specification is common text)
  + ITU-T H.262 V3 was approved in 2012-02; Amd.1 was approved in 2013-03 and was not published separately; it was instead incorporated directly into the V3 text and published 2013-09
  + ISO/IEC 13818-2:2013 (Ed. 3) FDIS ballot closed 2012-05-08; FDAM 1 ballot closed 2013-04-12 and was not published separately; it was instead incorporated directly into the V3 text and published 2013-10
  + Conformance testing (not joint with ITU-T)
    - ISO/IEC 13818-4:2004 (Ed. 2) FDIS closed 2004-08-22, published 2004-12-12; it specifies conformance testing for Part 1 (Systems), Part 2 (Video), Part 3 (Audio), and Part 7 (AAC)
    - ISO/IEC 13818-4:2004/Amd 3:2009 Level for 1080@50p/60p conformance testing
    - Cor 1:2007, Cor 2:2009, Cor 3:2012, Cor 4:2011 may also have video relevance
  + Reference software (not joint with ITU-T)
    - ISO/IEC TR 13818-5:2005 (Ed. 2) FDIS closed 2005-07-24, published 2005-10; it specifies reference software for Part 1 (Systems), Part 2 (Video), Part 3 (Audio), Part 7 (AAC) and Part 11 (IPMP)
* AVC (twin text)
  + ITU-T H.264 V14 was Consented at 22nd meeting on 2021-04-30 (with annotated regions, shutter interval, and miscellaneous corrections), approved 2021-08-22, published 2021-10-13
  + ISO/IEC 14496-10:2020 (Ed. 9) FDIS ballot closed 2020-11-27, published 2020-12-15
  + ISO/IEC 14496-10:2022 (Ed. 10), had been forwarded from DIS directly for publication 2022-01-21 (with annotated regions, shutter interval, and miscellaneous corrections) with an editing period, submitted to ITTF in 2022-05 after consultation with ISO staff on format of graphics files, upgraded to “DIS approved for registration” in ISO Project system 2022-07-04, published 2022-11-07
  + Preliminary draft text for YCgCo-Re and YCgCo-Ro issued at 26th meeting, second draft including SMPTE ST 2128 IPT-PQ-C2 issued at 28th meeting 2022-10, third draft issued at 29th meeting 2023-01, fourth draft issued at 30th meeting 2023-04, formal project requested and CD of 11th edition issued at 31st meeting 2023-07, DIS issued at 32nd meeting 2023-10, DAM ballot closed 2024-04-15.
    - H.264 V15 Consented 2024-04-26, last call began 2024-07-16, approved 2024-08-13, published 2024-11-13
    - ISO/IEC 14496-10:202x (Ed. 11) FDIS issued at 34th meeting 2024-04, DIS approved for registration as FDIS 2024-09-17, FDIS ballot issued 2025-01-14, FDIS ballot closed 2025-03-23; pending publication
  + Amendment to support some SEI messages of VSEI v4 requested at 37th meeting 2025-01, registered to work programme 2025-01-25, ready for action to issue ISO/IEC CDAM
  + Conformance testing (twin text)
    - ITU-T H.264.1 V6 Approved 2016-02-13, published 2016-06-17
    - Various amendments of ISO/IEC 14496-4:2004, including:
      * ISO/IEC 14496-4:2004/AMD 6:2005 Advanced Video Coding conformance
      * ISO/IEC 14496-4:2004/AMD 9:2006 AVC fidelity range extensions conformance
      * ISO/IEC 14496-4:2004/AMD 30:2009 Conformance testing for new profiles for professional applications
      * ISO/IEC 14496-4:2004/AMD 31:2009 Conformance testing for SVC profiles
      * ISO/IEC 14496-4:2004/AMD 38:2010 Conformance testing for Multiview Video Coding
      * ISO/IEC 14496-4:2004/AMD 41:2014 Conformance testing of MVC plus depth extension of AVC
      * ISO/IEC 14496-4:2004/AMD 42:2014 Conformance testing of Multi-Resolution Frame Compatible Stereo Coding extension of AVC
      * ISO/IEC 14496-4:2004/AMD 43:2015 3D-AVC conformance testing
      * ISO/IEC 14496-4:2004/AMD 45:2016 Conformance Testing for the Multi-resolution Frame Compatible Stereo Coding with Depth Maps Extension of AVC
  + Reference software (twin text)
    - ITU-T H.264.2 V7 Approved 2016-02-13, published 2016-05-30
    - Various amendments of ISO/IEC 14496-5:2001 have been published, including:
      * ISO/IEC 14496-5:2001/AMD 6:2005 Advanced Video Coding (AVC) and High Efficiency Advanced Audio Coding (HE AAC) reference software
      * ISO/IEC 14496-5:2001/AMD 8:2006 AVC fidelity range extensions reference software
      * ISO/IEC 14496-5:2001/AMD 15:2010 Reference software for Multiview Video Coding
      * ISO/IEC 14496-5:2001/AMD 18:2008 Reference software for new profiles for professional applications
      * ISO/IEC 14496-5:2001/AMD 19:2009 Reference software for Scalable Video Coding
      * ISO/IEC 14496-5:2001/AMD 33:2015 Reference software for MVC plus depth extension of AVC
      * ISO/IEC 14496-5:2001/AMD 34:2014 Reference software of the multi-resolution frame compatible stereo coding of AVC
      * ISO/IEC 14496-5:2001/AMD 35:2015 3D-AVC Reference software
      * ISO/IEC 14496-5:2001/AMD 39:2016 Reference software for the Multi-resolution Frame Compatible Stereo Coding with Depth Maps of AVC
      * ISO/IEC 14496-5:2001/AMD 42:2017 Reference software for the alternative depth information SEI message extension of AVC
* HEVC (twin text)
  + ITU-T H.265 V7 approved 2019-11-29, published 2020-01-10
  + ISO/IEC 23008-2:2020 (Ed. 4) FDIS ballot closed 2020-07-16, published 2020-08-27
  + ITU-T H.265 V8 Consented at the 22nd meeting (shutter interval information SEI message and miscellaneous corrections), published 2020-10-13
  + ISO/IEC 23008-2:2020/AMD 1:2021 (shutter interval information SEI message) published 2021-07-12
  + ISO/IEC 23008-2:2023 (Ed. 5) began as CDAM 2 High-range levels output of 25th meeting of January 2022, CDAM ballot closed 2022-04-15, conversion to 5th edition with miscellaneous corrections planned at 26th meeting of 2022-04, text submitted for DIS ballot 2022-07-10, DIS ballot closed 2023-01-10, FDIS issued 29th meeting of 2023-01, FDIS ballot opened 2023-08-06, closed 2023-10-02, published 2023-10-30
  + ITU-T H.265 V9 Consented at 31st meeting 2023-07, approved 2023-09-13, and pre-published 2023-09, published 2023-11-24.
  + Preliminary draft HEVC text for YCgCo-Re and YCgCo-Ro issued at 26th meeting 2022-04, second draft including SMPTE ST 2128 issued at 28th meeting 2022-10, third draft at 29th meeting 2023-01, fourth draft at 30th meeting 2023-04, formal work item requested and CDAM1 issued 31st meeting 2023-07, DAM issued with new (multiview) profiles and SEI messages at 32nd meeting 2023-10, DAM ballot closed 2024-04-08
    - H.265 V10 Consented 2024-04-26, last call opened 2024-07-01, closed 2024-07-28, approved 2024-07-29, pre-published 2024-08-06, published 2024-10-07
    - ISO/IEC 23008-2:2025 (Ed. 6) FDIS issued from 35th meeting 2024-04, DIS approved for registration as FDIS 2024-10-03, FDIS registered for formal approval 2024-10-13, FDIS ballot issued 2024-12-30, FDIS ballot closed 2025-02-24, published 2025-03-20
  + Amendment to support additional (multiview) profiles and some SEI messages of VSEI v4, project requested at 36th meeting 2024-11, project registered in ISO/IEC work programme 2025-01-25, CDAM issued at 37th meeting, consulation began 2025-02-01, pending closure of comment period
  + Conformance testing (twin text)
    - ITU-T H.265.1 V3 approved 2018-10-14, published 2019-01-15
    - ISO/IEC 23008-8:2018 (Ed. 2) Conformance specification for HEVC, published 2018-08-06
    - ISO/IEC 23008-8:2018/AMD 1:2019 Conformance testing for HEVC screen content coding (SCC) extensions and non-intra high throughput profiles, published 2019-10-15
  + Reference software (twin text)
    - ITU-T H.265.2 V4 approved 2016-12-22, published 2017-04-10
    - ISO/IEC 23008-5:2017 (Ed. 2) Reference software for high efficiency video coding, FDIS issued from 2016-02 meeting, published 2017-03-01
    - ISO/IEC 23008-5:2017/AMD 1:2017 Reference software for screen content coding extensions, FDAM issued from 2017-04 meeting, FDAM ballot opened 2017-08-10, closed 2017-10-07, published 2017-11-09
* VVC (twin text)
  + ITU-T H.266 V1 approved 2020-08-29, published 2020-11-10
  + ISO/IEC 23090-3:2021 (Ed. 1) published 2021-02-16
  + ITU-T H.266 V2 with operation range extensions, Consented 2022-01-28, Last Call began 2022-04-01, Approved 2022-04-29, pre-published 2022-06-06, published 2022-07-12
  + ISO/IEC 23090-3:2022 (Ed. 2) with operation range extensions, approval at WG level to proceed to FDIS 2022-01-21, FDIS ballot opened 2022-06-29, closed 2022-08-24, published 2022-09-25
  + ISO/IEC 23090-3:2024 (Ed. 3), initated as (Ed. 2) / Amd.1 New level and systems-related supplemental enhancement information, CDAM 1 issued from 26th meeting, ballot closed 2022-07-14, DAM 1 issued from 27th meeting, ballot closed 2023-01-03, FDIS issued at WG level 2023-07, FDIS ballot opened 2024-05-11, closed 2024-06-26, published 2024-07-17
  + ITU-T H.266 V3 Consented 2023-07, approved 2023-09-29 and pre-published 2023-09, published 2023-11-29
  + ISO/IEC 23090-3:2024/CDAM 1 Request & CDAM issued 2024-04, consultation deferred due to meeting timing, updated text issued 2024-07, consultation initiated 2024-09-05, closed 2024-10-31, ready for action to issue ISO/IEC DAM (or DIS)
  + Conformance testing (twin text)
    - ITU-T H.266.1 V1 Consented 2022-01-28, Last Call began 2022-04-01, Approved 2022-04-29, pre-published 2022-05-17, published 2022-07-12
    - ISO/IEC 23090-15:2022 (Ed. 1) approval at WG level to proceed to FDIS 2022-10-15, upgraded to “DIS approved for registration” in ISO Projects system 2021-10-24, upgraded to “FDIS registered for formal approval” 2022-07-11, FDIS ballot closed 2022-11-04, published 2022-11-24
    - ISO/IEC 23090-15:2024 (Ed. 2) began as Amd.1 Operation range extensions – CDAM 1 issued from 24th meeting 2021-10, DAM 1 issued from 25th meeting 2022-01-21, upgraded to “CD approved for registration as DIS” status in ISO Projects system 2022-05-31, upgraded to “DIS registered” 2022-06-22, DAM ballot closed 2022-11-15, consolidated into FDIS 2nd edition issued as an output of the 29th meeting in January 2023, ballot opened 2024-04-08, closed 2024-06-03, published 2024-07-04.
    - ITU-T H.266.1 V2 Consented 2023-07, approved 2023-09-13 and pre-published 2023-09, published 2023-10-19
    - ISO/IEC 23090-15 (Ed. 3) project requested at 37th meeting, project registered in work programme 2025-01-25, ready for action to issue CD.
  + Reference software (twin text)
    - ITU-T H.266.2 V1 Consented 2022-01-28, Last Call began 2022-04-01, Approved 2022-04-29, pre-published 2022-05-17, published 2022-07-12
    - ISO/IEC 23090-16:2022 V1 approval at WG level to proceed to FDIS 2022-01-21, upgraded to “DIS approved for registration” status in ISO Projects system 2022-04-21, upgraded to “FDIS registered for formal approval” 2022-04-22, FDIS ballot initiated 2022-07-24, FDIS ballot closed 2022-09-19, published 2022-10-23
    - H.266.2 V2 Consented 2024-04-26, last call opened 2024-05-16, closed 2024-06-12, approved 2024-06-13, pre-published 2024-08-06, published 2024-10-09
    - ISO/IEC 23090-16:202x (Ed. 2) Request & CD issued 2024-04, consultation deferred due to meeting timing, consultation initiated 2024-09-06, closed 2024-11-01, DIS issued at 36th meeting 2024-11, approved for registration as DIS 2024-12-18, DIS registered 2025-01-7, DIS ballot opened 2025-03-09, no action at the current meeting (Roughly corresponding to H.266.2 V2 already approved and published in ITU-T)
* VSEI (twin text)
  + ITU-T H.274 V1 approved 2020-08-29, published 2020-11-10
  + ISO/IEC 23002-7:2021 (Ed. 1) published 2021-01-28
  + ITU-T H.274 V2 Consented 2022-01-28, Last Call began 2022-04-01, Approved 2022-05-22 (after 1 Last Call comment and Additional Review), pre-published 2022-06-17, published 2022-07-25
  + ISO/IEC 23002-7:2022 (Ed. 2) approval at WG level to proceed to FDIS 2022-01-21, upgraded to “DIS approved for registration” status in ISO Projects system 2022-05-05 and “FDIS registered for formal approval” 2022-05-08, FDIS ballot closed 2022-09-27, published 2022-10-30
  + ISO/IEC 23002-7:2024 (Ed. 3) began as (2nd Ed.) Amd.1 Request for new edition and CD for additional SEI messages issued at 27th meeting, ballot closed 2022-10-10, DAM registered 2022-11-13, DAM ballot closed 2022-04-06, FDIS 3rd edition issued 2023-07, FDIS ballot began 2024-07-25, closed 2024-09-20, published 2024-10-30
  + ITU-T H.274 V3 Consent 2023-07, approved 2023-09-29, pre-published 2023-10-11, published 2024-03-12.
  + ISO/IEC 23002-7:202x (Ed. 4) Request & CDAM 1 issued 2024-04, consultation deferred due to meeting timing, updated text issued 2024-07, CD consultation initiated 2024-09-05, closed 2024-10-31, ready for action to issue ISO/IEC DAM (or DIS)
* CICP (twin text)
  + ITU-T H.273 V2 (with 4:2:0 sampling alignment and corrections for range of values for sample aspect ratio, ICTCP equations for HLG, and transfer characteristics function for sYCC of IEC 61966-2-1) Consented on 2021-04-30, Last Call closed during the 23rd meeting with approval on 2021-07-14, published 2021-09-24
  + ISO/IEC 23091-2:2021 (Ed. 2) had been forwarded from DIS directly for publication in 2021-04 and published 2021-10-18
  + ITU-T H.273 V3 Consent 2023-07, approved 2023-09, not published due to waiting for publication of SMPTE ST 2128.
  + ITU-T H.273 V4 Consented 2024-04-26, last call opened 2024-06-16, closed 2024-07-13, approved 2024-07-14, pre-published 2024-08-06, published 2024-10-07.
  + ISO/IEC 23091-2:2025 (Ed. 3) Request for new edition and CD for new edition (including YCgCo-Re and YCoCg-Ro) issued at 27th meeting, ballot closed 2022-10-10, DIS registered 2022-11-13, DIS ballot closed 2023-04-06, preliminary draft text for including SMPTE ST 2128 issued at 28th meeting, incorporated into preliminary FDIS at 30th meeting 2023-04, FDIS issued 2024-04 (after waiting for publication of SMPTE ST 2128, then proceeding), FDIS registered for formal approval 2024-10-24, FDIS ballot issued 2024-12-03, FDIS ballot closed 2025-01-28, published 2025-02-25.
* Conversion and coding practices for HDR/WCG Y′CbCr 4:2:0 video with PQ transfer characteristics (twin text)
  + 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

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

## Opening remarks

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

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

## Scheduling of discussions

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

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

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

* Wed. 26 March, 1st day
  + Morning sessions:
    - 0500–0620 Opening remarks, review of practices, agenda, IPR policy reminder
    - 0625–0700 Reports of AHGs 1-3
    - 0720–0925 Reports of AHGs 4-11
  + Afternoon sessions:
    - 1300–1400 Reports of AHGs 12-18
    - 1405–1505 CfE planning
    - 1525–1725 CfE planning
* Thu. 27 March, 2nd day
  + Morning sessions:
    - 0500–0700 review section 5.1.1 EE1 summary
    - 0720–0920 review section 5.1.1 EE1 summary and section 5.1.3 NNVC proposals
    - 0500–0920 HLS sections 6.2.2, 6.2.3, 6.2.4 (chaired by J. Boyce)
  + Afternoon sessions:
    - 1300–1500 EE2 review section 5.2.1 EE2 summary
    - 1520–1720 EE2 review section 5.2.1 EE2 summary
    - 1300–1720 HLS sections 6.2.3, 6.2.4, 6.2.5, 6.2.6, 6.2.7 (chaired by J. Boyce)
* Fri. 28 March, 3rd day
  + Morning sessions:
    - 0500–0700 continue review section 5.2.1 EE2 summary and section 5.2.3 EE2 related
    - 0720–0920 continue review section 5.1.3 NNVC proposals
    - 0500–0920 HLS sections 6.2.5, 6.2.6, 6.2.7, 6.2.8, 6.2.9 (chaired by J. Boyce)
  + Afternoon sessions:
    - 1300–1510 CfE planning (section 4.16)
    - 1530–1735 CfE planning (section 4.16), section 4.8
    - 1300–1720 HLS sections 6.2.6, 6.2.7, 6.2.8, 6.2.9, 6.2.10 (chaired by J. Boyce)
* Mon. 31 March, 4th day
  + 0500–0800 MPEG information sharing session
  + Morning session
    - 0820–0920 JVET plenary: Coordination/planning, open issues from tracks, plenary-level doc review
  + Afternoon sessions:
    - 1300–1500 Remaining review from 4.x categories, except sections 4.1, 4.2, 4.11, 4.18
    - 1530–1730 Joint with WG 2 / VCEG / AG 5: Next generation video standard, CfE
    - 1300–1520 HLS sections 6.2.8, 6.2.9, 6.2.10, 6.3 (chaired by J. Boyce)
* Tue 1 April, 5th day
  + Morning sessions:
    - 0500–0700 and 0720–0920 Review sections 4.2, 6.1, 4.11
    - 0500–0700 BoG on fast encoding configurations for CfE
  + Afternoon sessions:
    - 1300–1500 EE2 related section 5.2.3, non-EE2 section 5.2.4
    - 1600–1800 non-EE2 section 5.2.4 (chaired by Y. Ye)
    - 1300–1720 HLS sections 6.2.9, 6.2.10, 6.2 revisits, 6.3 (chaired by J. Boyce)
* Wed. 2 April, 6th day
  + 0500–0600 MPEG information sharing session
  + Morning sessions:
    - 0620–0820 HLS section 6.2 revisits, sections 6.3.1, 6.3.2 (chaired by J. Boyce)
    - 0620–0920 Report of BoG and side activity CfE testing, CfE planning, review DoCR on TR machine consumption (approx. first hour), section 4.15 HLS, section 4.18, other remaining 4.x (second part of session)
    - BoG on fast encoding configurations for CfE 0720–0920
  + Afternoon sessions:
    - 1300–1510 Review remaining items in sections 5.1.3 and 5.2.4
    - 1520–1815 Review remaining items in section 5.2.4
    - 1300–1720 HLS sections 6.3.1, 6.3.2, 6.3.3, 6.3.4, 6.4 (chaired by J. Boyce)
* Thu. 3 April, 7th day
  + Morning sessions:
    - 0500–0700 Joint with WG 2 / VCEG / AG 5: Next generation video standard, CfE
    - 0720–0920 section 4.17, remaining documents in sections 4.18 and 6.1
  + Afternoon sessions:
    - 1300–1530 JPEG liaison, revisits & remaining doc review 4.x, 5.1.x, 5.2.x
    - 1300–1720 HLS remaining items in sections 6.3.1, 6.3.4, 6.4, revisits, DoCRs (chaired by J. Boyce)
* Fri. 4 April, 8th day
  + Morning sessions:
    - 0500–0915 Plenary (with break 0655-0715) DoCR review, remaining doc review, revisits, output doc planning and EE1, AHG planning
  + 1300–1705 (with break 1500-1515) JVET wrap-up plenary:
    - EE2 review and review of JVET-AL0289
    - CfE planning incl. review of JVET-AL0338 and further review of JVET-AL0047
    - Establishment of AHGs
    - Approval of output docs
    - Review of WG 5 meeting recommendations
    - Software timeline
    - Future planning, a.o.b.
  + 2100–2300 MPEG information sharing session
  + 0009–0014 (Saturday) 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 (4)
  + AHG2: Text development and errata reporting (2)
  + AHG3: Software development (0)
  + AHG3: Test conditions (3)
  + AHG4: Subjective quality testing and verification testing (1)
  + AHG4: Test and training material (0)
  + AHG5: Conformance test development (0)
  + AHG7: ECM tool assessment (6)
  + AHG8: Optimization of encoders and receiving systems for machine analysis of coded video content (1)
  + AHG10: Encoding algorithm optimization (3)
  + AHG13: Film grain synthesis (5)
  + Implementation studies (0)
  + Profile/tier/level specification (0)
  + AHG15: Gaming content compression (0)
  + AHG16: Generative face video (4)
  + AHG17: CfE preparation (20)
  + AHG18: Ultra-low latency and error resilience (6)
  + CICP (4)
* 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 (27) (section 5.1)
  + AHG6/AHG12 and EE2: Enhanced compression beyond VVC capability (64) (section 5.2)
* AHG9: High-level syntax (HLS) proposals (section 6) with subtopics
  + Additions for HEVC and AVC (7) (section 6.1)
  + SEI messages in VSEIv4 (51) (section 6.2)
  + SEI messages in TuC doc (16) (section 6.3)
  + SEI messages on other topics (9) (section 6.4)
  + Non-SEI HLS aspects (0) (section 6.5)
* Joint meetings, plenary discussions, BoG reports (1) liaison (1), summary of actions (section 7)
* Project planning (section 8)
* Establishment of AHGs (section 9)
* Output documents (section 10)
* Future meeting plans and concluding remarks (section 11)

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

# AHG reports (18)

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

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

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

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

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

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

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

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

Software integration was finalized approximately according to the plan.

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

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

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

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

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

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

**Recommendations**

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

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

**Output documents produced**

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

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

Incorporated items at the JVET-AK meeting:

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

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

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

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

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

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

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

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

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

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

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

**Changes to be integrated or checked:**

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

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

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

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

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

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

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

To be integrated:

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

**Changes that have been integrated:**

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

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

**Related input contributions**

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

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

**Remaining VVC spec tickets**

Closed since JVET-AK0002 was reported:

* (none)

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

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

New (since JVET-AK0002 was reported)

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

**Remaining HEVC spec tickets**

Closed since JVET-AK0002 was reported:

* (none)

Carried over:

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

New (since JVET-AK0002 was reported):

* (none)

**Recommendations**

The AHG recommends to:

* Approve JVET-AK1004, JVET-AK1006, JVET-AK1017, JVET-AK2005, and JVET-AK2006 documents as JVET outputs,
* Compare the VVC documents with the VVC software and resolve any discrepancies that may exist, in collaboration with the software AHG,
* Encourage the use of the issue tracker to report issues with the text of both the VVC specification text and the algorithm and encoder description,
* Continue to improve the editorial consistency of VVC text specification and Test Model documents,
* Ensure that, when considering changes to VVC, properly drafted text for addition to the VVC Test Model and/or the VVC specification text is made available in a timely manner,
* Review bug tickets, and other AHG2 related inputs and act on them if found to be necessary.

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

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

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

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

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

**Software development**

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

The server is located at:

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

The registration and development workflow are documented at:

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

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

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

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

**VTM related activities**

The VTM software can be found at

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

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

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

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

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

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

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

***CTC Performance***

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

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

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

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

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **Random access Main 10** |  |  |
|  | **Over VTM 23.8** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -0.97% | -1.49% | -1.48% | 98% | 87% |
| Class A2 | -0.53% | 3.35% | 2.41% | 97% | 92% |
| Class B | 0.04% | 0.12% | -0.16% | 101% | 96% |
| Class C | 0.00% | 0.00% | 0.01% | 101% | 100% |
| Class E |  |  |  |  |  |
| **Overall** | -0.29% | 0.41% | 0.13% | 99% | 94% |
| Class D | 0.00% | 0.00% | 0.00% | 100% | 100% |
| Class F | 0.01% | 0.01% | 0.00% | 102% | 100% |

***Issues in VTM affecting conformance***

The following issues in VTM master branch may affect conformance:

* Missing HLS features (see sections below)

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

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

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

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

***SEI TuC software***

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

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

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

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

It was 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 was expected to be tagged during the 38th JVET meeting. The following merge requests were submitted:

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

**HM related activities**

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

The following MRs were merged:

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

The following MRs were pending [with status indicated]:

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

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

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

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

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

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

Help to address these tickets would be appreciated.

**360Lib related activities**

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

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

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

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

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

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

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

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

1. **SCM related activities**

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

1. **SHM related activities**

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

1. **HTM related activities**

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

One merge request is was merged:

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

The next release will also include the following changes:

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

1. **HDRTools related activities**

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

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

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

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

The following MRs are pending [with status indicated]:

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

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

1. **Bug tracking**

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

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

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

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

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

Bug tracking for HDRTools is located at:

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

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

1. **CTC alignment and merging**

There were currently 8 JVET CTC documents:

* JVET-AK2010 VTM/HM 4:2:0 test conditions
* JVET-Z2011 VTM/HM HDR test conditions
* JVET-AA2018 VTM/HM high bit depth test conditions (without spreadsheet)
* JVET-T2013 VTM non-4:2:0 test conditions
* JVET-AA1100 HM non-4:2:0 test conditions
* JVET-U2012 VTM 360 video test conditions
* JVET-AC1009 SHVC test conditions
* JVET-AC1015 SCM test conditions
* JVET-AE1013 3DV test conditions

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

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

1. **Guidelines for reference software development**

Current versions of the software guidelines are:

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

**Recommendations**

The AHG recommended to:

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

Significant work on implementing SEI messages in VTM. Some which were moved from TuC to v4 were still in the TuC branch of the software.

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

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

[JVET-AL0004](https://jvet-experts.org/doc_end_user/current_document.php?id=15387) JVET AHG report: Test material and visual assessment (AHG4) [V. Baroncini, T. Suzuki, M. Wien (co-chairs), W. Husak, S. Iwamura, P. de Lagrange, S. Liu, X. Meng, S. Puri, A. Segall, S. Wenger (vice-chairs)]

Activities

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

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

***Test sequences***

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

Due to copyright restrictions, the JVET database of test sequences is only available to accredited members of JVET (i.e., members of ISO/IEC MPEG and ITU-T VCEG). Members of JVET may contact the JVET chair for login information. It is suggested to update the password for the site after each meeting with the Zoom password of that meeting.

**Related contributions**

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

**Recommendations**

The AHG recommended:

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

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

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

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

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

**Activities**

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

**Timeline**

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

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

**Status on bitstream submission**

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

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

**Activities and Discussion**

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

VVC activities:

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

VVC operation range extensions activities:

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

VVC Multilayer activities:

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

HEVC Multiview supporting extended bit depth activities:

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

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

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

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

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

**Contributions**

No relevant contributions were noted.

**Ftp site information**

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

* VVC:

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

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

* VVC operation range extensions:

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

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

The ftp site for uploading bitstream file is as follows.

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

(user id: avguest, passwd: Avguest201007)

If using FileZilla, the following configuration is suggested:

Graphical user interface, text, application, email

Description automatically generated

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

**Recommendations**

The AHG recommends the following:

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

Bitstreams available for MV 10, MV extended (8), and MV extended 10. No bitstreams yet on multiview monochrome profiles, no activity on implementation since the 36th meeting. Plan for issuing issue a HEVC conformance amendment needs to be deferred for a later meeting.

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

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

**Software development**

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

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

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

The following changes were integrated into ECM-16.0:

Merge AHG7 branch with tools control [MR 822]

JVET-AK0135: CABAC contexts retraining [MR 819]

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

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

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

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

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

JVET-AK0065: Temporal ALF [MR 818]

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Fixes:

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

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

Convert assert to CHECK [MR 853]

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

ET with millisecond precision [MR 803]

Store cost for timdSAD [MR 805]

The following changes were integrated into ECM-16.1:

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

Fix MD5sum mismatch with AHG7 group1 off [MR 885]

Fix groupoff4 test [MR 884]

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

Convert some CHECK to CHEKCD [MR 888]

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

ET with millisecond precision [MR 804]

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

ECM-16.1 was tagged on February 28, 2025.

***CTC Performance***

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

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

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

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

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

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

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

**ECM memory consumption**

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

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

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

**Recommendations**

The AHG recommends to:

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

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

**Group off tests**

***Test settings and crosschecking***

The following five groups of tools were defined.

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

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

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

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

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

***Group 1 off***

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

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

***Group 2 off***

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

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

***Group 3 off***

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

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

***Group 4 off***

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

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

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

***Group 5 off***

Group 5 includes tools which need large memory access.

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

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

***Group 1-5 off***

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

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

***Summary***

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

**Issues**

***Resolved issues***

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

***Open issues***

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

**Input contributions**

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

**Recommendations**

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

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

***Software and Common Test Conditions***

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

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

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

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

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

***Technical Report***

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

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

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

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

**Input contributions**

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

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

**Recommendations**

The AHG recommended to:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**Activities**

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

**Recommendations**

The AHG recommends to:

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

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

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

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

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

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

**Less extensive partitioning search**:

--MaxMTTHierarchyDepth=1

--MaxMTTHierarchyDepthISliceL=2

--MaxMTTHierarchyDepthISliceC=2

**Implicit MTS instead of explicit one:**

--MTS=0

--MTSImplicit=1

**Lower number of merge candidates:**

--MaxNumMergeCand=5

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

--MaxMTTHierarchyDepth=2 --MaxMTTHierarchyDepthISliceL=2

--MaxMTTHierarchyDepthISliceC=2 --MaxMTTHierarchyDepthByTid=221111

1. **Recommendation**

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

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

**Anchor Encoding**

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

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

also distributed by AhG14 in JVET-AK0014.

***New training materials***

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

***Dataset access***

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

***Interaction with ECM***

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

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

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

***EE Coordination***

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

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

***Teleconferences***

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

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

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

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

***Performance Evaluation***

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

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

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

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

***Architectural changes***

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

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

***NNVC algorithms description***

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

**Input contributions**

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

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

**Recommendations**

The AHG recommends:

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

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

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

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | All Intra Main 10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -14.59% | -15.70% | -26.79% | 1197.4% | 527.4% |
| Class A2 | -21.11% | -23.87% | -28.39% | 1175.6% | 576.4% |
| Class B | -14.71% | -22.37% | -20.35% | 1115.0% | 622.9% |
| Class C | -14.85% | -11.82% | -12.99% | 1050.3% | 586.3% |
| Class E | -19.17% | -22.39% | -20.59% | 1033.0% | 649.6% |
| Overall | -16.53% | -19.17% | -21.17% | 1109.1% | 594.2% |
| Class D | -12.71% | -8.95% | -9.88% | 1027.3% | 624.9% |
| Class F | -30.26% | -33.90% | -34.10% | 719.4% | 656.4% |
| Class TGM | -43.26% | -48.84% | -48.12% | 543.2% | 622.8% |

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

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

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

**Contributions**

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

***Intra (9)***

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

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

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

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

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

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

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

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

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

***Inter (6)***

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**Recommendations**

The AHG recommended to:

* To review all the related contributions.

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

This period was slow with no meetings or discussions held.

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

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

The following are worthy of discussion for the second edition:

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

These are additional topics for consideration and discussion:

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

**Related contributions**

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

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

***Contributions***

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

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

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

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

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

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

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

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

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

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

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

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

Not uploaded.

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

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

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

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

**Recommendations**

The AHG recommends:

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

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

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

1. **Software development**

***Location***

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

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

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

***Software changes***

***NNVC-12.0***

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

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

In SADL, the following changes were integrated:

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

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

***Software version***

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

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

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

NNVC-11.0rc was tagged December 3rd, 2024

NNVC-10.0 was tagged August 9th, 2024

NNVC-9.1 was tagged May 28th, 2024

NNVC-9.0 was tagged May 13th, 2024

NNVC-8.0 was tagged February 20th, 2024

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

NNVC-7.1 was tagged November 29th, 2023.

NNVC-7.0 was tagged November 3rd, 2023.

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

NNVC-6.0 was tagged September 6th, 2023.

NNVC-5.1 was tagged July 19th, 2023.

NNVC-5.0 was tagged May 11th, 2023.

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

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

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

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

1. **CTC performance**

See configurations section for naming convention.

***Comparison to VTM***

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

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

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

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

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

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main 10** | | | | | | | |
|  | **BD-rate Over NNVC-10.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -9.44% | -13.81% | -15.06% | -9.67% | -16.12% | -17.77% | 119% | 3756% |
| Class A2 | -8.43% | -15.41% | -9.80% | -8.75% | -16.06% | -9.98% | 117% | 3619% |
| Class B | -7.83% | -16.23% | -14.70% | -8.16% | -18.57% | -17.48% | 116% | 3610% |
| Class C | -7.63% | -14.80% | -13.61% | -8.03% | -15.73% | -15.29% | 110% | 3133% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -8.22% | -15.20% | -13.50% | -8.54% | -16.82% | -15.45% | 115% | 3505% |
| Class D | -8.11% | -13.77% | -12.49% | -7.36% | -15.21% | -13.59% | 105% | 2816% |
| Class F | -4.44% | -8.80% | -7.54% | -5.54% | -12.17% | -11.56% | 117% | 1542% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | | |
|  | **BD-rate Over NNVC-10.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | -6.00% | -11.62% | -10.75% | -6.57% | -11.47% | -13.05% | 107% | 3324% |
| Class C | -6.12% | -12.78% | -10.34% | -6.96% | -12.06% | -8.63% | 102% | 3116% |
| Class E | -6.62% | -7.98% | -5.71% | -7.97% | -6.80% | -6.13% | 109% | 2797% |
| **Overall** | -6.19% | -11.10% | -9.35% | -7.05% | -10.50% | -9.85% | 106% | 3116% |
| Class D | -6.98% | -9.73% | -6.65% | -7.15% | -7.63% | -4.39% | 98% | 3028% |
| Class F | -3.58% | -5.89% | -5.19% | -5.78% | -6.59% | -8.53% | 108% | 1687% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | | | |
|  | **BD-rate Over NNVC-10.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | -6.59% | -13.84% | -12.80% | -6.85% | -14.83% | -15.94% | 109% | 3302% |
| Class C | -6.59% | -15.10% | -12.65% | -7.04% | -14.89% | -13.26% | 104% | 3035% |
| Class E | -7.63% | -9.40% | -7.19% | -9.23% | -9.21% | -9.18% | 116% | 3306% |
| **Overall** | -6.85% | -13.15% | -11.35% | -7.51% | -13.44% | -13.35% | 109% | 3212% |
| Class D | -7.42% | -11.49% | -9.48% | -7.53% | -9.29% | -8.74% | 99% | 2777% |
| Class F | -3.99% | -7.42% | -6.72% | -5.92% | -9.50% | -12.42% | 108% | 1657% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main 10** | | | | | | | |
|  | **BD-rate Over NNVC-10.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -10.04% | -15.76% | -15.86% | -9.90% | -18.72% | -18.73% | 161% | 2722% |
| Class A2 | -8.39% | -15.93% | -12.29% | -8.97% | -16.56% | -12.16% | 166% | 2401% |
| Class B | -8.35% | -15.94% | -16.39% | -8.69% | -18.44% | -18.75% | 172% | 2437% |
| Class C | -8.31% | -14.16% | -14.18% | -8.99% | -17.53% | -17.83% | 149% | 1758% |
| Class E | -11.85% | -17.56% | -18.40% | -12.46% | -17.80% | -19.96% | 162% | 2511% |
| **Overall** | -9.21% | -15.78% | -15.46% | -9.63% | -17.87% | -17.64% | 162% | 2314% |
| Class D | -8.20% | -11.93% | -12.73% | -8.35% | -16.84% | -17.48% | 139% | 1556% |
| Class F | -5.77% | -10.64% | -9.99% | -6.21% | -13.77% | -13.81% | 130% | 1898% |

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

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

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

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main 10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -15.60% | -13.69% | -21.60% | -17.26% | -19.06% | -23.79% | 305% | 155418% |
| Class A2 | -15.13% | -20.72% | -26.68% | -14.49% | -20.24% | -23.74% | 283% | 135823% |
| Class B | -13.10% | -24.21% | -17.36% | -11.95% | -22.58% | -16.70% | 294% | 146069% |
| Class C | -13.92% | -17.30% | -16.86% | -12.52% | -14.58% | -14.20% | 229% | 111863% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -14.22% | -19.57% | -19.94% | -13.67% | -19.28% | -18.86% | 275% | 135747% |
| Class D | -14.83% | -17.41% | -17.34% | -11.03% | -12.96% | -11.40% | 226% | 112306% |
| Class F | -8.99% | -11.35% | -10.48% | -9.24% | -12.20% | -10.80% | 412% | 59637% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -13.53% | -10.72% | -17.20% | -15.00% | -16.58% | -19.47% | 360% | 105630% |
| Class A2 | -13.56% | -17.53% | -21.27% | -14.30% | -18.54% | -18.26% | 265% | 84182% |
| Class B | -12.13% | -16.96% | -14.32% | -12.03% | -17.06% | -14.79% | 259% | 80684% |
| Class C | -13.07% | -14.27% | -16.16% | -12.79% | -13.89% | -15.46% | 194% | 52806% |
| Class E | -16.66% | -19.95% | -18.84% | -16.38% | -18.82% | -19.54% | 271% | 89903% |
| **Overall** | -13.56% | -15.91% | -17.12% | -13.80% | -16.81% | -17.09% | 259% | 78755% |
| Class D | -12.19% | -12.68% | -15.79% | -11.24% | -12.70% | -14.68% | 178% | 49898% |
| Class F | -9.96% | -12.44% | -10.41% | -9.68% | -12.47% | -10.99% | 168% | 65233% |

Note: Results from InterDigital, crosschecked by xxx.

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

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

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main 10** | | | | | | | |
|  | **BD-rate Over NNVC-10.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -7.18% | -5.57% | -5.74% | -7.66% | -6.78% | -6.23% | 107% | 1606% |
| Class A2 | -5.92% | -6.40% | -4.16% | -6.51% | -7.01% | -3.96% | 109% | 1481% |
| Class B | -5.45% | -7.56% | -6.50% | -6.25% | -8.21% | -7.34% | 110% | 1516% |
| Class C | -4.95% | -6.49% | -5.83% | -6.01% | -7.79% | -6.45% | 110% | 1382% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -5.75% | -6.65% | -5.70% | -6.52% | -7.57% | -6.20% | 109% | 1489% |
| Class D | -4.87% | -5.48% | -4.91% | -5.46% | -6.03% | -5.38% | 108% | 1307% |
| Class F | -2.93% | -3.49% | -3.22% | -3.87% | -5.61% | -4.54% | 112% | 726% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | | |
|  | **BD-rate Over NNVC-10.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -8.24% | -8.99% | -8.35% | -8.36% | -10.77% | -9.22% | 150% | 1248% |
| Class A2 | -6.80% | -8.35% | -6.85% | -7.16% | -8.55% | -6.21% | 151% | 1154% |
| Class B | -6.73% | -8.80% | -8.72% | -7.11% | -9.70% | -9.50% | 154% | 1176% |
| Class C | -6.25% | -7.86% | -7.59% | -7.16% | -9.37% | -8.65% | 143% | 966% |
| Class E | -9.34% | -10.06% | -9.98% | -10.08% | -9.77% | -9.18% | 153% | 1223% |
| **Overall** | -7.32% | -8.76% | -8.30% | -7.83% | -9.63% | -8.67% | 150% | 1141% |
| Class D | -6.10% | -6.89% | -6.85% | -6.61% | -8.78% | -8.50% | 136% | 911% |
| Class F | -4.31% | -5.60% | -5.58% | -4.75% | -7.00% | -6.89% | 122% | 861% |

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

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

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

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

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main 10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -12.07% | -10.17% | -10.56% | -19.18% | -21.21% | -20.88% |  |  |
| Class A2 | -8.86% | -6.49% | -1.95% | -17.40% | -15.13% | -14.57% |  |  |
| Class B | -7.29% | -15.44% | -14.36% | -7.96% | -17.45% | -16.84% |  |  |
| Class C | -6.91% | -13.77% | -13.51% | -7.78% | -14.78% | -15.09% |  |  |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -8.46% | -12.15% | -10.89% | -12.04% | -17.02% | -16.73% |  |  |
| Class D | -7.13% | -13.31% | -12.30% | -6.87% | -14.56% | -13.06% |  |  |
| Class F | -4.02% | -8.28% | -7.29% | -5.03% | -10.94% | -10.87% |  |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -10.98% | -9.96% | -11.73% | -13.82% | -13.69% | -13.78% |  |  |
| Class A2 | -11.00% | -4.54% | -1.25% | -17.09% | -6.78% | -2.52% |  |  |
| Class B | -7.86% | -15.36% | -16.39% | -8.27% | -17.73% | -18.36% |  |  |
| Class C | -7.71% | -14.17% | -14.72% | -8.57% | -17.34% | -17.80% |  |  |
| Class E | -11.22% | -17.07% | -18.08% | -11.90% | -17.26% | -19.04% |  |  |
| **Overall** | -9.43% | -12.68% | -13.00% | -11.34% | -15.07% | -14.95% |  |  |
| Class D | -7.61% | -12.34% | -13.39% | -7.97% | -16.35% | -17.00% |  |  |
| Class F | -5.39% | -9.85% | -9.70% | -5.81% | -12.75% | -13.41% |  |  |

Note: Results from HUTS, crosschecked by xxx.

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

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

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main 10** | | | | | | | |
|  | **BD-rate Over NNVC-11** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -0.62% | -0.96% | -0.90% | -0.26% | -1.79% | -2.13% | 100% | 97% |
| Class A2 | -0.59% | -1.31% | -0.13% | -0.42% | -1.23% | -0.52% | 100% | 99% |
| Class B | -0.58% | -1.01% | -0.41% | -0.21% | -1.51% | -0.82% | 97% | 96% |
| Class C | -0.77% | -1.21% | -0.10% | -0.28% | -1.19% | -0.25% | 94% | 94% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -0.64% | -1.11% | -0.37% | -0.28% | -1.42% | -0.87% | 97% | 96% |
| Class D | -1.07% | -0.54% | -0.22% | -0.52% | -0.93% | -0.37% | 93% | 92% |
| Class F | -0.44% | -0.65% | -0.32% | -0.54% | -1.57% | -0.88% | 95% | 90% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | | |
|  | **BD-rate Over NNVC-11** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | -0.16% | -0.11% | 0.32% | 0.41% | 0.38% | 0.21% | 99% | 90% |
| Class C | -0.55% | -1.30% | 0.50% | 0.05% | -2.00% | 0.59% | 100% | 98% |
| Class E | -0.11% | -3.78% | 2.22% | 0.56% | -4.88% | 0.39% | 101% | 78% |
| **Overall** | -0.28% | -1.42% | 0.85% | 0.33% | -1.73% | 0.39% | 100% | 89% |
| Class D | -0.69% | -0.89% | 1.37% | -0.07% | -3.36% | 2.04% | 100% | 101% |
| Class F | -0.26% | -0.49% | 0.52% | -0.28% | -1.35% | -1.18% | 101% | 93% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | | | |
|  | **BD-rate Over NNVC-11** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | -0.29% | 0.60% | 0.65% | 0.54% | 1.82% | 1.30% | 98% | 91% |
| Class C | -0.64% | -1.62% | 0.09% | 0.16% | -2.29% | -0.01% | 101% | 100% |
| Class E | -0.29% | -3.94% | 1.87% | 0.29% | -4.75% | -0.93% | 103% | 90% |
| **Overall** | -0.41% | -1.27% | 0.77% | 0.35% | -1.19% | 0.31% | 100% | 94% |
| Class D | -0.87% | -0.59% | -0.21% | -0.12% | -1.97% | -0.07% | 100% | 100% |
| Class F | -0.36% | -0.51% | 0.17% | -0.46% | -1.46% | -0.58% | 100% | 99% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main 10** | | | | | | | |
|  | **BD-rate Over NNVC-11** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -0.95% | -0.18% | 1.04% | -0.57% | -0.40% | -0.78% | 94% | 96% |
| Class A2 | -0.47% | -0.66% | -0.09% | -0.47% | -0.63% | -0.32% | 97% | 97% |
| Class B | -0.53% | -0.73% | 0.01% | -0.46% | -0.95% | -0.50% | 100% | 100% |
| Class C | -0.65% | -0.02% | 0.64% | -0.45% | -0.30% | -0.09% | 97% | 94% |
| Class E | -0.71% | -0.59% | -0.41% | -0.62% | -0.70% | -1.20% | 98% | 96% |
| **Overall** | -0.65% | -0.45% | 0.24% | -0.50% | -0.62% | -0.54% | 97% | 97% |
| Class D | -0.64% | 0.41% | 0.73% | -0.42% | -0.69% | -0.77% | 95% | 93% |
| Class F | -0.41% | -0.95% | -0.36% | -0.42% | -1.31% | -0.53% | 96% | 97% |

Note: Results from InterDigital, crosschecked by Nokia.

1. **Contributions**

There were 2 contributions for AhG14 and 1 telco report.

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

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

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

1. **Configurations**

The following configurations were 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 the previous NNVC software basis
* N: not tested.

The column “xcheck” is read as follow:

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

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

Deprecated options:

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

**Recommendations**

The AHG recommended to:

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

Encourage people to submit merge requests fixing identified bugs.

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

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

1. **Test results**

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

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

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

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

**SDR**

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

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

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

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

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

**HDR**

There are still no HDR versions for Level1 and Darktree.

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

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

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

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

1. **Input contributions**

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

1. **Recommendations**

The AHG recommended to:

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

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

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

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

**Related contributions**

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

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

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

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

**Recommendations**

The AHG recommended to:

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

Contributions to AHG9 can be reviewed separately in HLS track.

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

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

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

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

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

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

Relatedcontributions

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

**Recommendations**

The AHG recommends:

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

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

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

***Teleconferences***

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

The following topics were discussed:

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

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

1. **Related contributions**

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

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

1. **Recommendations**

The AHG recommends:

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

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

# Project development (60)

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

Contributions in this area were discussed during 0850–0905 on Monday 31 March 2025 (chaired by JRO).

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

This information contribution contains a survey of deployed products and services using the HEVC standard and the formal specifications in which it is supported, along with a brief introduction to the standard written for broad readership. Revision marking is included to show changes relative to JVET-AI0020-v2 of July 2024.

As of January 7, 2024, the reported support in browsers had further risen to 93% for “all users” (94% for “all tracked”, “91% for tracked desktop”, and 96% for “tracked mobile”).

As of August 2024, ScientiaMobile reported statistics for video capabilities of mobile devices, reporting that by the second quarter of 2024, 95% of smartphone usage was from devices with hardware support for HEVC decoding.

As of February 2025, Bitmovin reported the following statistics from a video developer survey of September to December 2024 with 167 responding “video developers and industry experts” from 34 countries:

* 1. 49% of developers “currently using” HEVC in production
  2. 25% of developers “planning to implement” HEVC within 12 months

The terrestrial and satellite broadcasters **France 2** and **France 3** began UHD broadcasting using HEVC in late 2023 or early 2024, deploying the service in advance of the 2024 Paris Summer Olympics. A complete transition is planned, with shutdown of the current HD service projected in 2029.

The Italian public broadcaster **RAI** (Radiotelevisione italiana) switched its “Mux 2” terrestrial multiplex to HEVC and began broadcasting some channels exclusively in this format on August 28, 2024.

**Amazon’s Twitch Enhanced Broadcasting** was released with beta support for HEVC in September 2024 (using Nvidia encoders).

**Firefox** browser support for HEVC began in January 2025, for use when hardware support is available on the device.

* 1. For Windows devices, the support was added to an early beta release (for version 129) in July 2024, a beta release in November 2024 and the corresponding main release 134 on January 6, 2025 (official release date January 7, 2025).
  2. For Linux devices, the support (based on the Linux VA-API) was added in a beta release (for version 137) on March 4, 2025. The corresponding main release is expected in April 2025.

**Broadcasting summary**: Summarizing what is further detailed in the document:

1. HEVC is the *primary* video broadcast format in Benin (2017), Croatia (2020), Czech Republic (2020), Germany (2017), Italy (2017), Netherlands (2019), Poland (2022), and Seychelles (2017).
2. It is also used for terrestrial broadcast in France (2024), Hungary (2020), Iran (2018), Korea (2016), and various African countries (via Chinese-operated broadcast 2017).
3. With a variety of service providers, HEVC has basically been deployed globally by satellite, cable, and broadband IP broadcasters since around 2017.

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

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

Revision marking is included to show changes relative to JVET-AJ0021-v2 of December 2024.

Bitmovin reported the following statistics in February 2025 from a video developer survey of September to December 2024 with 167 responding “video developers and industry experts” from 34 countries:

1. 6% of developers “currently using” VVC in production
2. 13% of developers “planning to implement” VVC within 12 months

**The Ultra Video Group at Tampere University** released uvg266, a VVC encoding codebase first announced in early 2022, developed from the prior Kvazaar HEVC encoder software package. Its initial development focused was only on intra coding. It has since been expanded to include inter coding as well, although it continues to have a particular emphasis on intra coding.

**HandBrake**, a video transcoder library, was updated to support VVC decoding in release 1.9.0 using the Intel QuickSync Video (QSV) pipeline on 1 December 2024.

**GStreamer**, a library for constructing graphs of media-handling components, was released with VVC support in release 1.26.0 on 11 March 2025.

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

Was presented in joint meeting with parent bodies (see section 7.3.1).

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

Was presented in joint meeting with parent bodies (see section 7.3.1).

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

Contributions in this area were discussed during 0615–0700 on Tuesday 1 April 2025 (chaired by JRO).

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

This document provides proposed draft text edits for HEVC, focused on the profile specification aspects of the draft text in the JVET-AK1006 output document of the previous meeting, the identified problems recorded in JVET-AK1004, and the USNB comments on the ISO/IEC CDAM consultation. The suggested edits are especially, but not exclusively, relating to the multiview profiles. The contribution is characterized as essentially editorial in nature.

The contribution is primarily in the form of an edited copy of the current published ITU-T text (the 10th edition approved in July 2024), with change marks made using editing IDs that identify the nature of the changes that are suggested. Editors’ notes are included that can be found either by searching for change marks or by searching for the prefixing string “[Ed. ”.

The work on these edits was not complete at the time of the “-v1” document submission, and the author indicated an intent to submit additional versions. However, the document should suffice for showing the approximate spirit and nature of the suggested changes.

It was agreed that the suggested changes and editorial fixes/clarifications in v3 are necessary (and some further items were already identified during the presentation, to be included in v4 of JVET-AL0223.

Some of the changes also clarify nesting of profiles in the context of scalable and multiview profiles defined around 10 years ago.

The changes were agreed to be integrated into JVET-AL1006 (as delta text) and into a preliminary version of the next H.265 version JVET-AL1018 (integrated text).

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

See section 4.2.

## AHG3: Software development (0)

This section is kept as a template for future use.

## AHG3: Test conditions (3)

Contributions in this area were discussed during 1320–1355 on Monday 31 March 2025 (chaired by JRO).

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

The document proposes an update to the CTC and the cfg directory on the ECM git repository, which properly sets the IntraPeriod parameter for RA in the configuration files.

It was agreed by software coordinator that a clarification to avoid mistaken simulations would ba appropriate, but rather than duplicating config files a better solution would be to include another parameter in the config file such that the encoder can set the intra period (depending on frame rate) automatically correct per sequence.

F. Bossen will take action.

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

This document requests JVET to consider modifying the method used for routine objective rate-distortion testing of “low-delay” configurations for high-resolution video content. It is commented that it has become common for experiment results using this type of encoding to be unavailable for review in a timely manner (e.g., at JVET meetings) due to the time required for running the experiments, which each involve encoding a long series of frames in a sequential manner. The suggested alternative is to divide a test sequence into closed-GOP segments that are coded independently of each other and to measure only the bit rate and distortion for the non-intra frames. It is acknowledged that this approach may not be appropriate for subjective testing, but it is suggested to be reasonable for typical objective test experiments. Tests performed in this manner are suggested to use a different configuration name and abbreviation than LD / LDB / LDP, such as IFS / IFSB / IFSP for “independent forward segment” (IFS) coding testing. Using a different abbreviation for this scheme would help to clarify which type of testing has been done.

A hypothetical alternative approach of using temporal sublayers is also suggested to be a possible way to reduce encoding times, but that seems more difficult to implement in test model software. In such a scheme, the lowest temporal layer would be coded first, followed by parallel encoding of the higher temporal sublayers, with all frames using only forward temporal prediction. The result would be mathematically equivalent to the result that would be obtained by sequential encoding with temporal sublayers.

The proponents’ understanding is that the current “low delay” CTC testing scheme uses a dyadic hierarchy for QP settings but does not use temporal sublayers for the referencing structure.

To make the proposal specific, an intra period of 64 frames is suggested for the IFS scheme, and it is proposed for objective testing of 720p and higher resolutions (CTC test sequence classes A, B and E).

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

It was commented that the problem is mainly relevant for ECM, as runtime in VTM is manageable (as long as picture size is restricted to HD). It would be better to seek for test conditions that would be manageable in runtime (such as some oft the ideas of faster partitioning at the current meeting)

One expert expressed support to think about the proposal.

It was suggested that another approach might be to test low delay with a long intra period. Even for RA, often longer intra periods are used than one second.

The implementation of temporal sublayers for low delay might not be simple in VTM, and might cause some disadvantage in compression. Due to dependency, it might not right away allow parallel encoding.

No item to take action at the current meeting. Further study would be necessary to confirm how the inserted intra pictures would need to be configured (QP, etc.), and also to find how reliable results are in terms of judging the benefit. It could for example be assessed how precise the coding gain from one ECM version to the next would be reflected in LD modes.

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

Was discussed in BoG JVET-AL0337

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

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

Contributions in this area were discussed during 1310–1330 on Friday 4 April 2025 (chaired by JRO).

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

This document proposes updates to the verification test plan for VVC multilayer coding.For spatial scalability, it is suggested to

* Test only 2x scaling factor, HD+UHD
* Select only one QP for base layer, targeting around MOS 7 or 8 when upscaled to UHD, mostly due to loss of detail sharpness. Suitable QP may be around 27 to 29.
* Use 10% bitrate for the enhancement layer (select enhancement layer QP that gives the closest bitrate ratio)
* Test against both upscaled base layer and single-layer UHD
* Optionally, also test SHVC in the same configuration (using the SHM version and configuration used in SHVC verification tests). However, testing against SHVC is more relevant in category 2 and could be dropped for category 1.

For quality ladder, it is suggested to focus on:

* 2x scaling ratio using HD+UHD, with 50% bitrate for the enhancement layer (equal bitrate for both layers, like in SHVC verification tests)
* 1.5x scaling ratio using 720p+HD, with 33% bitrate for the enhancement layer (half bitrate for enhancement layer compared to base layer, like in SHVC verification tests)
* Test against full-resolution single-layer
* Use 3 or 4 rate points for each sequence, potentially dropping the low quality end (e.g. focus on MOS 4, 6, 8)
* Also test SHVC in similar conditions (using SHM version and configurations used in SHVC verification tests)

Test sequences are suggested to be used (possibly a selection) from the set described in AG 5 N 160.

It may be necessary to conduct preparation work in the AHG period before the 39th meeting, to settle on test sequences, VTM version, precise configuration, and organize encoding of bitstreams.

For SHVC, an HEVC base layer would be used, even though in principle VVC would be possible as external reference.

Further work in AHG4, target to propose a draft of updated test plan as input to the 39th meeting, and potentially conduct expert viewing in Daejeon.

## AHG4: Test and training material (0)

This section is kept as a template for future use.

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

## AHG5: Conformance test development (0)

This section is kept as a template for future use.

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

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

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

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

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

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

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

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

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

Further study encouraged – no immediate point for action.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Was discussed in BoG JVET-AL0337

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

Was discussed in BoG JVET-AL0337

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

Within the study of AHG7 about tools with excessive memory requirement, denoted as group5, it is asserted that the legacy VVC SPS flag (sps\_log2\_max\_luma\_transform\_size\_minus5) that controls the maximum transform size is broken in ECM. This contribution provides the details of the problem and proposes a solution to re-enable the usage of this SPS flag.

It was agreed that for the purpose of AHG7 study (not in CTC) it is appropriate to use the configuration restriction of not allowing CU size larger than TU size (encoder only). It is noted that this results in slightly more loss than necessary, but fixing the problem in software would be a big effort, as various ECM tools might need to be fixed.

Decision(SW/BF): Adopt the necessary software patch to make the encoder-only solution working.

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

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

Contributions in this area were discussed during 1355–1415 on Monday 31 March 2025 (chaired by JRO).

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

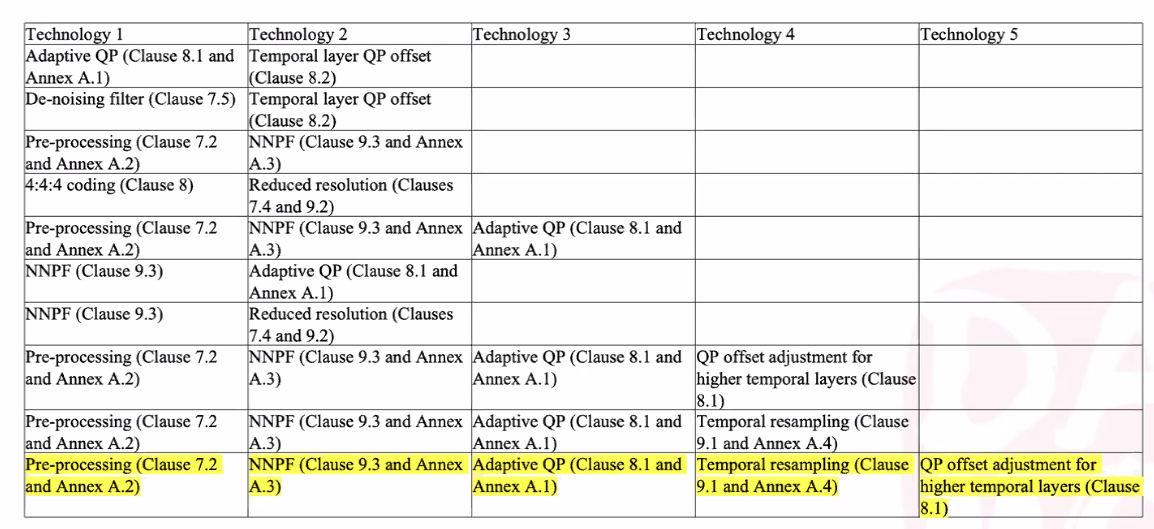
This contribution reports the dense QP coding results of jointly enabling adaptive temporal resampling, pre-processing, ROI-based adaptive QP (ROIAQP), QP offset adjustment for higher temporal layers (QPOA) and post-processing algorithms for machine vision.

According to suggestion of last JVET meeting, two sets of algorithms are evaluated under common test conditions (CTC). Set 3 is the combination of adaptive temporal resampling, pre-processing, ROIAQP and post-processing. Set 4 additionally enabling QPOA on top of set 3. It is reported that set 3 achieves 33.77% (RA), 44.33% (LD) and 80.91% (AI) averaged BD-rate savings for object detection on SFU-HW dataset, and 62.89% (RA), 59.96% (LD), 92.33%(AI) averaged BD-rate savings are achieved for object tracking on TVD dataset. Set 4 achieves 35.84% (RA), 44.45% (LD) and 80.91% (AI) averaged BD-rate savings for object detection on SFU-HW dataset, and 65.03% (RA), 63.36% (LD), 92.33% (AI) averaged BD-rate savings for object tracking on TVD dataset.

This contribution reports the dense QP coding results of jointly enabling adaptive temporal resampling, pre-processing, ROI-based adaptive QP (ROIAQP), QP offset adjustment for higher temporal layers (QPOA) and post-processing algorithms for machine vision.

According to suggestion of last JVET meeting, two sets of algorithms are evaluated under common test conditions (CTC). Set 3 is the combination of adaptive temporal resampling, pre-processing, ROIAQP and post-processing. Set 4 additionally enabling QPOA on top of set 3. It is reported that set 3 achieves 33.77% (RA), 44.33% (LD) and 80.91% (AI) averaged BD-rate savings for object detection on SFU-HW dataset, and 62.89% (RA), 59.96%(LD), -92.33xx%(AI) averaged BD-rate savings are achieved for object tracking on TVD dataset. Set 4 achieves 35.84% (RA), 44.45% (LD) and 80.91% (AI) averaged BD-rate savings for object detection on SFU-HW dataset, and 65.03xx% (RA), 63.36xx%(LD), -92.33xx%(AI) averaged BD-rate savings for object tracking on TVD dataset.

It was requested to extend the table of combinations as follows:



The combination can be enabled via the config file, the code existed before and was not changed (was cross-checked previously independently).

It was pointed out that the QP offset adjustment is in clause 8.2 (not 8.1). This also needs to be corrected in the current table of the TR (JVET-AK2030).

It was agreed to include the yellow highlighted row as 10th combination into the table. It was encouraged to upload the bitstreams for the new combinations to the MPEG content server.

Editors of the TR were asked to prepare a draft of the DoCR to be reviewed on Wednesday.

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

Contributions in this area were discussed during 1415–1510 on Monday 31 March 2025 (chaired by JRO).

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

It was reported that JVET-AL0074 includes description of a method where the best selection of enhancement layer QP and the performance improvement achieved by enhancement layer can be explaind by “bitrate sweep”. It was suggested to p erform further study and provide more information with an input contribution by the next meeting for better understanding of the method. This is relevant to get a better understanding how to best configure multi-layer encoders.

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

Was discussed in BoG JVET-AL0337.

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

[JVET-AL0332](https://jvet-experts.org/doc_end_user/current_document.php?id=15659) Crosscheck of JVET-AL0055 (AhG10: On constrained encoder configuration of VTM) [R. Ishimoto, T. Ikai (Sharp)] [late]

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

There are two rounds of non-RD intra mode selection in the current ECM. First, mode 0, 1 and all even number angular intra modes are tested and a smaller number of modes are selected based on non-RD cost measurements. Second, two adjacent odd number angular intra modes for each of the selected angular modes are further tested. If the current block is MPDIP eligible and the tested mode is an MPDIP mode, MPDIP is used in the first round of mode selection to calculate the non-RD cost. This contribution proposes that mode 0, 1 and all odd number instead of even number angular intra modes are tested to avoid too many MPDIP prediction calculations in the first round of mode selection. If the tested odd number angular intra mode is either excluding mode or MDIP, an adjacent even mode is used to estimate the bits for non-RD cost calculation. Similar to the current ECM, two adjacent even number angular intra modes for each of the selected angular modes are further tested, but the excluding modes or MDIP selected from the first round will not be included in the second round of mode selection. There are no other changes to the intra mode selection process. Simulation results of the proposed method on top of the ECM-16.1 are reported below:

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

*Random-Access\**: {-0.01%, -0.01%, 0.08%, EncT: 99.6%, DecT: 100.2%}

Cross-checker supports the proposal, also reports that less MPDIP checking is performed and MPDIP is less frequently used in total, they found even larger runtime reduction but believe that was not reliable in their cluster.

Also another independent expert supported this as a good simplification of encoder.

Decision(SW): Adopt JVET-AL0114.

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

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

The current approach for matching target bitrate for subjective evaluation is to increase the base QP by one at a given frame. This may give an abrupt change in quality after the QP change. In this document it is proposed to start from the base QP closest to the target bitrate and adjust the lambda to correspond to a fractional QP in-between the two closest QPs.

It is proposed to add this functionality to the VTM reference software and is suggested to use it for matching a target bitrate in the context of subjective quality evaluation.

v2 also contains results for low-delay configuration and also some fixes to the results.

It was asked if results for ECM are also available? Not yet.

Results in terms of adjusting to the target rate are slightly less accurate than for the current QP+1 method.

It was commented that VTM has already different approaches for estimating the best adjustment point.

To be further studied in the context of preparing anchors for CfE.

It was asked if the current “QP+1” method was designed to match the target rate +/- 2% (as usually required in past Calls)? Not known, might have been designed 10-15 years ago.

Proponents are requested to prepare rate-matched bitstreams following the conditions defined in JVET-AL2026 in the context of the AHG17 activities.

Decision (SW/non-CTC): Adopt JVET-AL0207, to be included in VTM23.9

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

Contributions in this area were discussed during 0725–0920 on Tuesday 1 April 2025 (chaired by JRO).

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

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

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

The same change is proposed for VSEI and HEVC (but not for AVC). In the second version of this contribution the proposed change for AVC is withdrawn since the extension mechanism in the SEI message syntax table does not exist in AVC. The second version of the proposal also adds setting the variable SeiExtensionBitsPresentFlag equal to 1 in the syntax table.

The proposed solution would not be in conflict with existing implementations, as the new syntax elements could be ignored. The parameters would give the information about the intended resolution that the parameters were generated for in the SEI message itself.

It was asked if it would in principle be possible to have several SEI messages for different resolutions in the same bitstream. It was commented that this could be problematic for existing implementations that would ignore the new parameters, and not know which one to use. It would further cause the problem that those would need to be within a given resolution. It was further commented that additional messages could also be provided by SPO/PON.

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

This work presents several enhancements to the film grain analysis process. The proposed enhancements, primarily software updates, represent a natural progression aimed at improving the functionality of the software. They include:

* Improved cut-off frequency estimation where cut-off frequencies are now estimated per intensity interval.
* Improved scaling factor estimation by aggregating over the time data points used to fit the curve.
* Not performing analysis of chroma film grain when there is no grain in luma.
* Fixing the bug in cut-off frequency estimation.
* Fixing the bug (at one place only) that considered only 10bit input when processing data points in scaling function estimation.

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

Different cutoff frequencies can be used per intensity interval, and a 16x16 block grid is used for estimation. Both are functionalities supported by the SEI message, but not in current analysis software yet.

Scaling factor is stabilized to have less variation over different frames.

Decision(SW): Adopt JVET-AL0282 to film grain part of VTM

Decision: Also include in the TR new version JVET-AL2020

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

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

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

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

The showcase demonstrates for an image example that applying FGC with parameters intended for usage at full resolution at the coded lower resolution and upsampling to full resolution is inappropriate in quality. Using parameters designed for low resolution and upsampling is somewhat better, but not as good as when the film grain is overlaid after upsampling. Also the effect of different appearance before and after resolution switching is shown.

It was commented that in terms of some existing hardware implementation, it would be important to make the processing at coded resolution and not at display resolution. This would not be possible when using the picture size of SPS.

It was commented that in principle translation of parameters from one resolution to another would be possible. Also, it would be relevant that the grain does not change when resolution is switched. Grain characteristics are usually related to a certain resolution, and it is important that the SEI message signals which is the intended resolution, and this information is coming from PPS in the current FGC design.

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

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

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

Conceptually similar to JVET-AL0086, with some syntax differences.

It was commented that in some previous precedence case, using extension mechanisms was disliked. It might however in the current case resolve the problem for new implementations and avoid possible conflict with existing implementations.

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

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

Proponents believe that this could also be implemented for HEVC and AVC, but current proposal is only for VVC.

It was commented that in case of a resolution change, it might happen that an SEI message is cancelled, such that a persistence problem might occur when changing back to the old resolution.

It was further suggested that it might also be desirable to include colour information.

It was asked how a decoder would know to ignore a non-nested FGC SEI (if present along with nested ones) – it would be up to the decoder to select.

It was commented that at this moment a minimum change would be desirable to resolve the known problem. Further study would be necessary to identify issues in terms of necessity of having colour expression, or have FGC sent for different resolutions, or re-purpose FGC parameters for a different resolution if needed at the receiver end.

It was commented that in the extension mechanisms proposed in JVET-AL0204, an implicit resampling mechanism is foreseen, which also refers to the aspect of cropping.

Decision: Include in TuC JVET-AL2032

General summary:

At this point of discussion, the solution proposed in JVET-AL0086 and JVET-AL0204 appears the most appropriate. Proponents are asked to provide a joint text proposal for the extension mechanism. Other experts are asked to check the aspects of implicit resampling and handling of cropping in JVET-AL0204 for adequateness, and also possible usage in the resolution switching in streaming applications.

[JVET-AL0339](https://jvet-experts.org/doc_end_user/current_document.php?id=15666) AHG9: Merged text of JVET-AL0086 and JVET-AL0204 for the FGC SEI message [M. M. Hannuksela, J. Boyce (Nokia), J. Samuelsson-Allendes, S. Deshpande (Sharp)] [late]

This contribution proposes a joint text merging the proposals of JVET-AL0086 and JVET-AL0204 related to the FGC SEI message.

The same change is proposed for VSEI and HEVC.

The following aspects are proposed in this contribution:

1. Gating the extension of the FGC SEI message as proposed in JVET-AL0086-v2.
2. fg\_spatial\_resolution\_present\_flag included in the extension of the FGC SEI message, which is a gating flag for fg\_pic\_width\_in\_luma\_samples and fg\_pic\_height\_in\_luma\_samples. (JVET-AL0086)
3. Addition of fg\_pic\_width\_in\_luma\_samples and fg\_pic\_height\_in\_luma\_samples to the extension of the FGC SEI message. When present, they indicate the width and the height of the picture for which the film grain modelling information is indicated in units of luma samples. When fg\_pic\_width\_in\_luma\_samples and fg\_pic\_height\_in\_luma\_samples are not present, there is no change to the existing specifications on picture width and height for the FGC SEI message. (JVET-AL0204, JVET-AL0086)
4. Clarifications how the input image Î to which the film grain model applies is derived. (JVET-AL0204)

Proponents explain they believe that together with the specifications in SPO and PON, the specification text contains enough information for correct interpretation, including the presence of multiple messages in the PON context.

A similar text as for VVC (section 3 of the contribution) would also be needed for HEVC in terms of usage in SPO/PON, and also the FGC SEI message would need to be modified in HEVC.

No action on AVC.

It was commented that in SPO at least two SEI messages need to be present, therefore it cannot be used for the case when multiple variants of FGC are needed (as for the application case of JVET-AL0211). Further study would be needed for that, and could be resolved by either modifying SPO/PON, or adding yet another SEI message for that purpose.

Decision: Adopt JVET-AL0339 for JVET-AL1006, JVET-AL2005, JVET-AL2006

## Implementation studies (0)

This section is kept as a template for future use.

## Profile/tier/level specification (0)

This section is kept as a template for future use.

## AHG15: Gaming content compression (0)

This section is kept as a template for future use.

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

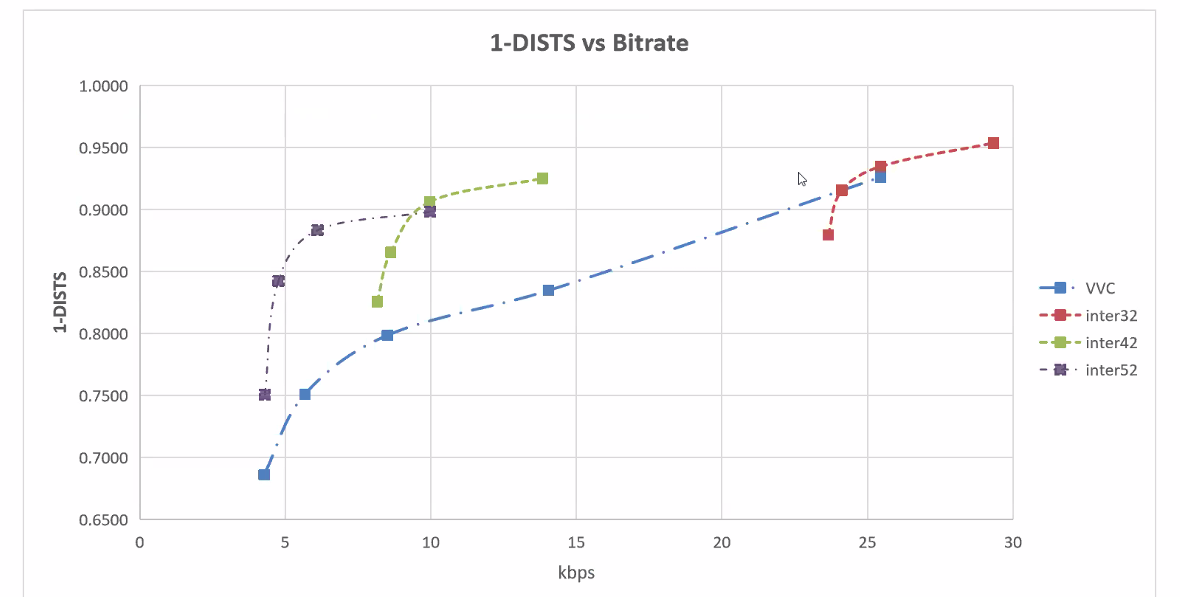
Contributions in this area were discussed during 0730–0840 on Wednesday 2 April 2025 (chaired by JRO).

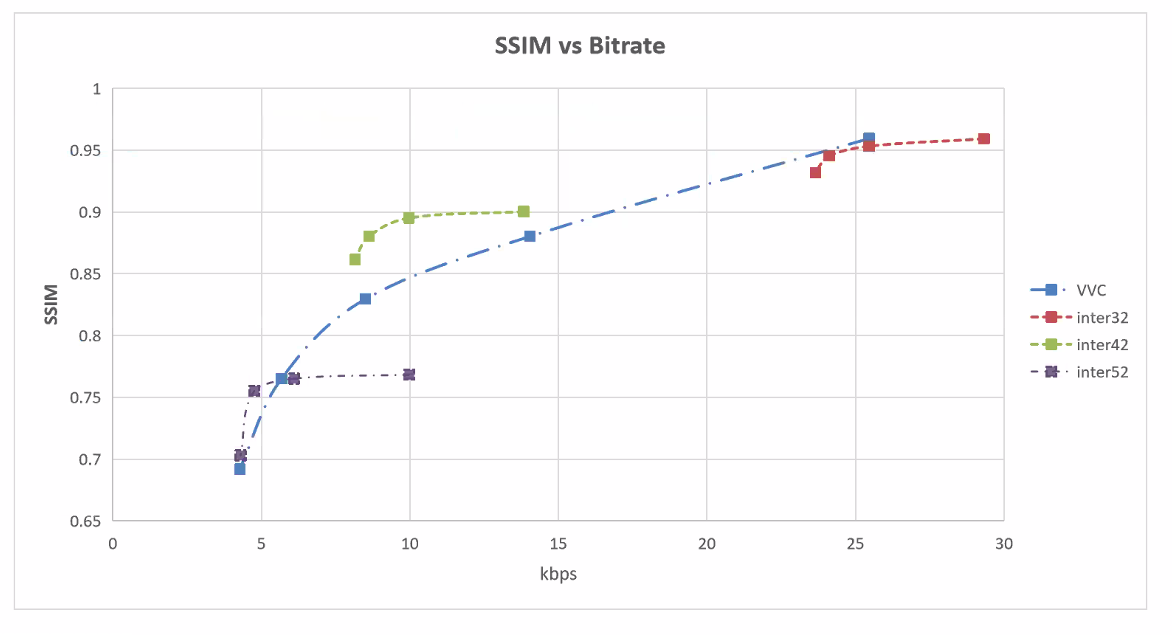
Also refer to section 6.2.6.

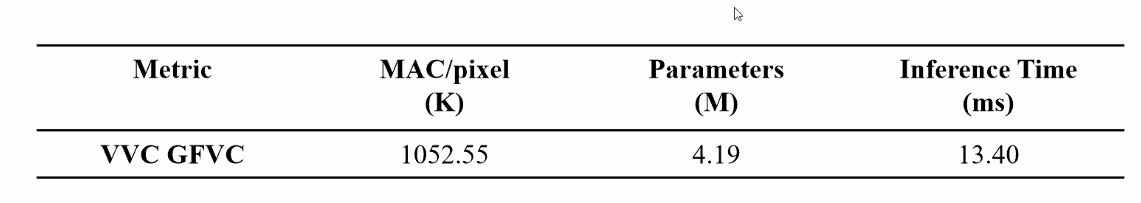
[JVET-AL0101](https://jvet-experts.org/doc_end_user/current_document.php?id=15426) AHG16: Further experiments on VVC GFVC [L. Liu, C. Jung (Xidian Univ.)]

In JVET-AK0068, a GFVC extension of the VVC standard has been proposed for face video compression, named VVC GFVC. According to the JVET note of 37th JVET meeting, this contribution reports the test results for inter frame with different QPs, bad case visual results and network complexity. Following the training strategy proposed in JVET-AK0068, the input inter frames and intra frame are compressed by VTM 22.2 at different QPs (22, 32, 42, 52), then VVC GFVC directly calls the trained second stage model (inter QP(52), intra QP(22)) and retrains 5 epoch for it on different QP inter frame (inter QP(42, 32, 22), intra QP(22)) in the third training stage, while the different QP intraframes (intra QP(22, 32, 42, 52)) are only used for inference. Compared to the anchor VTM 22.2 (LDB), the BD-rate performance of VVC GFVC is as follows:

* For inter QP 22, VVC GFVC achieves average BD-rate savings of {-24.27%, -0.00%, -108.14%, -0.00%} in DISTS, LPIPS, PSNR and SSIM on Class A and Class B.
* For inter QP 32, VVC GFVC achieves average BD-rate savings of {-2.34%, -0.00%, -48.57%, -0.00%} in DISTS, LPIPS, PSNR and SSIM on Class A and Class B.
* For inter QP 42, VVC GFVC achieves average BD-rate savings of {21.32%, 16.71%, 14.86%, 22.20%} in DISTS, LPIPS, PSNR and SSIM on Class A and Class B.
* For inter QP 52, VVC GFVC achieves average BD-rate savings of {43.50%, 46.81%, 5.64%, 4.24%} in DISTS, LPIPS, PSNR and SSIM on Class A and Class B.







Different models were trained for QP52, QP42 and QP32. Almost no benefit against VVC with QP32.

It was asked how the method would compare against the SEI-based GFVC approach. The current framework also includes possibility of hybrid solutions, where some bad-quality inter frames are coded in VVC.

It would be interesting to see if (for example at very low bit rates) the quality could become better than with the SEI message, by avoiding the overhead caused by sending parameters per frame.

It was recommended to perform comparison against the SEI message under CTC of GFVC, JVET-AJ2035.

It was suggested that the intra picture coded at QP22 could also be used as a long-term reference in VVC to improve quality.

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

This contribution provides further experiments incorporating SEI messaging into the QP-adaptive GFVC framework (JVET-AK0069) on 256x246 and 512x512 test sequences from Classes A, B, C and D, in accordance with JVET AHG16's feedback. The results on the 256x256 test set in SEI mode reveal that the QP-adaptive GFVC achieves BD-rate reductions of 11.32% in DISTS and 10.3% in LPIPS. Moreover, when evaluated on both the 256×256 and 512×512 test sets, the QP-adaptive GFVC demonstrates BD-rate reductions of 16.57% in DISTS and -1.89% in LPIPS. The results verify the robustness and effectiveness of the QP-adaptive GFVC in enhancing perceptual quality and compression efficiency across different resolutions and compression conditions.

Was already reviewed in HLS, and not assessed to be mature.

From the results, it is not clear that there is benefit. The RD graphs are crossing and overlapping, so BD rates are not conclusive. No cross-check available.

The CTC JVET-AJ2035 is not fully followed.

Further study.

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

In JVET-AG0048, we investigated the issue of interoperability among different GFVC systems and solved the interoperablity problem by adding face parameter translators to the AHG16 software. With these translators, it was shown that three different types of face parameters from different GFVC algorithms can be effectively adapted to one another while retaining promising coding performance. During 34th to 37th JVET meetings, several updates have been made to the GFVC models in the AHG16 software, including more algorithms, more diverse training data, multi-resolution models etc., which resulted in the existing parameter translators in the latest AHG16 software becoming outdated (e.g. inability to handle 512x512 resolution). In this contribution, we propose to update face parameter translators in the AHG16 software with a refined difference translation scheme. Experimental results show that refined translators can achieve translations between 4 multi-resolution models on both 256×256 and 512×512 resolutions while retaining promising coding performance.

The translation in feature difference domain provides results which are visually closer to the original than with previous translators between different GFVC algorithms. Also objective metrics are clearly improved.

Decision(SW): Add JVET-AL0147 to AHG branch of software, replace existing translation.

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

This contribution proposes to add a colour calibration process on the generated face pictures as an optional post-processing to solve the occasional colour shift issue observed in some generated pictures by the proponent. Three options are provided in the contribution as follows.

* Option 1: add a calibration flag in the GFV SEI message and perform colour calibration on the generated picture based on the distribution parameters derived from the current decoded picture when the calibration flag is on.
* Option 2: add a calibration flag in the GFV SEI message and signal the colour distribution parameters when the flag is on, and perform the colour calibration on the generated pictures based on the distribution parameters signalled.
* Option 3: add an indication flag in GFV SEI message to indicate whether the current generated picture can be used for the colour calibration of the generated picture.

In version 2, Option 3 which has minimum impact on the text was added.

In version 3, based on the comments received in the first round of document review and offline discussion with the HLS expert, the proposed semantics in option 3 was refined.Was already reviewed in HLS. It was already suggested to have a syntax element with meaning that some colour post processing is recommended.

It was asked if the calibration could not also be done by decoder-side postprocessing, without adding signalling per picture, e.g. by histogram comparison and alignment, or colour gamut inconsistencies.

The calibration is only necessary for some sequences where the colour shift occurs.

It was also commented that some of the issues may be caused by the generation in RGB domain which is more unstable than in YUV or other domains.

The issue could probably be resolved by improved synthesis algorithms or additional decoder side processing.

No action for v4 SEI.

## AHG17: CfE preparation (15+4)

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

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

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

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

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

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

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

Was presented in AHG meeting, and sequences included in viewing

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

Was presented in AHG meeting, and sequences included in viewing

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

Was presented in AHG meeting, and sequences included in viewing

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

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

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

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

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

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

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

Continuation of review of other documents in this category was planned on Friday; and a meeting with parent bodies was planned on Monday.

JVET-AL0047v3 contains edits made on the basis of the discussions above.

JVET-AL0047v4 contains edits based on the conclusions and agreements from the joint meetings with parent bodies (see section 7.3.1)

Further edits based on v4 can be found as attachment to the BoG report JVET-AL0337v3, integrating the conclusions and agreements in the BoG related to reduced-runtime encoding, which had also been presented in the joint meeting and modified in some aspccts during that meeting

The BoG attachment was presented by JRO and further discussed during 1445-1555 on Friday 4 April. Numerous edits were made, and the following upload JVET-AL0047v5 was agreed to become the basis for the CfE output JVET-AL2026, to be finalized in an AHG17 telco meeting.

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

Was presented in AHG meeting, and sequences included in viewing

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

Was presented in AHG meeting, and sequences included in viewing

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

Was presented in AHG meeting, and sequences included in viewing

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

Provided as an attachment is a marked-up version of JVET-AL0047-v1 “Proposed draft text: Call for Evidence on video compression with capability beyond existing standards” covering ultra low delay and error resilience.

From discussion in AHG meeting, AHG report JVET-AL0041:

“Would require more clear definition of testing conditions (also based on applications and requirements), to potentially enable that some proponent demonstrates support of such functionality could be improved by normative elements, in balance with other benefits of a potential proposal. It should also be clarified at the level of parent bodies which of such functionality would be important to be explicitly requested for in a CfP.”

From discussion in JVET after presentation on Monday 31 March 0905-0930

Proponent believes that success of a next generation standard might not only depend on better compression with reasonable tradeoff, but also on other functionality support.

It was emphasized that when proposals are brought on support of other functionality, it would be important to be able assessing them, i.e. having testing conditions which could be either used in a CfP or subsequent standards development.

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

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

Difficulties in designing constrained encoder test conditions:

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

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

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

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

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

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

Diverging opinions on whether also decoder complexity should be limited.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

It was requested to generate plots where

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

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

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

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

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

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

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

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

See section 4.10.

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

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

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

Experiments have shown following:

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

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

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

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

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

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

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

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

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

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

Was discussed in BoG JVET-AL0337.

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

See also section 4.4.

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

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

--MaxMTTHierarchyDepth=2 --MaxMTTHierarchyDepthISliceL=2

--MaxMTTHierarchyDepthISliceC=2 --MaxMTTHierarchyDepthByTid=221111

Was already presented in JVET on Mar. 28 - to be further discussed in BoG JVET-AL0337.

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

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

[JVET-AL0338](https://jvet-experts.org/doc_end_user/current_document.php?id=15665) AHG17: target bitrates for non-CTC sequences [M. Wien, E. François, E. Alshina, P. Nikitin, A. Wieckowski, K. Anderson, Y. Ye]

This contribution reports the results of the side activity in charge of adjusting the rates for the non-CTC sequences. The approach consisted in starting from the bitrates proposed in JVET-AL0054, and consolidating them based on the results of expert viewing reported in JVET-AK0335 (ACR MOS scores), in JVET-AL0053 (DCR, ACR MOS scores and succession tests scores), VTM/ECM comparisons made in Rennes meeting in JVET-AH2029 (DCR scores), and in VVC verification tests (JVET-T2020, JVET-V2020, JVET-W2020).

A table summarizing the considered sequences per category and a table summarizing the recommended bitrates are provided and were presented during 1330-1345 on Friday 4 April 2025. It was agreed that the rate points and selection of sequences (marked green) shall be used in the draft CfE and in the dry-run activity to be conducted in Daejeon.

If necessary, sequences that are not considered at this time might be re-invoked at a later stage.

## AHG18 Ultra-low latency and packet loss resilience (3+4)

Contributions in this area were discussed during 0730–0900 on Thursday 3 April 2025 (chaired by JRO).

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

No need for presentation

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

The error recovery SEI message is proposed to address low latency error resiliency. JVET-AK0193 describes an error recovery system with backchannel feedback of network losses and modification by the encoder of reference picture selection to use the last successfully received picture in the DPB.

The proposed SEI message enables the encoder to signal information to the decoder for such a system with backchannel feedback following network losses and encoder adaptation to avoid using reference pictures that are impacted by network losses. The proposed SEI message signals a reference picture delta POC value, which is used to identify a range of POC values of pictures that are not used as references for the current picture and subsequent pictures in decoding order, so that a decoder can easily determine which pictures are expected to be free of prediction drift. The proposed SEI message can also be used for subpictures, with a separate reference picture POC value signalled per subpicture.

The idea is to send information about used reference pictures at higher level rather than scanning the RPL. It was however questioned how beneficial that is, as a MANE commonly is not able to interpret such information, and also SEI messages are currently not inspected by MANE.

Hypothetically, the MANE could conclude something from mere presence of this SEI message, but then the POC would not be needed

It was responded that potentially also error concealment at the decoder could benefit from such information, but this would require more study.

Not obvious what the benefit of such SEI would be. Further study.

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

This contribution proposes a new SEI message called loss recovery information (LRI) SEI message that is asserted can be beneficial to enhance packet loss resilience in video transmission. The proposed SEI message would enable the use of an additional recovery picture for important regions or the entire picture, allowing selective frame or region replacement.

The recovery picture would be coded in a different layer of the bitstream (redundant). The recovery picture could contain different regions. Regions might be overlapping.

Is recovery picture intra coded? This would cost a lot of bits.

Is the redundant picture always transmitted, and would it be sent for every picture? Could be, this is up to the encoder. It was commented that this is similar to using redundant slices defined in AVC (whih was never used practically).

Further study would be necessary to demonstrate benefit against other classical options in error protection, including scalable/layered coding, what the rate overhead would typically be to get an effect, etc.

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

In 37th JVET an AHG18 on ultra-low latency and packet loss resilience was established. This contribution proposes evaluation methodology and test conditions suggested to be used for performance assessment in context of the AHG18 work. The document proposes objective quality metrics to be evaluated, and corresponding excel template for quality plots construction and summary collecting.

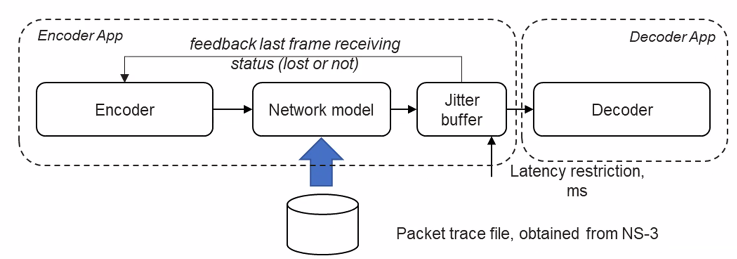
It was suggested to conduct visual comparison in the next meeting, e.g. comparing PSNR of frozen frames and corrupted reference against the subjective quality.

It was suggested that other concealment methods used during AVC and SHVC (MANE) development might also be considered in the future. Also test conditions used by that time should be studied.

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

This contribution describes the simulation software submitted for AGH18 on ultra-low latency and packet loss resilience based on contribution [JVET-AK0193](https://jvet-experts.org/doc_end_user/current_document.php?id=15164). The purpose of this document is to give an introduction and help to be familiar with software. The document describes main modifications of encoder and decoder applications of VTM, entry point for network transmission emulation, and basic logic of main modules. Content of this document was mainly presented during AHG18 teleconference call on 2025-02-19. The software is available in [https://vcgit.hhi.fraunhofer.de/jvet-ahg-ull/VVCSoftware\_VTM/](https://vcgit.hhi.fraunhofer.de/jvet-ahg-ull/VVCSoftware_VTM/-/tree/ull-master)

It was commented that the software provided in the link requires an update.



It was explained that the software is running encoder and decoder separately. The encoder app has a “jitter buffer” which gets input from the network simulator and simulates the feedback to be sent from the decoder if a packet loss would occur. The decoder gets the bitstream which comes with the packet losses and subsequent repair packets.

It was commented that trace files should not be used in optimizing concealment and packetization strategies.

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

Document JVET-AL0176 proposes methodology and test conditions for ultra-low latency (ULL) and error resilience performance evaluation in context of AHG18 work. This contribution describes proposed framework for ULL metrics evaluation. The exemplary quality-against-latency-restriction curves are provided for unicast and multicast scenario. Simulation results of VTM for single layer and scalable two-layer coding are provided. The contribution contains a list of modifications and fixes to enable AHG18 simulation software working according to proposed test conditions.

For the feedback scenario, losses are dependent on the latency. Decoder is performing frame freezing or generates pictures based on broken reference, and PSNR is measured against that.

Freeze ratio is also measured.

The decoder software might also be useful as basis for implementing more sophisticated concealment strategies.

As the frozen frame does not necessary look bad, PSNR may not be an appropriate metric. The same might be true if other concealment methods would be used which are not necessarily provide pixel fidelity.

Improvement is shown when using a scalable solution. However, in lossless case, bitrate is increased.It was commented that a very complex network model may not be needed for this study.

It was agreed to add the software to the AHG branch fur further study and basis for further developments.

[JVET-AL0326](https://jvet-experts.org/doc_end_user/current_document.php?id=15653) AHG9/AHG18: Modification to error recovery SEI message [H. Tan (LGE), M. M. Hannuksela, J. Boyce (Nokia)] [late]

This contribution proposes some changes on top of the error recovery SEI message that is proposed in JVET-AL0069. The proposed changes are for incorporating temporal sub layers into the signalling of the proposed error recovery SEI message. It is asserted that the support for temporal sub layers is desirable as with it the error recovery SEI message allows encoder to use better reference pictures in the event of picture loss during transmission.

Further study – see the notes under JVET-AL0069 which is the basis.

## CICP (4)

Contributions in this area were discussed during 0840–0945 Wednesday 2 April and 0920–0950 on Thursday 3 April 2025 (chaired by JRO).

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

New entries are proposed for the CICP (H.273) colour primaries and matrix coefficients codepoints in order to enable description of source monochrome pictures, including black-and-white video intended for viewing, or for pictures not included for direct viewing, such as alpha or depth.

The VSEI VUI includes syntax elements which refer to CICP codepoints for interpretation, which are either all present or all not present in the VUI, gated by vui\_colour\_description\_present\_flag. It is asserted that it is not possible to describe monochrome content with the current VSEI VUI and CICP. No changes to the VSEI VUI are proposed, as the proposed modifications to CICP are asserted to be sufficient to describe monochrome pictures.

The -v2 version of this contribution references the TuC on CICP in JVET-AH1005.

It is proposed to define a monochrome primary in CICP, but not explicitly referring it to alpha or depth, as done in the current JVET-AH1005, and also define related matrix coefficients.

It was commented that the purpose of indicating alpha and depth was to allow encoding those independent/standalone in legacy standards using existing profiles.

It was further commented that also “unspecified” might be used for monochrome.

It was commented that usage of matrix coefficients for monochrome appears inconsistent, beyond its intended usage as no colour components are present. Further, multiple ways exist to encode luma without chroma in the video standards.

Monochrome generated from different conversions (601, 709, 2020 etc.) is different.

There are so many possibilities what a monochrome video may express (luma, G/R/B only, depth, alpha, …) or what it is intended to mean, that it is currently open if it is possible to exactly describe, and if CICP can do that.

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

Monochrome grayscale data is commonly colour mapped into RGB colour components for improved visualization. It is asserted that definitions of colour maps are not currently standardized by any standardization body. It is proposed to add a new colour map codepoint in CICP to define commonly used colour maps in a standardized manner. It is also proposed to define colour map codepoint entries for the Turbo, Jet, and Viridis colour maps.

Related contribution JVET-AL0219 proposes a colour mapping SEI message that references the colour map codepoint in CICP proposed in this contribution.

It was commented that some other mappings commonly used might need be desirable to express

The mapping from RGB to monochrome would be difficult to express, as it included kind of (vector) quantization. Reverse mapping is described by lookup table.

Would it be necessary to define the precision of the lookup table values? Would also mapping to YCbCr be useful? Would it be necessary to consider display properties?

Requires further study, also about the relevance to be included in CICP.

In general, interest is expressed that this might be useful.

Further study – see the additional notes under JVET-AL0219.

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

The Technologies under Consideration for future extensions of video CICP contain new colour primaries and matrix coefficients to support monochrome samples.

This document suggests making progress on the TuC.

* ISO/IEC 23091-2 is equivalent to ITU-T H.273 for the scope of this document (referred to as "CICP"). In this document, "monochrome" is equivalent to "grayscale" and "4:0:0".
* CICP defines semantics and formulas for three-component samples (4:4:4, 4:2:2, and 4:2:0) but not for monochrome samples (4:0:0).
* The CICP TuC contain colour primaries and matrix coefficients for monochrome samples.

Image file formats, such as HEIF and its ColourInformationProperty, store CICP colour primaries, transfer characteristics, and matrix coefficients to describe the encoded samples embedded in the file.

We have seen non-Unspecified (2) CICP colour primaries, transfer characteristics, and matrix coefficients values associated with monochrome items, despite CICP only containing definitions for three-component samples.

For example, what should be the behavior of an AVIF parser encountering a monochrome item tagged with identity matrix coefficients (0)?

* Should these matrix coefficients be ignored and considered as Unspecified (2)?
* Should the file be rejected?
* Should the monochrome samples be virtually converted to three-component before matrix coefficients apply? If so, what conversion formula should be used?

Rather than addressing this issue in HEIF by removing the possibility of such syntax or by redefining the (non-)compliance of such files, we believe CICP should contain definitions for monochrome samples.

This document suggests addressing again the contents of the CICP TuC and making progress towards allowing and defining values for monochrome samples.

It was commented that currently CICP has no mechanism to express what a monochrome component contains. It is expected that some of such information could be found in the video stream (SEI, VUI), but not necessarily visible at the systems level.

Proponents are requested to bring a more concrete proposal about possible modifications by the next meeting. In terms of including a code point for monochrome and usage of matrix coefficients, this should if possible be aligned with the ideas of JVET-AL0217. It was further pointed out that the current method in TuC also gives no guidance for interpreting alpha and depth values which are carried in the associated video stream.

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

This is a proposal to add a new code point for the XYB colour representation, which is specified in the JPEG XL still image coding standard, in the CICP specification (ITU-T H.273 / ISO/IEC 23091-2:2025) and any other relevant specification, such as in HEVC and AVC. The justification is to simplify interoperability with the JPEG XL image format that internally compresses images using the XYB colour space, as well as to make the XYB colour space available for other, including video, applications that may use different compression technologies.

No presenter was available. This was kept for further study.

# Low-level tool technology proposals (104)

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

### Summary and BoG reports (2)

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

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

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

NNVC has three major operation points with NN-intra always enabled and NN-based in-loop filters with different level of complexity: High Operational Point (HOP, 471kMAC/pixel), Low Operational Point (LOP, 21.4kMAC/pixel) and Very Low Operational Point (VLOP, 9.9kMAC/pixel). Compared with VTM, NNVC HOP5 provides {14.2%, 19.5%, 19.9%}, NNVC LOP4 provides {8.2%, 15.3%, 13.5%} and NNVC VLOP3 provides {5.8%, 6.6%, 5.7%} bitrate saving for {Y, Cb, Cr} channels in the RA configuration. Observed run time increase relatively to VVC is ×2.5, ×1.2, ×1.1 (encoding) and ×1135, ×35, ×15 (decoding) for HOP, LOP and VLOP configurations respectively. EE1 tests were targeting improving the performance complexity trade-off of all three operation points of neural-network based filter and investigation NN-based Inter tool. One of the test categories was devoted to re-training using additional data set (BVI AOM).

1. **Introduction**

Code base for the EE1 tests was NNVC12.0, anchor is default configuration of **NNVC-12.0** (NN-Intra and **LOP5** filter enabled). NNVC common test conditions, 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 and BVI-AOM. Comparison is done between tests which use the same sub-set of training data.

For tests competing with technologies in NNVC it was agreed to configure the proposed solution targeting close to existing NNVC tool complexity, but not exceeding it**:**

1. kMAC/pxl of EE1 test ≤ kMAC/pxl NNVC (*must*),
2. the number of channels (both input and output) in neural network modules which are modified **must be keep multiple of 16**,
3. Number of Parameters EE1 test ≤ Number of Parameters NNVC (*if possible*).

If it is not possible to respect both constrains 1) and 2) at the same time then two sub tests need to be performed: first test respecting the constrain 1) only – in order to prove the value of the proposed change, and the second test respecting constrain 2) with minor violation of 1) - in order to provide software and hardware friendly design.

Only tests with results provided to quantized (int 16) model are considered for adoption to NNVC, float point model results are provided just for information.

Exact parameters settings were announced by proponents by 2nd AhG11/14 teleconference on March 5.

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.

*Performance relative to VTM anchor of NNVC tools combinations which serve as comparison point for corresponding tests in EE1*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test | Random Access | | | | | All Intra | | | | | Total kMAC/pxl | Total Param (Mprm) | |
| Y | U | V | Enc | Dec | Y | U | V | Enc | Dec |  |
| NNIntra+LOP | **-8.2%** | -15.3% | -13.5% | 1.2 | 35 | **-9.2%** | -15.8% | -15.5% | 1.6 | 26 | 21.4 | 1.5 |
| NNIntra+HOP | **-14.2%** | -19.6% | -20.0% | 2.5 | 1135 | **-13.7%** | -15.9% | -17.1% | 2.5 | 769 | 471 | 2.7 |
| NNIntra+VLOP | **-5.8%** | -6.6% | -5.7% | 1.1 | 15 | **-7.3%** | -8.8% | -8.3% | 1.7 | 13 | 9.9 | 1.4 |
| NNIntra+CALOP4 | **-8.5%** | -18.0% | -17.1% | 2.3 | 36 | NA | NA | NA | NA | NA | 21.6 | 1.5 |

1. **List of tests**

This round of EE1 tests includes:

* **EE1-1: LOP and VLOP in-loop filter**
  + EE1-1.1 – Multiscale blocks in LOP5 and VLOP3 filters [[JVET-AL0164](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0164-v1.zip)](https://jvet-experts.org/doc_end_user/current_document.php?id=15090)
    - Tester: Nokia, cross-check: Qualcomm [JVET-AL0173](https://jvet-experts.org/doc_end_user/current_document.php?id=15498) (inference only)
  + EE1-1.2 – LOP5 improvement with parallel 1x3/3x1 Backbone [JVET-AL0084](https://jvet-experts.org/doc_end_user/current_document.php?id=15409)
    - Tester: Dolby/Ittiam, cross-check: Bytedance [JVET-AL0246](https://jvet-experts.org/doc_end_user/current_document.php?id=15573) (training in progress, inference verified)
  + EE1-1.3 – Dimension-wise decomposed multiplier for content-adaptive loop-filter [JVET-AL0169](https://jvet-experts.org/doc_end_user/current_document.php?id=15494)
    - Tester: TCL, cross-check: Nokia [JVET-AL0185](https://jvet-experts.org/doc_end_user/current_document.php?id=15510) (still running)
  + EE1-1.4 - Conditional loop-filter [JVET-AL0145](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0145-v1.zip)
    - Tester: Nokia, cross-check: Ericsson (perfect match reported)
  + EE1-1.5 – Partial convolution and over-parametrization ***withdrawn***
* **EE1-2: NN-inter prediction**
  + E1-2.1 Lightweight Multiscale Reference Frame Generation for VVC Inter Coding [[JVET-AL0104](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0104-v1.zip)](https://jvet-experts.org/doc_end_user/current_document.php?id=15042)
  + Tester: Xidian Uni, cross-check: Nokia ([JVET-AL0297](https://jvet-experts.org/doc_end_user/current_document.php?id=15624))
  + EE1-2.2 RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding [JVET-AL0105](https://jvet-experts.org/doc_end_user/current_document.php?id=15430)
    - Tester: Xidian Uni, cross-check: Nokia [JVET-AL0298](https://jvet-experts.org/doc_end_user/current_document.php?id=15625), comparison point: NNVC-12 default
* **EE1-3: NNVC tools re-training**
  + EE1-3.1 –Retraining LOP4 and LOP5 using extended dataset from BVI-AOM [JVET-AL0085](https://jvet-experts.org/doc_end_user/current_document.php?id=15410), [JVET-AL0144](https://jvet-experts.org/doc_end_user/current_document.php?id=15469), [JVET-AL0187](https://jvet-experts.org/doc_end_user/current_document.php?id=15512)
    - Volunteers: Dolby/Ittiam, Ericsson, InterDigital, comparison point: NNVC-12 default
  + EE1-3.2 – NNVC-HOP5 retraining adding BVI-AOM [[JVET-AL0189](https://jvet-experts.org/doc_end_user/current_document.php?id=15514)](https://jvet-experts.org/doc_end_user/current_document.php?id=15244)
    - Volunteers: InterDigital, comparison point: NNVC-12 HOP5
  + EE1-3.3 – NNVC-VLOP retraining adding BVI-AOM [JVET-AL0190](https://jvet-experts.org/doc_end_user/current_document.php?id=15515)
    - Volunteers: InterDigital, Tencent comparison point: NNVC-12 VLOP3

1. **Test results summary**

Details of each test can be found in attached presentation.

***EE1.1- LOP and VLOP filter modifications***

NNVC-12 LOP5 filter is are depicted in the diagrams below (JVET-AK0150 and JVET-AK0195).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| d1 | | d2 | | d3 | | d4 | | d5 | |
| 16 | | 8 | | 4 | | 2 | | 2 | |
| C | | CY1 | | CUV1 | | CY | | CUV | | Ca | |
| 32 | | 176 | | 144 | | 32 | | 32 | | 32 | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *RecExtY*  [1,144,144 ] | | |  | *RecExtUV*  [2,72,72] | | | |  | *PredExtY*  [1,144,144 ] | | | | |  | *PredExtUV*  [2,72,72] | | | | | |  | | | *BS*  [1, 144, 144] | | | | |  | | | | | *QPbase*  [1, 144, 144] | | |  | | *QPblock*  [1, 144, 144] | |  | *IPB*  [1, 144, 144] | | |
| [DCT](#_DCT) | | |  |  |  | | | | [DCT](#_DCT) | | | | |  |  | |  | | | | | 2↓ | | | | | | |  | | | | | 2↓ | | |  | | 2↓ | |  | 2↓ | | |
| [6,72,72 ] | | |  |  |  | | | | [6,72,72 ] | | | | |  |  | |  | | | | | [1,72,72 ] | | | | | | |  | | | | | [1,72,72 ] | | |  | | [1,72,72 ] | |  | [1,72,72 ] | | |
| [CONV](#_convolution_layer) 3×3, 6, d1, 2↓ | | | | | |  | | | | [CONV](#_convolution_layer) 3×3, 6, d2, 2↓ | | | | | | |  | | | | [CONV](#_convolution_layer) 1×1, 1, d3, 2↓ | | | | | | |  | | | | | [CONV](#_convolution_layer) 1×1, 1, d4, 2↓ | | |  | | [CONV](#_convolution_layer) 1×1,  1, d4,2↓ | |  | [CONV](#_convolution_layer) 1×1,  1, d5,2↓ | | |
|  |  | | |  | |  | | | | |  |  | | |  | | | |  | | | | | | |  | | | | |  | |  | | | |  |  | | |  |  |
| [CONCAT](#_concatenation_of_tensors) (d1, d2, d3, d4, d4, d5) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [ d1+ d2+ d3+ d4+ d4+ d5+ d7+ d8= d6,72,72 ] | | | | | | | | | | | | | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 1×1, d6, C | | | | | | | | | | | | | | | | | | | | | | | | | |
| [PReLU](#_Parametric_rectified_linear) | | | | | | | | | | | | | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 1×3, C, C, 2↓ | | | | | | | | | | | | | | | | | | | | | | | | | |
| [ C,72,36 ] | | | | | | | | | | | | | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 3×1, C, C, 2↓ | | | | | | | | | | | | | | | | | | | | | | | | | |
| [ C,36,36 ] | | | | | | | | | | | | | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 1×1, C, C | | | | | | | | | | | | | | | | | | | | | | | | | |
| [PReLU](#_Parametric_rectified_linear) | | | | | | | | | | | | | | | | | | | | | | | | | |
| [ C,36,36 ] | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | | | | | |  | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 1×1, C, CY1 | | | | | | | | | | | | | | | | | | | |  | | | | | | [CONV](#_convolution_layer), 1×1, C, CUV1 | | | | | | | | | | | | | | | | | | |
| [BBBlock](#BBBLOP4) (1), CY1 | | | | | | | | | | | | | | | | | | | |  | | | | | | [BBBlock\_uv](#BBBLOP4_uv) (1), CUV1 | | | | | | | | | | | | | | | | | | |
| [ CY1,34,34 ] | | | | | | | | | | | | | | | | | | | |  | | | | | | [ CUV1,34,34 ] | | | | | | | | | | | | | | | | | | |
| [BBBlock](#BBBLOP4) (1), CY1 | | | | | | | | | | | | | | | | | | | |  | | | | | | [BBBlock](#BBBLOP4)\_uv (1), CUV1 | | | | | | | | | | | | | | | | | | |
| [ CY1,32,32 ] | | | | | | | | | | | | | | | | | | | |  | | | | | | [ CUV1,32,32 ] | | | | | | | | | | | | | | | | | | |
| [TwinBlock](#TwinBlockAK0150) (0), CY1 | | | | | | | | | | | | | | | | | | | |  | | | | | | [BBBlock\_uv](#BBBLOP4_uv) (0), CUV1 | | | | | | | | | | | | | | | | | | |
| [TwinBlock](#TwinBlockAK0150) (0), CY1 | | | | | | | | | | | | | | | | | | | |  | | | | | | [BBBlock\_uv](#BBBLOP4_uv) (0), CUV1 | | | | | | | | | | | | | | | | | | |
| [TwinBlock](#TwinBlockAK0150) (0), CY1 | | | | | | | | | | | | | | | | | | | |  | | | | | | [BBBlock\_uv](#BBBLOP4_uv) (0), CUV1 | | | | | | | | | | | | | | | | | | |
| TripleBlock(0), CY1 | | | | | | | | | | | | | | | | | | | |  | | | | | | | | | | | |  | | | | | | | | | | | | |
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|  | | | | | | |  | | | | | | [add](#_per_element_addition) | | | | | | | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 1×1, CY1, CY | | | | | | | | | | | | | | | | | | |  | | | | | | [CONV](#_convolution_layer), 1×1, CUV1, CUV | | | | | | | | | | | | | | | | | | | |
| [dwCONV](#_depthwise_separable_convolution), 1×3, CY, CY | | | | | | | | | | | | | | | | | | |  | | | | | | [CONV](#_convolution_layer), 1×3, CUV, CUV | | | | | | | | | | | | | | | | | | | |
| [dwCONV](#_depthwise_separable_convolution), 3×1, CY, CY | | | | | | | | | | | | | | | | | | |  | | | | | | [CONV](#_convolution_layer), 3×1, CUV, CUV | | | | | | | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 1×1, CY, CY | | | | | | | | | | | | | | | | | | |  | | | | | | [CONV](#_convolution_layer), 1×1, CUV, CUV | | | | | | | | | | | | | | | | | | | |
| [PReLU](#_Parametric_rectified_linear) | | | | | | | | | | | | | | | | | | |  | | | | | | [PReLU](#_Parametric_rectified_linear) | | | | | | | | | | | | | | | | | | | |
| [CONV](#_convolution_layer), 1×1, CY, 16 | | | | | | | | | | | | | | | | | | |  | | | | | | [CONV](#_convolution_layer), 1×1, CUV, 8 | | | | | | | | | | | | | | | | | | | |
| [ 16,32,32 ] | | | | | | | | | | | | | | | | | | |  | | | | | | [ 8,32,32 ] | | | | | | | | | | | | | | | | | | | |
| [Shuffle](#_shuffle_layer)(2) | | | | | | | | | | | | | | | | | | |  | | | | | |  | | | | | |  | | | | | | |
| [ 4,64,64 ] | | | | | | | | | | | | | | | | | | |  | | | | | |
| [IDCT](#_IDCT) | | | | | | | | | | | | | | | | | | |  | | | | | | [IDCT](#_IDCT) | | | | | | | | | | | | |
| [ 1,128,128 ] | | | | | | | | | | | | | | | | | | |  | | | | | | [ 2,64,64 ] | | | | | | | | | | | | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **BBBlock** (x)   |  |  |  |  |  | | --- | --- | --- | --- | --- | | [ C1,h,w ] | | | | | | [PReLU](#_Parametric_rectified_linear) | | |  | | | [CONV](#_convolution_layer), 1×1, C1, C | | |  | | | [dwCONV](#_depthwise_separable_convolution), 1×3, C, C | | |  | [crop](#_cropping_layer)(2x) | | | [dwCONV](#_depthwise_separable_convolution), 3×1, C, C | | |  |  | | [crop](#_cropping_layer)(2x) | | |  | | | [CONV](#_convolution_layer), 1×1, C, C1 | | |  | | | [add](#_per_element_addition) | | | | | [ C1,h-((x==1)?2:0),w-((x==1)?2:0)] | | | | | | **BBBlock\_uv** (x)   |  |  |  |  |  | | --- | --- | --- | --- | --- | | [ CUV1,h,w ] | | | | | | [PReLU](#_Parametric_rectified_linear) | | |  | | | [CONV](#_convolution_layer), 1×1, CUV1, C | | | | [dwCONV](#_depthwise_separable_convolution), 3×3, C, C | | |  | [crop](#_cropping_layer)(2x) | | | [crop](#_cropping_layer)(2x) | | |  | | | [CONV](#_convolution_layer), 1×1, C CUV1 | | | | [add](#_per_element_addition) | | | | | [ CUV1,h-((x==1)?2:0),w-((x==1)?2:0)] | | | | | |
| **Twin Block** (x)   |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | [ C1,h,w ] | | | | | | | | | | | [PReLU](#_Parametric_rectified_linear) | | | |  |  | | | | | | [CONV](#_convolution_layer), 1×1, C1, C | | | |  |  | | | | | | [dwCONV](#_depthwise_separable_convolution), 1×3, C, C | | | |  |  | | | | | | [dwCONV](#_depthwise_separable_convolution), 3×1, C, C | | | |  |  | | | | | | [CONV](#_convolution_layer), 1×1, C C1 | | | |  |  | | | | | | [add](#_per_element_addition) | | | | | |  | | | [ C1,h,w] | | | | | | | |  | | [PReLU](#_Parametric_rectified_linear) | | | |  |  | | | | | | [CONV](#_convolution_layer), 1×1, C1, C | | | |  |  | | | | | | [dwCONV](#_depthwise_separable_convolution), 1×3, C, C | | | |  |  | | | |  | | [dwCONV](#_depthwise_separable_convolution), 3×1, C, C | | | |  |  | | | | | | [CONV](#_convolution_layer), 1×1, C C1 | | | |  |  |  |  | | | | [add](#_per_element_addition) | | | | | |  | | | [ C1,h,w] | | | | | | | |  | | [PReLU](#_Parametric_rectified_linear) | | | | | |  | | | [add](#_per_element_addition) | | | | | | | | [**Attention**](#AttentionAk0150) | | | | | | | | [ C1,h,w] | | | | | | | | | **Attention**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | [ C1,h,w ] | | | | | | | | | | | | | | [CONV](#_convolution_layer), 1×1, C1, Ca | | | | | | | |  | |  | | | | | [PReLU](#_Parametric_rectified_linear) | | | | | | | |  | |  | | | | |  | |  | | | | | |  | | |  | | | | | [MaxPool](#MaxPool), 2×2, 2↓ | | | | | |  | [CONV](#_convolution_layer), 1×1, Ca, Ca | | | | | |  | | | [**DW Block**](#DWBlockAK0150) | | | | | | [PReLU](#_Parametric_rectified_linear) | | | | | |  | | | [BiLinear](#Bilinear_Interpolation), 2×2, 2↑ | | | | | |  | | | |  | | |  | | | [add](#_per_element_addition) | | | | | | | |  | | | | [Conv](#_convolution_layer_1), 1x1, Ca, C1 | | | | | | | |  | | | | [HardSigmoid](#HardSigmoid) | | | | | | | |  | | | | [mult](#_per_element_multiplication) | | | | | | | | | | | | [ C1,h,w ] | | | | | | | | |   **DW Block** (x)   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | [ Ca,h,w ] | | | | | | | [dwCONV](#_depthwise_separable_convolution), 3×3, Ca, Ca | | |  |  | | [CONV](#_convolution_layer), 1×1, Ca, Ca | | |  | | | [PReLU](#_Parametric_rectified_linear) | | | | [add](#_per_element_addition) | | | | | [ Ca,h,w ] | | | | | | |

***NNVC 12 LOP5 architecture figure***

Note: The TripleBlock is the same as the TwinBlock but with three BBBlocks in sequence.

The complexity for LOP filter is 16.606 kMAC/pxl (including MaxPool and HardSigmoid), 247 K parameters.

Results of tests in this category are summarized in the tables below.

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Random Access | | | | | All Intra | | | | | kMAC/pxl | | | Num Param, M | | |
| Y | U | V | EncT | DecT | Y | U | V | EncT | DecT | Total | Filter | Intra | Total | Filter | Intra |
| NNVC-LOP5 | **0.0%** | **0.0%** | **0.0%** | **100%** | **100%** | **0.0%** | **0.0%** | **0.0%** | **100%** | **100%** | **21.4** | **16.6** | **4.8** | **1.5** | **0.247** | **1.3** |
| EE1-1.1.1 | 0.1% | 1.3% | 1.1% | 100% | 99% | -0.0% | 1.2% | 1.5% | 100% | 101% | 21.3 | 16.5 | 4.8 | 1.5 | 0.247 | 1.3 |
| EE1-1.1.2 | 0.1% | -0.0% | 0.3% | 101% | 102% | 0.1% | -0.3% | -0.2% | 100% | 102% | 21.3 | 16.5 | 4.8 | 1.5 | 0.247 | 1.3 |
| EE1-1.2 | 0.1% | -0.1% | -0.3% |  | 99% | 0.1% | -0.1% | -0.6% |  | 100% | 21.4 | 16.6 | 4.8 | 1.5 | 0.247 | 1.3 |
| EE1-1.4 | 0.0% | 0.0% | 0.1% | 100% | 123% | 0.0% | 0.0% | 0.0% | 100% | 101% | 21.4 | 16.6 | 4.8 | 1.5 | 0.247 | 1.3 |

***EE1-1: content adaptive LOP in-loop filter modifications***

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Random Access | | | | | kMAC/pxl | | | Num Param, M | | |
| Y | U | V | EncT | DecT | Total | Filter | Intra | Total | Filter | Intra |
| NNVC-CALOP4 | **0.0%** | **0.0%** | **0.0%** | **100%** | **100%** | **21.4** | **16.6** | **4.8** | **1.5** | **0.247** | **1.3** |
| EE1-1.3 | -0.2% | -0.4% | -0.5% |  |  | 21.4 | 16.6 | 4.8 | 1.5 | 0.247 | 1.3 |

***EE1-1: content adaptive VLOP in-loop filter modifications***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Random Access | | | | | All Intra | | | | | kMAC/pxl | | | Num Param, M | | |
| Y | U | V | EncT | DecT | Y | U | V | EncT | DecT | Total | Filter | Intra | Total | Filter | Intra |
| NNVC-VLOP3 | **0.0%** | **0.0%** | **0.0%** | **100%** | **100%** | **0.0%** | **0.0%** | **0.0%** | **100%** | **100%** | **9.9** | **5.1** | **4.8** | **1.4** | **0.067** | **1.3** |
| EE1-1.1.1 (float) | 0.1% | -0.1% | 0.2% | 119% | 123% |  |  |  |  |  | 9.9 | 5.1 | 4.8 | 1.4 | 0.070 | 1.3 |
| EE1-1.4 | 0.1% | 0.0% | 0.0% | 100% | 101% | 0.0% | -0.1% | 0.0% | 100% | 102% | 9.9 | 5.1 | 4.8 | 1.4 | 0.067 | 1.3 |

EE1-1.1 – (by Nokia) introduces multiscale blocks in LOP5 and VLOP3 filters[.](https://jvet-experts.org/doc_end_user/current_document.php?id=15090) Expected effect – BD-rate gain in Chroma.

EE1-1.2 – (by Dolby/Ittiam) improves LOP5 with parallel 1x3/3x1 Backbone. Expected effect – reduction for number of sequential convolution (lower latency with proper implementation).

EE1-1.3 – (by TCL) improves content adaptivity of CALOP. Expected effect – BD-rate gain.

EE1-1.4 - Conditional loop-filter. Expected effect – BD-rate gain in chroma or at least reduction (in average) for number of filtered samples.

***EE1.2- NN-Inter***

EE1-2.1 – (by Xidian Uni) Lightweight Multiscale Reference Frame Generation for VVC Inter Coding

More complex variant: 547 k/pixel, 25M model parameters. If trained on Vimeo-90K (89800 video scenes) then 6-7% gain was reported. Training with BVI-DVC and BVI-AOM (278 video scenes)resulted in significant lower gain.

EE1-2.2 – (by Xidian Uni) RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding

Less complex variant: 487 k/pixel, 2.75M model parameters. If trained on Vimeo-90K (89800 video scenes) then 5-7% gain was reported. Training with BVI-DVC and BVI-AOM (278 video scenes) resulted in significant lower gain 1% in average. Training on just BVI-DVC provides better performance. Proponent explains this by similarity of motion characteristics between BVI-DVC and JVET test set.

***EE1.3- NNVC filters re-training using BVI-AOM***

Most trainings are still ongoing.

Current NNVC training set: BVI-DVC & TVD & DIV2K.

Extended NNVC training set: BVI-DVC & TVD & DIV2K &BVI-AOM

EE1-3.1 – retraining LOP5

by Dolby/Ittiam: Current training set 0.1% (drop in RA cfg), new training set -0.1% (gain in RA cfg)

by Ericsson: new training set gain in Chroma, drop or no gain in Luma.

by InterDigital: new training set (all intra cfg) gain in Chroma, drop in Luma.

EE1-3.2 – retraining HOP5

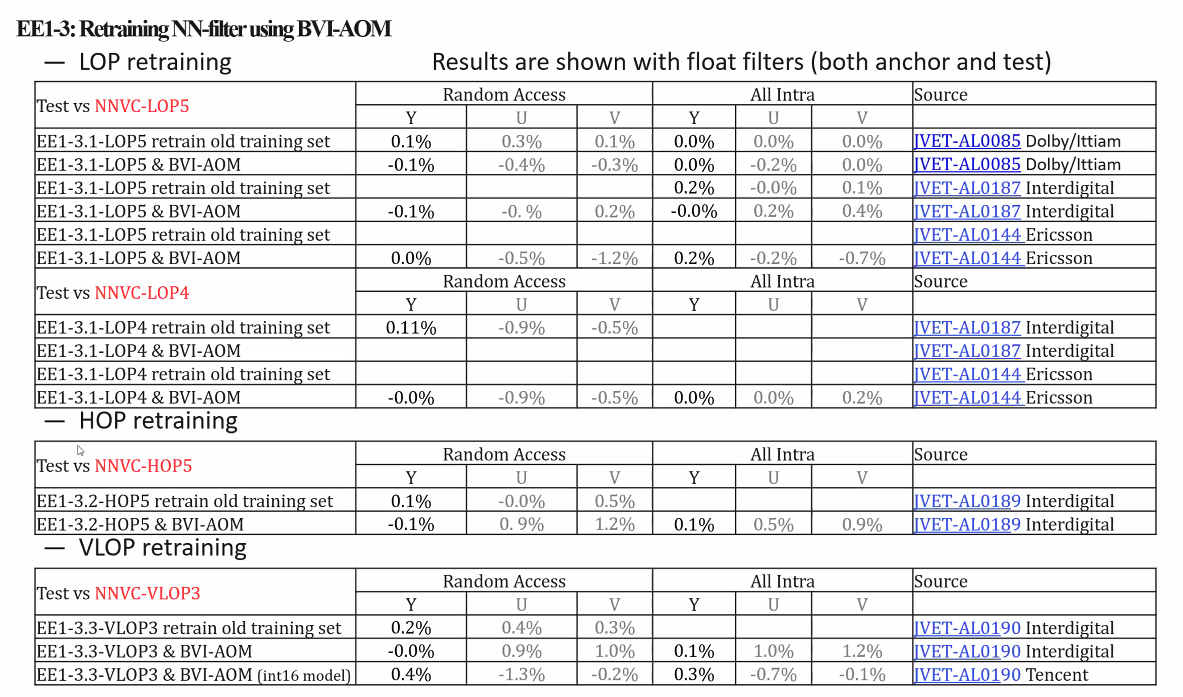
by InterDigital: new training set (RA cfg) gain in Chroma, drop in Luma.

EE1-3.3 – retraining VLOP3

by InterDigital: new training set drop or no gain (in RA cfg and all intra cfg).

by Tencent: new training set gain in Chroma, drop in Luma (in RA cfg and all intra cfg).

Analysis for this phenomenon is needed, likely training strategy requires modification.



For EE1-1.1 (multiscale blocks), less gain was found than expected for chroma, and some small loss for luma, when implemented on top of LOP5. Further investigation is necessary why this might be the case – there is some related contribution.

EE1-1.2 has small loss in luma, some gain in chroma and is asserted to be simpler due to possibility of performing convolutions in parallel. Training crosscheck was finalized during the meeting. The matching is within the usually expected margin, and the luma/chroma balance is even better with the cross-check. Decision: Adopt the architecture from JVET-AL0084, using the model parameters from cross-check JVET-AL0246. It was also requested to double-check the correctness of the LOP diagram to be used in JVET-AL2019.

EE1-1.3 (decomposed multiplier in overfitting of content-adaptive filter) provides gain, but the overfitting run time is increased significantly. Due to proponents, this is caused by the GPU time used. It should be confirmed by cross-checkers if that is the case. It was later confirmed by cross-checkers that the number of multipliers is not increased compared to the current adaptive filter in training. Training crosscheck was finished, difference is within the typical margin, slightly less gain in luma and chroma. Training time is roughly the same. Decision: Adopt JVET-AL0169. Training script also should be submitted with the merge request.

EE1-1.4 uses separate enabling/disabling of luma and chroma filtering at frame level (instead of jointly on/off at block level) for LOP, and for VLOP separate both at frame and block level. It was reported that by tendency, chroma is filtered less frequently, but luma is filtered more frequently by this. This is having almost no impact for AI and RA, but in LD configurations has 1-2% gain in chroma, but luma drop of 0.1..0.2%/0.6..0.7% in VLOP/LOP is observed. It was commented that the complete removal of block-level control may be inappropriate in LOP, and was also not part of the original proposal in the last meeting, where a more significant chroma gain was observed in LOP4 (where however some other mechanism was used by inputting different QP into luma and chroma filters which had the disadvantage of increased decoder complexity, and also LOP5 may take away some chroma gain). It is asserted that the results indicate separate handling of luma/chroma filter enabling is useful, but the current results are not considered sufficiently attractive. Also, the worst case complexity is not reduced. It was asked if it would be possible to implement the separate luma/chroma control only at frame level, as the loss in luma for VLOP is probably caused by the additional separate block-level flags. Further study was encouraged (if possible in an EE).

For EE1-2.x (inter prediction) it was found that extending the training set by BVI-AOM did not provide advantage decreased the benefit. According to proponents, this may be caused that the amount of rigid motion is higher in BVI-AOM. With Vimeo-90K (which has 300x more video clips than the BVI sets) performance would be much better (as shown in JVET-AL0104). It was also commented that higher losses with BVI-AOM seem to occur for classes B, C and D. It was further commented that some of the drop may also be caused by the model used in JVET-AL0105 is different from JVET-AK0077 of the last meeting and JVET-AJ0099). It was also commented that the training parameters are different than those used before.It can be concluded that BVI sets are definitely not sufficient for training a decent model for inter prediction.

From current results, the model of JVET-AL0105 is most attractive in complexity/performance tradeoff, but results with training on Vimeo are not available. It was concluded to investigate this further in an EE, and if possible, also get a training cross-check by a party that has access to the Vimeo database. Further investigation on integerization would also be necessary.

In EE1-3.x, the same training scripts were used by participants, but hyperparameters such as number of epochs, learning rate might be different.

Generally, the performance does not seem to be much different, regardless if BVI-AOM is added to training or not (sometimes slightly worse, sometimes better). Likely, the characteristics are not too much different for the two parts of BVI.

It was discussed if the results might indicate that an overfitting of filters to the CTC set could already have occurred, but no clear indication of this.

Most experts commented that the results would not give justification to extend the training dataset for loop filters by the BVI-AOM part of the set.

It was discussed if training could target better performance for high resolution classes by adding more data of that type, but some experts commented that they did not have such findings in own experiments.

It was discussed if it might make sense also trying re-training from scratch (all stages), but previous reports on benefit of this seemed not to give much benefit (<0.5%), and it would be a big effort. Another option would be just re-training stage 4 (generating distorted data with current version of the filters), which however would be quite some effort and might not be useful for filters that are still under changes. Not of priority at this moment. It could potentially be interesting studying this for HOP which has not undergone changes over several meeting cycles, just to know how much gain it might give. This could better be done as AHG study rather than EE.

For consistency, it is agreed at this moment that it is appropriate to stay with BVI-DVC for training of loop filters.

[JVET-AL0043](https://jvet-experts.org/doc_end_user/current_document.php?id=15348) [AHG11] [AHG14] Teleconference on NNVC [E. Alshina, F. Galpin]

No need for presentation

### EE1 contributions: Neural network-based video coding (11)

Contributions in this area were discussed in the context of the EE summary report JVET-AL0023.

[JVET-AL0084](https://jvet-experts.org/doc_end_user/current_document.php?id=15409) EE1-1.2: LOP5 improvement with parallel 1x3/3x1 Backbone [T. Shao, P. Yin, S. McCarthy (Dolby), J. N. Shingala, A. Shyam, A. Suneja, S. P. Badya (Ittiam)]

[JVET-AL0246](https://jvet-experts.org/doc_end_user/current_document.php?id=15573) Crosscheck of JVET-AL0084 (EE1-1.2: LOP5 improvement with parallel 1x3/3x1 Backbone) [Y. Li (Bytedance)] [late]

[JVET-AL0085](https://jvet-experts.org/doc_end_user/current_document.php?id=15410) EE1-3.1: NNVC-LOP5 retraining with additional BVI-AOM dataset [A. Suneja, J. N. Shingala, A. Shyam, S. P. Badya (Ittiam), T. Shao, P. Yin, S. McCarthy (Dolby)]

[JVET-AL0104](https://jvet-experts.org/doc_end_user/current_document.php?id=15429) EE1-2.1: Lightweight Multiscale Reference Frame Generation for VVC Inter Coding [P. Li, C. Jung, Q. Qin (Xidian Univ.)]

[JVET-AL0297](https://jvet-experts.org/doc_end_user/current_document.php?id=15624) Crosscheck of JVET-AL0104 (EE1-2.1: Lightweight Multiscale Reference Frame Generation for VVC Inter Coding) [L. Murn (Nokia)] [late]

[JVET-AL0105](https://jvet-experts.org/doc_end_user/current_document.php?id=15430) EE1-2.2: RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding [Q. Qin, C. Jung (Xidian Univ.)]

[JVET-AL0298](https://jvet-experts.org/doc_end_user/current_document.php?id=15625) Crosscheck of JVET-AL0105 (EE1-2.2: RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding) [L. Murn (Nokia)] [late]

[JVET-AL0144](https://jvet-experts.org/doc_end_user/current_document.php?id=15469) EE1-3.1: Retraining LOP4 and LOP5 using extended dataset from BVI-AOM [D. Liu, J. Ström, M. Damghanian, P. Wennersten (Ericsson)]

[JVET-AL0145](https://jvet-experts.org/doc_end_user/current_document.php?id=15470) EE1-1.4: Conditional loop-filter [M. Santamaria, F. Cricri (Nokia)]

[JVET-AL0284](https://jvet-experts.org/doc_end_user/current_document.php?id=15611) Crosscheck of JVET-AL0145 (EE1-1.4: Conditional loop-filter) [J. Ström (Ericsson)] [late]

[JVET-AL0164](https://jvet-experts.org/doc_end_user/current_document.php?id=15489) EE1-1.1: Multiscale blocks in LOP5 and VLOP3 filters [R. Yang, M. Santamaria, F. Cricri, H. Zhang, J. Lainema, M.M. Hannuksela (Nokia)]

[JVET-AL0173](https://jvet-experts.org/doc_end_user/current_document.php?id=15498) Crosscheck of JVET-AL0164 (EE1-1.1: Multiscale blocks in LOP5 and VLOP3 filters) [Y. Li (Qualcomm)] [late]

[JVET-AL0169](https://jvet-experts.org/doc_end_user/current_document.php?id=15494) EE1-1.3 Dimension-wise decomposed representation of multiplier for content-adaptive loop filtering [Z. Xu, J. Konieczny, A. Filippov, C. Hollmann, V. Rufitskiy, T. Dong (TCL)]

[JVET-AL0185](https://jvet-experts.org/doc_end_user/current_document.php?id=15510) Crosscheck of JVET-AL0169 (EE1-1.3 Dimension-wise decomposed representation of multiplier for content-adaptive loop filtering) [M. Santamaria (Nokia)] [late]

[JVET-AL0187](https://jvet-experts.org/doc_end_user/current_document.php?id=15512) EE1-3.1: NNVC-LOP4 and LOP5 retraining with additional BVI-AOM dataset [T. Dumas, A. Monier, F. Galpin (InterDigital)] [late]

[JVET-AL0189](https://jvet-experts.org/doc_end_user/current_document.php?id=15514) EE1-3.2 – NNVC-HOP5 retraining adding BVI-AOM [F. Galpin (InterDigital)] [late]

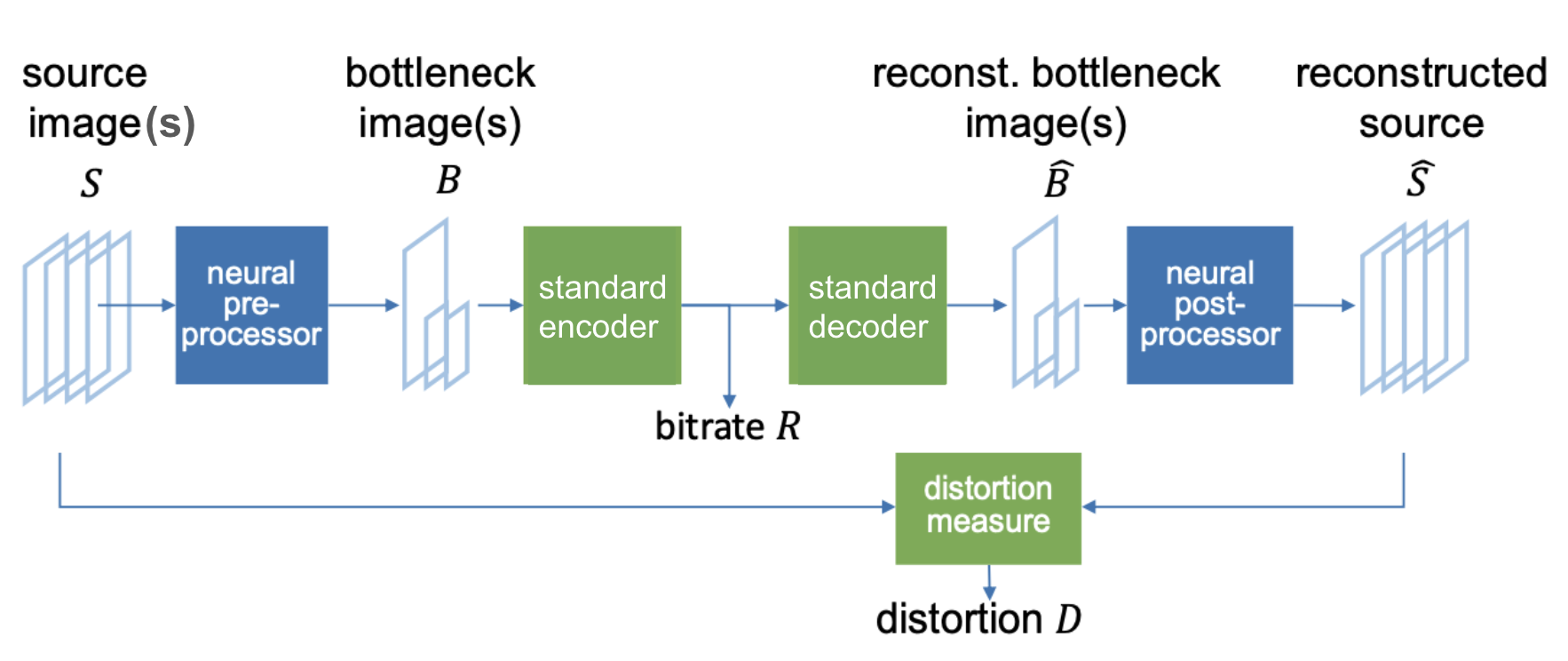
[JVET-AL0190](https://jvet-experts.org/doc_end_user/current_document.php?id=15515) EE1-3.3 – NNVC-VLOP3 retraining adding BVI-AOM [F. Galpin, Z. Ameur (InterDigital), R. Chang, L. Wang, X. Xu, S. Liu (Tencent)] [late]

### EE1 related and beyond-EE contributions: Neural network-based video coding (14)

Contributions in this area were discussed during 0820–0935 on Thursday 27 March 2025, during 0720–0920 on Friday 28 March 2025 and during 1300–1500 on Wednesday 2 April 2025 (chaired by JRO).

[JVET-AL0060](https://jvet-experts.org/doc_end_user/current_document.php?id=15366) Sandwiched Compression: Repurposing Standard Codecs with Neural Network Wrappers [O. Guleryuz (Google)]

This contribution discusses means of sandwiching standard image and video codecs between pre- and post-processing neural networks. The networks are jointly trained through a differentiable codec proxy to minimize a given rate-distortion loss. This sandwich architecture is not only geared toward improving the standard codec's performance on its intended content, but more importantly, toward adapting the codec to other types of image/video content and to other distortion measures. The sandwich learns to transmit ``neural code images'' that optimize overall rate-distortion performance, targeting significant improvements especially when the overall problem is well outside of the scope of the codec's design. Example applications of the sandwich architecture to standard codecs with mismatched sources transporting different numbers of channels, higher resolution, computer graphics, and with perceptual distortion measures are included. Respective rate-distortion-quality results are provided. Differentiable codec proxies approximating current standard codecs that enable sandwich designs are discussed. Example results on model complexity, visual quality under perceptual metrics, as well as sandwich configurations that offer interesting potentials in video compression and streaming are pointed to.



It was asked if the examples shown were part of the training data (e.g., cases where aliasing was avoided)? That was not the case.

Training was done outside of the codec. No specific implementation of a standard codec was used, only an approximation (“proxy”)

Examples bringing good gain were using superresolution and colour mapping. Was de-noising also used (e.g. reducing artifacts introduced by codec)? Somehow this would be part of the training.

It was asked if there would be only one version of pre-/postprocessing, independent of content. This would probably not be the case. It would need to be considered carefully how much rate would be necessary to communicate to the receiver end which kind of post processing would need to be used (e.g., NNPF could be used for that case).

One intention is also to repurpose conventional codecs for using perceptual metrics such as LPIPS.

Complexity of Pre-/postprocessor between 40 and 210 kMAC/pixel. The latter can run in real-time (70 fps) for a 1Kx1K picture size.

It was commented thar investigation on visual quality compared to standard codecs would be interesting (e.g., in CfE?).

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

Bit-exact reconstruction is a requirement for modern codecs and standards. For a bit-exact standardization, undefined compiler specific operations must be avoided in the definition of calculations. The range of HW accelerator support considered for Neural Network tools should include both GPU and NPU. Expanded HW support comes with native floating point format support but limited integer support. It is asserted that despite using integer calculations, a NN design could fail to give bit-exact reconstruction in the event of undefined integer overflow. Methods are described to define such overflow or to provide means to prevent overflow allowing bit-exact reconstruction. It is recommended to study use of a floating-point format supported by common HW for use in accelerating NN calculation and defining a bit-exact calculation. If integer calculations are defined, overflow must be strictly avoided and a tool for proving avoidance of overflow is recommended to be developed.

It was emphasized that it would be important to use formats supported by various processing platforms (GPU, CPU, NPU, etc.). FP16 seems to be such a format, however also having different variants, as e.g. specified in IEEE 754. It was recommended to

* Identify classes of HW architectures (e.g., CPU, GPU, NPU, ASIC) needed to be considered and develop criteria for resources i.e., format and MAC requirements.
* Study the potential of FP16 to produce a bit-exact definition and support various HW acceleration. Note, IEEE 752 includes different rounding-direction attributes and confirmation must be made that a common set of rounding options are supported in addition to the IEEE 752 format.
* Evaluate performance of FP16 versus other NNVC models FP32 and INT16.
* For integer definition, produce analysis that overflow is avoided in the worst-case operation assuming 16-bit multiplies and 32-bit accumulator. This will impose limits on the model quantization. The impact of such limits on coding performance needs to be understood.

In the discussion, it was commented that SADL already implements different methods for checking overflows, such that if possible they could be avoided. However, even for INT16, there is no guarantee that different processors would handle overflows in the same way.

It is generally agreed that the topic of bit-exact reconstruction is highly important in the context of video standardization, and without doubt quantization of network parameters etc. has a lot of headroom of improvements.

[JVET-AL0121](https://jvet-experts.org/doc_end_user/current_document.php?id=15446) AHG11: Sample-based adaptive blending weight selection for LOP [H. Kwon, H. Ko (HYU)]

This contribution presents a method to select the weight adaptively for blending DBF- and LOP-filtered samples. The proposed method introduces an additional condition to control the blending weight selection based on the sample values. In this contribution, two approaches were evaluated: (1) a baseline method applied to both intra and inter slices and (2) a modified condition applied exclusively to inter slices. Experimental results for the proposed methods, based on NNVC-12.0, are reported as follows:

Test 1 (Baseline):

* RA: {Y: -0.06% U: -0.19% V: -0.23% | EncT: 99% DecT: 104%},
* LDB: {Y: -0.19% U: -0.83% V: -1.17% | EncT: 100% DecT: 103%},
* AI: {Y: 0.02% U: 0.01% V: 0.04% | EncT: 99% DecT: 100%}

Test 2 (Modified condition):

* RA: {Y: -0.06% U: -0.24% V: -0.26% | EncT: 100% DecT: 103%},
* LDB: {Y: -0.14% U: -1.10% V: -1.44% | EncT: 101% DecT: 102%}

Test 2 does not apply the method to intra pictures, where test 1 has loss. Why is decoding time increased? It is believed that the filter is used more frequently with the condition.

The adaptive weight needs computation at pixel basis both at encoder and decoder for classification.

Interesting gain in chroma, less in luma.

It was agreed to investigate this in an EE, and also to investigate the method of “appendix 1” of the slide deck, where signalling the additional processed blocks is used, but if possible also avoiding the sample-level classification at the decoder. It was also planned to investigate using the method for other filters (HOP, VLOP, which may require different threshold values), and report about usage of filtering in additional blocks.

[JVET-AL0136](https://jvet-experts.org/doc_end_user/current_document.php?id=15461) AHG11: Over-Parameterized LOP In-Loop Filter [J. Han, C. Jung, Q. Qin (Xidian Univ.)]

This contribution proposes to enhance the backbone block (BBB) of LOP in-loop filter based on over-parameterized training. The proposed method does not increase multiply-accumulate (MAC) complexity and model parameters during inference, but enhances performance of the LOP in-loop filter by over-parameterized training. During the training phase, this contribution replaces the 1×3 and 3×1 separable convolution layers in LOP4 BBB with the over-parameterized convolution (OPC) module. The OPC module has a multi-branch structure to enhance the multi-scale feature extraction, thus improving the performance of the LOP4 network. During the inference phase, the OPC module is fused back into the original 1×3 and 3×1 separable convolution layers, which is identical to the original LOP in-loop filter. Compared to the NNVC-11.0 anchor (NNIntra enabled by default), the BD-rates of the proposed float32 model are {-0.02% (Y), -0.64% (U), -0.82% (V)} for the AI configuration and {-0.04% (Y), -1.90% (U), -1.55% (V)} for the RA configuration.

The contribution improves over a previous proposal on overparameterized model (JVET-AJ0080).

It was commented that the test was performed relative to NNVC11 (LOP4), and was not comparing against float model. Further, overparameterization likely causes longer training time, which might be more moderate in this proposal due to less usage of overparameterization.

It was agreed to investigate this in an EE on top of the newest LOP5, and possibly also to the other models of NNVC. Impact on training time relative to not using overparameterization should be reported, or ideally a version with comparable training time as for LOP5 should be investigated.

In the contribution, an training data set based on NNVC10 was used. In the EE, the set with distorted data based on NNVC6 should be used to allow better comparison with other proposals (see the rules in the EE description).

[JVET-AL0137](https://jvet-experts.org/doc_end_user/current_document.php?id=15462) AHG11: Backbone Block Enhancement of LOP In-Loop Filter with Over-Parameterized Training and Variable Channels [J. Han, C. Jung, Q. Qin (Xidian Univ.)]

This contribution proposes backbone block (BBB) enhancement of LOP in-loop filter with over-parameterized training and variable channels. The 1x3 and 3x1 separable convolutions in the LOP BBB are replaced with the 1x5 and 5x1 separable convolutions to increase the receptive field and enhance the prediction accuracy of the LOP network. Over-parameterized training to extend the 1x5 and 5x1 separable convolutions into a multi-branch structure is utilized to enhance the multi-scale feature extraction capability of the LOP BBB. Variable channels are adopted in the LOP BBB to enhance the richness of its input information while reducing network complexity. Therefore, this contribution reduces the complexity of LOP4 in-loop filter from 16.83 kMAC/pixel to 16.81 kMAC/pixel while enhancing the BD-rate performance. Compared to the NNVC-11.0 anchor, the BD-rate performance of the proposed float model with NNIntra enabled provides: {-0.19% (Y), -1.57% (U), -1.70% (V)} for the AI configuration, and {-0.07% (Y), -2.42% (U), -2.44% (V)} for the RA configuration.

It was commented that the proposal has interesting gains, to be studied in an EE. Similar comments apply as for JVET-AL0136 regarding aligning model, training, comparison point, etc.

Additional complexity impact of the increased filter lengths should be studied, as well as the contribution in gain that comes by the usage of 5x1/1x5 filter kernels.

It was asked how the kMAC number decreases while the number of parameters increases. This is caused by reducing BBB blocks to 32x32 earlier, while the longer filter kernels require more parameters.

[JVET-AL0165](https://jvet-experts.org/doc_end_user/current_document.php?id=15490) AHG11: Training NNSR using Reparameterization and Progressive Activation [H. Cho, S. Bahk, H. Kim (KHU), D. Kim, S. Lim (ETRI)]

This contribution proposes a training method that utilizes a reparameterization method to improve the performance of the NNSR in NNVC-11.0. In the proposed method, additional branches of network layers are employed during training to enhance feature learning, while the original network structure is maintained for inference. However, in the reparameterization method, each branch of network layers in training must remain linear to be merged into a single branch for inference. This limits the network’s ability to learn nonlinear features. To mitigate this limitation, the proposed method further introduces a progressive activation, which transitions from a nonlinear activation function to a linear activation function as the number of epochs increases.

These methods have been implemented based on the NNVC11.0 NNSR using SADL.

The BD-Rate results over NNVC11.0 NNSR for int16 are as follows:

1. Using reparameterization method

AI: -0.01%, -0.03%, -0.13%

RA: -0.02%, -0.06%, -0.25%

2. Using reparameterization method and progressive activation function

AI: %, %, %

RA: %, %, %

Gains reported above are only considering classes A1/A2.

Number of parameters and kMAC is increased relative to current NNSR.

The “progressive activation” replaces RELU by leaky RELU, therefore it should also increase the number of multiplications to be counted.

It was commented that the gain reported is more in the margin that usually could be observed in re-training.

No results on the benefit of overparameterization yet.

Training time increased approx. by 20 minutes/epoch.

Further study recommended, also reporting results without complexity increase relative to current NNSR, and with comparable training time.

[JVET-AL0166](https://jvet-experts.org/doc_end_user/current_document.php?id=15491) EE1 related: Improved VLOP with Attention [Y. Li, L. Kerofsky, M. Karczewicz (Qualcomm)]

A unified filter architecture for the Low-performance Operation Point (LOP) was proposed in JVET-AE0165 and refined in JVET-AF0043. Updated training strategy and configuration were presented in JVET-AH0042. VLOP1 was derived from LOP in JVET-AH0051. VLOP3 with earlier cropping and reduced inputs were integrated in JVET-AJ0054 and JVET-AJ0066. In JVET-AK0150, VLOP3 with residual groups and spatial attention was proposed with a significant coding gain.

This contribution proposes an improvement of the VLOP with attention mechanism of JVET-AK0150. The improvements are with respect to the simplification of the model and the model training stability as well as the performance. The simulation was conducted by using the NNVC-12 reference software, training was performed by using the VLOP3 training strategy, and SADL int16 model was used for the inference.

Complexity of the proposed model for VLOP is 5.09 (block-wise) kMAC/pixel.

The proposed filter (Int16 model) with NNIntra enabled provides: {-0.5%, -0.7%, -0.7%} BD-rate change for AI test configuration, and {-0.5%, -1.1%, -0.4%} for RA test configuration, versus the VLOP3 int16 (NNIntra enabled).

Compared to the VTM, the proposed filter with NNIntra enabled provides: {-7.8%, -9.4%, -9.0%} for the AI configuration, and {-6.2%, -7.6%, -6.1%} for the RA configuration.

The 3x3 convolution instead of separable was re-introduced in the proposal to reduce number of stages and improving the convergence and stability in training. It also improves chroma gain. It was however commented that it might be more critical in terms of generating overflows.

Two stages with attention blocks (compared to four in LOP).

It was commented that also the aspect of performing cropping in the beginning for luma is interesting.

Generally, there was interesting gain for VLOP.

It was agreed to investigate this in EE1.

[JVET-AL0167](https://jvet-experts.org/doc_end_user/current_document.php?id=15492) EE1 related: Further simplification of VLOP with Attention [Y. Li, L. Kerofsky, M. Karczewicz (Qualcomm)]

A unified filter architecture for the Low-performance Operation Point (LOP) was proposed in JVET-AE0165 and refined in JVET-AF0043. Updated training strategy and configuration were presented in JVET-AH0042. VLOP1 was derived from LOP in JVET-AH0051. VLOP3 with earlier cropping and reduced inputs were integrated in JVET-AJ0054 and JVET-AJ0066. In JVET-AL0166, improved VLOP3 with residual groups and spatial attention was proposed with a significant coding gain.

This contribution proposes a simplification of the VLOP with attention mechanism of JVET-AL0166. The simplification is to remove the residual group to reduce the intermediate memory usage for holding the activations. The simulation was conducted by using the NNVC-12 reference software, training was performed by using VLOP3 training strategy but with a lower starting LR of 0.0002, and SADL int16 model was used for the inference.

Complexity of the proposed model for VLOP is 5.09 (block-wise) kMAC/pixel.

The proposed filter (Int16 model) with NNIntra enabled provides: {-0.3%, 0.0%, -0.4%} BD-rate change for AI test configuration, and {-0.2%, -0.0%, -0.3%} for RA test configuration, versus the VLOP3 int16 (NNIntra enabled).

It was commented that a drop of performance is experienced in classes C and D.

No specific action is requested, contribution mainly for information.

[JVET-AL0184](https://jvet-experts.org/doc_end_user/current_document.php?id=15509) EE1-related: Deep Reference Frame Generation for Inter Prediction Enhancement [D. Ding, X. Chen, Z. Chen (Wuhan Univ.)]

This contribution reports the EE1-related test results of NN-based inter prediction. This contribution primarily focuses on an updated strategy for incorporating deep reference frames into the reference picture lists, while adopting the network architecture, training, and inference strategies from JVET-AF0208. Unlike JVET-AF0208, which considers the generated frame as an additional reference directly inserted into the reference picture list, the updated strategy replaces one of the existing reference frames with the generated reference frame. This ensures that the number of reference frames for B-frames and P-frames remains consistent with the default configuration of NNVC CTC.

Implemented on the VTM-11.0\_NNVC-12.0, the test results under the NNVC-RA configuration (with LOP filter and NN-intra enabled) are reported as follows:

DRF network from JVET-AF0208 (3800K, 504kMAC/pixel): -2.38%/-1.28%/-1.41% bitrate savings for the Y/U/V components in RA.

The last frame is replaced, and the new frame goes to position 2 of the list.

Vimeo-90K triplet is used for training

Compared to JVET-AF0208, some loss occurs

Complexity approx. 500 kMAC/pix

SADL, no integer

It was commented that better results might be achieved if longer sequences would be used (triplet has only 3 frames), and/or more sophisticated training strategy would be applied like in current EE1.

Applied only to temporal layers 3-5 with closest distances.

It was agreed to study this in in EE1-2 with comparable condition in training etc. as the other method from Xidian Univ. Varying the number of reference pictures is not of highest importance in that study, but must be comparable for different proposals.

[JVET-AL0312](https://jvet-experts.org/doc_end_user/current_document.php?id=15639) Crosscheck of JVET-AL0184 (EE1-related: Deep Reference Frame Generation for Inter Prediction Enhancement) [Z. Xie (OPPO)] [late]

[JVET-AL0196](https://jvet-experts.org/doc_end_user/current_document.php?id=15521) AHG 11: Neural Network Coded Reference Frame for Intra Coding with Residual Coding and Intra Blocks [F. Brand, T. Solovyev, E. Alshina (Huawei)]

This contribution presents a method to combine end-to-end trained image compression methods with long-proven methods from VTM. The method comprises using an end-to-end coded image as reference image for a modified I-Frame. The encoder can then decide whether and how to use the NN-reference frame. In this method data transfer from a GPU/NPU is only necessary on full frame level into the decoded picture buffer, thus solving a major problem in realizing neural-network-based components in hardware while using specialized hardware. Compared to the previous contribution JVET-AK0177 the method now allows full residual coding and standard intra blocks by VTM on top of the AI-coded frame. This method is implemented on top of the single-pass heuristic-based mode selection method from JVET-AK0177. Compared to the AI gains of -3.27%/-0.01%/+0.18% with a runtime of 53% (JVET-AK0177), this method can increase and stabilize the gain to -4.11%/-15.70%/-13.29% with a runtime of 92%. To counter the runtime increase, this contribution furthermore proposes to reduce the runtime by setting the MTT depth to zero if the NN-coded reference frame is used, which reduces the encoder runtime to 63%, with gains of -4.10%/-15.22%/-12.98%.

Switched off for QP22, where loss would occur.

The old approach had some local losses, which is now resolved by allowing to switch to conventional intra coding. Only quadtree is used in fast mode for intra pictures. For RA, normal partitioning is used

Decoding time (CPU) is around 80x compared to VTM in AI. Encoder runtime is also measured on CPU

RA gain around 1.1% on average.

It was asked if any information is available about percentage of usage? Around 50%, by tendency more at high rate, but often the usage is highly dependent on the rate matching. It would be desirable to make such information available in a new version.

It was commented that a combined RDO of NN and conventional branches might improve compression.

Basically every I frame is coded twice, however some early stopping criteria are applied in VTM also when MTT is on.

JPEG-AI would not be suitable for this, as it does not have guarantee of sample-accurate reconstruction.

Was it combined with ECM? No.

The bitstream conveying the NN coded part is separate from the VVC bitstream. Always the entire picture is sent, even when parts are not used. Further optimization could further improve results.

Proponents suggest to establish a VTM branch to enable further study of approaches of this.

[JVET-AL0203](https://jvet-experts.org/doc_end_user/current_document.php?id=15528) [AHG11] A Hybrid Framework Integrating End-to-End Learned Image Codec with Conventional Codec [N. Zou, A. Hallapuro, F. Cricri, H. Zhang, M. M. Hannuksela (Nokia)]

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. 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:

Class A1 -0,70 % (Y), -0,94 % (Cb), -1,80 % (Cr)

Class A2 -1,73 % (Y), -5,07 % (Cb), -3,99 % (Cr)

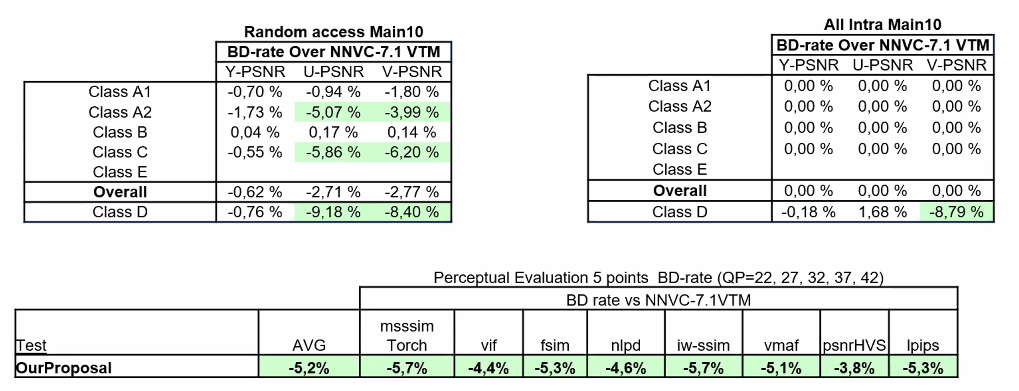
Class B 0,04 % (Y), 0,17 % (Cb), 0,14 % (Cr)

Class C -0,55 % (Y), -5,86 % (Cb), -6,20 % (Cr)

Class D -0,76 % (Y), -9,18 % (Cb), -8,40 % (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 |
| -5.2% | -5.7% | -4.4% | -5.3% | -4.6% | -5.7% | -5.1% | -3.8% | -5.3% |



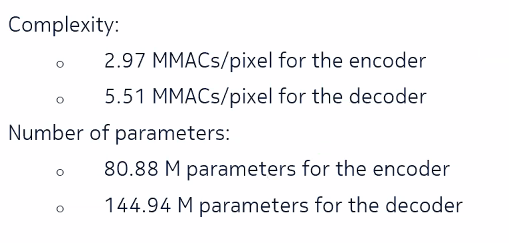
It was suggested not to use the acronym LIC (which is used for local illum. comp. usually)

The bitstream of the NN-coded intra frame is part of the VVC bitstream as new NAL unit type.

No gain on AI, as it is never used due to different QP settings compared to RA.

Selection between NN-coded or conventional coded intra frame is done at frame level, only one of them is selected and included in the bitstream.

Would the switching lead to visibility of GOP structures? Not checked.



[JVET-AL0230](https://jvet-experts.org/doc_end_user/current_document.php?id=15557) AhG11/AhG12: Performance of the NNVC ILF in ECM [D. Rusanovskyy, K. Panusopone, S. Hong, L. Wang (Nokia)]

See section 5.2.4.4.

[JVET-AL0243](https://jvet-experts.org/doc_end_user/current_document.php?id=15570) [AHG11] Multilayer framework for supporting a hybrid codec using End-to-End Learned Image Codec and Conventional Video Codec [F. Urban, Y. Chen, F. Galpin, E. François (InterDigital)] [late]

In this contribution, we present a framework to support a hybrid codec that combines End-to-End Learned (E2E) image compression methods with conventional compression methods such as VVC. The framework is based on a modification of VVC to allow external picture coding. The multi-layer capability of VVC can then be used transparently to allow the use of such pictures inside VVC, while allowing the encoder to do low-level RD choices in the enhancement layer. The hybrid codec involves using E2E-coded intra frames and VTM-coded inter frames. The main advantage of this approach is that it allows the use of an external picture without defining explicitly the external codec, while allowing the use of a standard VVC decoder on the enhancement layer. In practice, the external codec can be run independently on AI accelerator and only the resulting picture is used by the VVC decoder.

An example of use with JPEG-AI encoded intra pictures is demonstrated using random-access configuration and multi-layer on top of VTM 23.

A mechanism is employed similar to SHVC (such a mechanism is not existing in VVC) to use an external reference as base layer, integrated in NNVC software. JPEG-AI is used, bitstream is separate.

Unlike the other two proposals, the inter picture (if in layer 1 or higher) might itself select if it is better to use the AI coded (layer 0) or the conventional coded (layer 1) reference.

Further study in AHG11/14, with the goal to combine the aspects of the three methods of JVET-AL0196, JVET-AL0203 and JVET-AL0243 to provide an interface with NN-coded intra frames. As a first effort, proponents should discuss the options, benefits and priorities of elements of such an interfaces.

[JVET-AL0250](https://jvet-experts.org/doc_end_user/current_document.php?id=15577) AHG11: Cross-component enhanced NNSR [T. Yang, W.-X. He, Y.-Q. Zhu, J.-D. Ye, X.-T. Xie, J.-S. Gong, Q. Liu (HUST), Z.-Y. Lv (vivo)] [late]

The existing NNSR model achieve coding gains on luma with a low complexity, while it remains loss on chroma. This contribution proposes a cross-component enhanced block for NNSR, which feeds deep features from the luma branch into the chroma branch with attention mechanism to enhance chroma processing.

The proposed model has been integrated into NNVC12.0. The overall BD-rate savings are reported as follows:

Multi-ratio: AI { -0.83%, 2.47% (-0.56%), 2.50% (-0.41%)}

RA { -0.86% (-0.04%), 1.92% (-0.41%), 2.07% (-0.39%)}.

JVET-AJ0056: AI { -0.83%, 3.03%, 2.91%}

RA { -0.82%, 2.33%, 2.46%}.

It was commented that the improvement relative to the current NNSR is relatively small (in the range of 0.4%). However, the aspect of cross-component processing in NNSR is new, such that it appears interesting to study in an EE, following the usual rules.

[JVET-AL0291](https://jvet-experts.org/doc_end_user/current_document.php?id=15618) EE1-related: Recommendations for resolving mismatches between LOP5 description and implementation [N. Le, F. Cricri (Nokia)] [late]

This document reports potential mismatches between the architecture of LOP5 documented in JVET-AK2023 and its implementation in NNVC12 software.

In [JVET-AK2023](https://jvet-experts.org/doc_end_user/current_document.php?id=15330) the NNVC-12 LOP5 is depicted in several diagrams. However, there are inconsistencies between these diagrams and its corresponding implementation in NNVC12 software repository. In this document, we address these mismatches and provide suggestions to correct these mismatches, based on the assumption that the LOP5 definition in NNVC12 is the correct version.

It was agreed that the proposed corrections relative to the EE1 description need to be carefully checked by editors, to make the description of LOP5 in JVET-AL2019 matching the software implementation (note that JVET-AK2019 did not yet contain this part of the description.

### SADL and NNVC implementation, CTC (2)

Contributions in this area were discussed during 1500–1510 on Wednesday 2 April 2025 (chaired by JRO).

[JVET-AL0100](https://jvet-experts.org/doc_end_user/current_document.php?id=15425) AHG14: The extension of SADL library [W. Ma, N. Fu, W. Bao, Z. Chen (Wuhan Univ.)]

This contribution presents the extensions in the Small AdHoc Deep Learning (SADL) library from Wuhan University. These extensions include a new layer (Tile) and SIMD256/SIMD512 acceleration for the Conv2dTranspose\_2x2.

Decision(SW): Include both elements of JVET-AL0100 in next version of SADL.

[JVET-AL0265](https://jvet-experts.org/doc_end_user/current_document.php?id=15592) AhG14: SADL update [F. Galpin (InterDigital)] [late]

This contribution presents updates in the Small AdHoc Deep Learning (SADL) library. The update contains both some fixes and new features.

The changes brought some speedup for LOP5 and VLOP3, but gave an increased runtime HOP (see the AHG14 report; all changes were in the the range <=5%).

All changes are agreed to be included in SADL 13.

## AHG6/AHG12: Enhanced compression beyond VVC capability (64)

### Summary and BoG reports (1)

Contributions in this area were discussed during 1300–1515 and 1535–1740 on Thursday 27 March 2025, and during 0500–0625 on Friday 28 March 2025 (all chaired by JRO).

[JVET-AL0024](https://jvet-experts.org/doc_end_user/current_document.php?id=15402) EE2: Summary report of exploration experiment on enhanced compression beyond VVC capability [V. Seregin, J. Chen, R. Chernyak, K. Naser, J. Ström, F. Wang, M. Winken, X. Xiu, K. Zhang (EE coordinators)]

**List of tests**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Partitioning** | | | |
| 1.1a | Set MaxTTChromaISlice to 64 | P.-H. Lin  (Qualcomm) | R.-L. Liao  (Alibaba) |
| 1.1b | Chroma partition prediction | P.-H. Lin  (Qualcomm) | R.-L. Liao  (Alibaba) |
| 1.1c | Test 1.1a + Test 1.1b | P.-H. Lin  (Qualcomm) | C.-W. Kuo (Kwai) |
| 1.1d | Test 1.1a + Test 1.1b with non-normative variant | P.-H. Lin  (Qualcomm) | C.-W. Kuo (Kwai) |
| **2 Intra prediction** | | | |
| 2.1 | EIP filters with diagonal shapes | K. Panusopone (Nokia) | Z. Xie  (OPPO) |
| 2.2a | Constraints to CCPmerge modes | Y.-J. Chang  (Qualcomm) | J. Lainema  (Nokia) |
| 2.2b | Constraints to CCP modes | Y.-J. Chang  (Qualcomm) | J. Lainema  (Nokia) |
| 2.2c | Encoder only changes (Test 2.2a + Test 2.2b + SATD optimization) | Y.-J. Chang  (Qualcomm) | H. Huang  (OPPO) |
| 2.2d | Test 2.2a + Test 2.2b + Test 2.2c (SATD optimization) | Y.-J. Chang  (Qualcomm) | H. Huang  (OPPO) |
| 2.3 | CCP merge mode with adjustment | Y. Wang  (Bytedance) | C. Ma  (Kwai) |
| 2.4 | Block vector guided EIP | Z. Xie  (OPPO) | K. Panusopone (Nokia) |
| 2.5 | Flip-aware BV prediction in SGPM | J. Huo  (Xidian Univ.) | X. Li  (Alibaba) |
| 2.6a | On handling of Planar mode in MPM list | G.Wang  (vivo) | J. Fu  (PKU) |
| 2.6b | Additional DIMD blending modes in MPM list | G.Wang  (vivo) | Y. Liu  (Transsion) |
| 2.6c | Test2.6a+Test2.6b | G.Wang  (vivo) | J. Fu  (PKU)  Y. Liu  (Transsion) |
| 2.7 | Block vector guided DIMD | L. Zhang  (OPPO) | Y. Wang  (Bytedance) |
| 2.8a | Subblock-based CCCM | F. Pu  (Dolby) | withdrawn |
| 2.8b | Subblock-based CCCM without TU splitting | F. Pu  (Dolby) | withdrawn |
| 2.9 | Test 2.1 + Test 2.4 | K. Panusopone (Nokia)  Z. Xie  (OPPO) | P. Andrivon  (Ofinno) |
| 2.10 | Multiple filter taps for EIP | Z. Lyu  (vivo) | Z. Deng  (Bytedance) |
| 2.11 | Test 2.4 + Test 2.10 | Z. Xie  (OPPO)  Z. Lyu  (vivo) | Z. Deng  (Bytedance) |
| 2.12 | Non-adjacent DIMD for TMRL | V. Rufitskiy  (TCL) | withdrawn |
| **3** **Inter prediction** | | | |
| 3.1 | Subblock based spatial MVP | Z. Deng  (Bytedance) | Z. Lyu  (vivo)  S. Iwamura (NHK) |
| 3.2 | Extension on spatial and temporal merge candidates | J.-L. Lin  (Qualcomm) | L. Zhang (OPPO) |
| 3.3a | Additional spatial merge candidates | N. Zhang  (Bytedance) | X. Li  (Alibaba) |
| 3.3b | Additional pairwise-average merge candidates | N. Zhang  (Bytedance) | X. Li  (Alibaba) |
| 3.3c | Additional multiple-average merge candidates | N. Zhang  (Bytedance) | X. Li  (Alibaba) |
| 3.3d | Test 3.3a + Test 3.3b + Test 3.3c | N. Zhang  (Bytedance) | X. Li  (Alibaba) |
| 3.3e | Test 3.3d + Test 3.2 | N. Zhang  (Bytedance)  J.-L. Lin  (Qualcomm) | L. Zhang  (OPPO) |
| 3.4a | Joint GPM split modes and partition indices reordering | C. Ma  (Kwai) | J. Chen  (Alibaba) |
| 3.4b | Test 3.4a + replacing the existing GPM reordering scheme | C. Ma  (Kwai) | J. Chen  (Alibaba) |
| 3.5 | On affine motion compensation | H. Huang  (Qualcomm) | C. Ma  (Kwai) |
| 3.6 | MV refinement for TMVP | Z. Zhang  (Qualcomm) | Z. Deng  (Bytedance) |
| 3.7a | 4-tap interpolation filter set 0 for template matching | Z. Dai  (Alibaba) | L. Xu  (OPPO) |
| 3.7b | 4-tap interpolation filter set 1 for template matching | Z. Dai  (Alibaba) | L. Xu  (OPPO) |
| 3.7c | 4-tap interpolation filter set 0 for bilateral matching and DMVR | Z. Dai  (Alibaba) | L. Xu  (OPPO) |
| 3.7d | 4-tap interpolation filter set 1 for bilateral matching and DMVR | Z. Dai  (Alibaba) | L.Xu  (OPPO) |
| 3.8a | CMVP extension for constructed affine merge candidates with additional candidates | C. Li  (Alibaba) | L. Zhao (Bytedance) |
| 3.8b | CMVP extension for constructed affine merge candidates with no additional candidates | C. Li  (Alibaba) | L. Zhao (Bytedance) |
| 3.9 | Extended BDOF usage for MV refinement | R. Yu  (Qualcomm) | Y. Wang  (Bytedance) |
| 3.10a | OBMC modifications for GPM | R. Yu  (Qualcomm) | withdrawn |
| 3.10b | OBMC operation order of blocks and subblocks | R. Yu  (Qualcomm) | withdrawn |
| 3.10c | Test 3.10a + Test 3.10b | R. Yu  (Qualcomm) | withdrawn |
| **4** **Transform and coefficients coding** | | | |
| 4.1 | Advanced SBT | G. Laroche  (Canon) | Y. Zhang  (Qualcomm) |
| 4.2a | Advanced SBT with simplified search method | Y. Zhang  (Qualcomm) | G. Laroche  (Canon) |
| 4.2b | Combination test of Test 4.1 and Test 4.2a | Y. Zhang  (Qualcomm)  G. Laroche  (Canon) | L. Zhao (Bytedance) |
| 4.3a | On TS binarization and context bin budget management | M. Abdoli  (Xiaomi) | P. Astola  (Nokia) |
| 4.3b | Test 4.3a on very high bitrate (QP 2-7-12-17) | M. Abdoli  (Xiaomi) | P. Astola  (Nokia) |
| 4.3c | Test 4.3b with no context coded bin constraint on TS | M. Abdoli  (Xiaomi) | P. Astola  (Nokia) |
| 4.4a | Using the second NSPT set for IntraNN | G. Verba (Qualcomm) | T. Dong, V. Rufitskiy (TCL) |
| 4.4b | Retraining NSPT kernels | G. Verba (Qualcomm) | T. Dong, V. Rufitskiy (TCL) |
| 4.4c | Test 4.4a + Test 4.4b | G. Verba (Qualcomm) | M. Abdoli  (Xiaomi) |
| 4.4d | Test 4.4c + increase the number of output coefficients for NSPT | G. Verba (Qualcomm) | M. Abdoli  (Xiaomi) |
| **5 In-loop filtering** | | | |
| 5.1 | ALF-CCCM | P.Astola (Nokia) | R. G. Youvalari (Xiaomi) |
| 5.2 | CCSAO with reused CTU control | C.-W. Kuo (Kwai) | W. Yin  (Bytedance) |
| 5.3a | Cross-chroma input for chroma-ALF | W. Yin  (Bytedance)  C. Ma  (Kwai) | N. Hu  (Qualcomm) |
| 5.3b | Cross-chroma input for CC-ALF | W. Yin  (Bytedance)  C. Ma  (Kwai) | N. Hu  (Qualcomm) |
| 5.3c | Test 5.3a + Test 5.3b | W. Yin  (Bytedance)  C. Ma  (Kwai) | N. Hu  (Qualcomm) |
| 5.4 | NN-based luma ILF with ALF | Y. Li (Qualcomm) |  |
| **6 Other** | | | |
| 6.1 | Adaptive picture-level vertical mirroring | D. Mieloch (PUT) | M. Abdoli  (Xiaomi) |

**Description of tests**

***Partitioning***

**Test 1.1:** **Chroma partition prediction in separate tree condition (**[**JVET-AL0143**](https://jvet-experts.org/doc_end_user/current_document.php?id=15468)**)**

In this test, a chroma partition prediction method is evaluated for separate tree condition. It includes two aspects:

* Set the partition parameter MaxTTChromaISlice to 64 (currently it is set to 32)
* Disable some splits of a chroma block by the decoded luma region. For each chroma CTU, average luma BT depth, average luma MTT depth and non-squared blocks ratio are calculated from all the blocks in the collocated luma CTU. Splits of a chroma block are disallowed by the following conditions:
  + If BTdepthcurr > BTdepthlumaavg + BTdiff – 1, the TT splits of this block are disabled
  + If MTTdepthcurr + BTdiff < MTTdepthlumaavg and MTTdepthcurr is equal to 0, the TT splits of this block are disabled
  + If MTTdepthcurr + BTdiff < MTTdepthlumaavg, MTTdepthcurr is equal to 0 and ratiow>h/ratioh>w of luma blocks in collocated luma CTU is larger than half, the vertical/horizontal BT split is disabled

where BTdiff is the difference of luma and chroma maximum BT size in logarithmic scale.

Test 1.1a: Set MaxTTChromaISlice to 64.

Test 1.1b: Chroma partition prediction.

Test 1.1c: Test 1.1a + Test 1.1b.

Test 1.1d: Test 1.1a + Test 1.1b (encoder only).



Among the variants, test 1.1c comes with a small gain (which is combination of a and b) . It was asked why the decoding time is reduced. According to proponents, this is likely due to disallowing less certain splits in partitioning, which also causes less encoder checks. Test a has large encoding run time increase, and also larger gain relative to c, which in the combination with test b which makes the run time decrease.

Decision: Adopt JVET-AL0143 test 1.1.c.

***Intra prediction***

**Test 2.1: EIP filters with diagonal shapes (**[**JVET-AL0205**](https://jvet-experts.org/doc_end_user/current_document.php?id=15530)**)**

In ECM, three EIP filter shapes are supported shown in the figure below. In all three EIP filter shapes, their support areas only cover samples above and to the left of the predicting sample.

A screenshot of a game

AI-generated content may be incorrect.

In the test, EIP filters with diagonal shapes including samples above-right and below-left of the predicting sample in their support areas shown in the next figure are evaluated.

X

X

X

X

X

O

X

X

X

X

X

X

X

X

X

X

X

X

X

X

O

X

X

X

X

X

X

X

X

X

X

X

X

X

X

X

O

input of EIP

output of EIP

X

X

X

X

X

X

X

O

X

X

Test 2.1: EIP filters with diagonal shapes.

**Test 2.4: Block vector guided EIP (**[**JVET-AL0106**](https://jvet-experts.org/doc_end_user/current_document.php?id=15431)**)**

In the test, a block vector shown in the figure below, which is derived from the sparse searching process of IntraTMP in ECM, is used to determine the reference area for calculating the EIP filter parameters instead of directly using the adjacent spatial reconstructed area and BV EIP mode is coded as a sub-mode of EIP with a flag. Only square filter shape is allowed for the sub-mode.

A diagram of a diagram

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Test 2.4: Block vector guided EIP

**Test 2.9: Combination of Test 2.1 and Test 2.4 (**[**JVET-AL0206**](https://jvet-experts.org/doc_end_user/current_document.php?id=15531)**)**

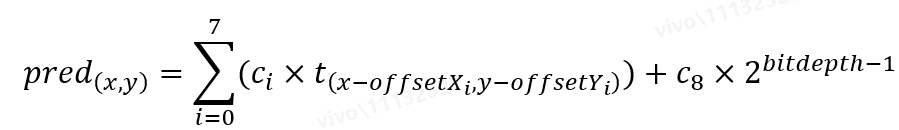
In the test, EIP filters with diagonal shapes replace the ones in ECM-16.1 and block-vector guided EIP is working as a sub-mode of regular EIP.

Test 2.9: Test 2.1 + Test 2.4

**Test 2.10: Multiple filter taps for EIP (**[**JVET-AL0124**](https://jvet-experts.org/doc_end_user/current_document.php?id=15449)**)**

In the test, two filter taps are supported and the index indicating which filter tap is used is signalled. The EIP mode in ECM uses a 15-tap filter and another 9-tap filter was applied to multi-model EIP only and is only applied to block whose area is larger than or equal to 64, and smaller than or equal 256.

For EIP mode using 9-tap filter, the prediction is calculated as follows:



Test 2.10: Multiple filter taps for EIP.

**Test 2.11: Combination of Test 2.4 and Test 2.10 (**[**JVET-AL0107**](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0107-v1.zip)**)**

In the test, BV guided EIP method only allows single-model EIP filter with square-shape, and the method of using multiple filter taps is only applied to multi-model EIP candidates.

Test 2.11: Test 2.4 + Test 2.11.

**Test 2.2: On cross-component intra prediction (**[**JVET-AL0191**](https://jvet-experts.org/doc_end_user/current_document.php?id=15516)**)**

This test evaluates different constraints to CCP and CCPmerge modes to improve the performance trade-off.

Since the CCPmerge list is constructed and reordered by template costs, the first candidate with the lowest template cost can contribute more gains.

In Test 2.2a, the CCPmerge fusion is restricted to use only the first CCPmerge candidate, where the fusion flag is only signalled if the first candidate is used.

In ECM, there are two types of CCP modes, i.e., single model and multi-model, and three types of templates, i.e., top-only template, left-only template, and top-and-left template. The constraints for CCP modes are tested by disabling either multi-model or single-model, and/or disabling the templates among top-only template, left-only template, and top-and-left template.

In Test 2.2b, the included constraints for CCP modes are listed as follows, where signalling is modified to exclude those modes if the disabling condition is satisfied:

* Multi-model CCCMwMDF mode is disabled if template is top-only and left-only
* Multi-model GLCCCM mode is disabled if template is top-only and left-only
* GLM mode is disabled if template is top-only template

In Test 2.2c, a mode candidate list is constructed at encoder by evaluating SATD/SAD cost (similar encoder process is used for intra modes evaluation for luma component) for intra chroma modes, and up to 27 candidates (based on the cost difference between a candidate and the first candidate) with the smallest cost are selected to perform full rate-distortion optimization. Additionally, it also uses mode selection from tests 2.2a and 2.2b but without any signalling restriction.

Test 2.2a: Constraints to CCPmerge modes

Test 2.2b: Constraints to CCP modes

Test 2.2c: Encoder only changes (Test 2.2a + Test 2.2b + SATD)

Test 2.2d: Test 2.2a + Test 2.2b + Test 2.2c (SATD optimization)

**Test 2.3: CCP merge mode with adjustment (**[**JVET-AL0126**](https://jvet-experts.org/doc_end_user/current_document.php?id=15451)**)**

CCP merge mode with adjustment is tested, in which a CCP model is updated using a template comprising of neighbouring samples of the current block. If the CCP model is a CCCM model as formulated in (1), the first parameter *c*0 and other parameters will be updated using an adjustment parameter *u* as in (2), where *decimBits* denotes the decimal precision in CCCM.

predChromaVal = *c*0C + *c*1N + *c*2S + *c*3E + *c*4W + *c*5P + *c*6B (1)

*c*’0 = *c*0 + (*u* << (*decimBits* – *shift*)) (2)

The optimal *u* is determined from a pre-defined set according to the SAD costs by applying the updated CCP model to the template.

In the test, the pre-defined set of *u* is {–7, –5, –3, –1, 1, 3, 5, 7} and *shift* is set equal to five. When CCP merge mode is used, a flag is signalled to indicate whether the method is applied or not. If used, the CCP merge candidate list is constructed only including CCCM models and its variants (e.g., Gradient and location based CCCM, CCCM using non-downsampled luma samples, CCCM with multiple downsampling filters), and an additional flag is signalled to indicate whether to adjust other parameters.

**Test 2.5: Flip-aware BV prediction in SGPM (**[**JVET-AL0188**](https://jvet-experts.org/doc_end_user/current_document.php?id=15513)**)**

In ECM, the IBC-RRIBC flip type is inherited in IBC, DBV, and BVG-CCCM modes, and a flip-aware BV adjustment (motion shift is added to a block vector candidate obtained from a neighbouring block according to a symmetric rule) approach is applied to refine the block vector candidate. BV based prediction is also used in combination with SGPM, when the merge candidates (adjacent and non-adjacent blocks) with block vectors are constructed. However, as shown in the next table, the IBC-RRIBC flip type is not inherited from merge BV candidates and a flip-aware BV adjustment approach is not applied to refine the block vector candidate in SGPM.

Inheritance of IBC-RRIBC flip type in different modes

|  |  |
| --- | --- |
| Mode | Whether to inherit IBC-RRIBC flip type and apply flip-aware BV adjustment |
| IBC | Yes |
| DBV | Yes |
| BVG-CCCM | Yes |
| SGPM | No |

In the test, IBC-RRIBC flip type is inherited from a merge candidate for SGPM and flip-aware BV adjustment approach is applied to refine the block vector candidate. Correspondingly, when RRIBC is applied (flip type > 0), the samples in a prediction block based on BV are flipped according to the flip type of the current block, which is similar to the case of IBC, DBV, BVG-CCCM modes.

Test 2.5: Flip-aware BV prediction in SGPM.

**Test 2.6: Improvement on MPM (**[**JVET-AL0125**](https://jvet-experts.org/doc_end_user/current_document.php?id=15450)**)**

In ECM, in MPM list construction, the first entry is always the Planar mode, the remaining entries are composed of the intra modes of the left (L), above (A), below-left (BL), above-right (AR), and above-left (AL) neighbouring blocks, DIMD modes, and the intra modes of non-neighbouring blocks.

In the test, the following MPM modification aspects are included:

1. Planar mode is conditionally added to the MPM list, if a current CU satisfies the IntraNN enabling condition, the Planar mode will not be placed in the first position in the MPM list.
2. In the MPM list filling process, more DIMD modes are added and placed at the top of the MPM list, and besides DIMD mode, two dimdBlendModes are added instead of one.

Test 2.6a: On handling of Planar mode in MPM list.

Test 2.6b: Additional DIMD blending modes in MPM list.

Test 2.6c: Test 2.6a + Test 2.6b.

**Test 2.7: Block vector guided DIMD (**[**JVET-AL0108**](https://jvet-experts.org/doc_end_user/current_document.php?id=15433)**)**

In the test, BV is used to located neighbouring samples for DIMD intra modes derivation. This mode is indicated by a flag as a sub-mode of DIMD.

Up to 5 block vectors are obtained by a searching process similar to IntraTMP. To reduce complexity, the process of obtaining BVs and deriving intra modes is modified as follows:

1. After sparse search and obtaining merge candidates, only the best BV candidate is used for further refinement search instead of using 30 candidates as in IntraTMP;
2. A template cost threshold is set proportional to the minimum template cost, and BVs with template costs above the threshold will not be used to build HoG and prediction;
3. The reference area is sub-sampled to derive intra modes when the current block size is equal to or greater than 128.

With each block vector, a reference area in the current picture is determined as shown in the next figure and its samples are used to derive the intra modes and corresponding amplitudes.

Two intra modes with the highest amplitudes are selected from the HoG and the prediction of the current block is the blending of those 2 predictors and a non-directional predictor. These two intra modes are also used to select the transform set when using the multiple transform set selection method. The non-directional predictor is the blending of up to 5 BV-based predictors obtained using the block vectors.

A diagram of a graph and direction

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Encoder optimization is also performed for the method considering SATD cost to whether include the mode into full RD check.

Test 2.7: Block vector guided DIMD



Test 2.9 was supported by various experts, including crosschecker. The change is asserted to be straightforward, and the benefits of 2.1 and 2.4 are additive in 2.9. the additional test 2.10 (multiple filter taps) does not have a good tradeoff, and in combination with the other two tests (2.11) has less gain than 2.9.

Decision: Adopt JVET-AL0206 test 2.9

Tests 2.2x target encoder run time decrease by constraining and/or performing less RD checks in the context of CCP merge. Tests 2.2c and 2.2d have attractive tradeoff (small loss, but >4% encoder time reduction, test d a bit more). Even though it could be asserted that most run time reduction comes from the SATD optimization, and using that as a non-normative change rather than never using signalling of the modes which are constrained in a and b (as done in c), or introducing a syntax change (as done in d), such a test had not been requested, and in general from the results available, test d is supported by several experts as being the most attractive variant.

Decision: Adopt JVET-AL0191 test 2.2d.

Test 2.3 has some gain both in luma and chroma without on impact on encoding and decoding time. The refinement is computed on the template, but no additional RD check necessary. It is asserted that there would be no interference with the encoder optimization in 2.2, as the SATD optimization would not beused in that additional step.

Decision: Adopt JVET-AL0126 test 2.3.

Test 2.5 extends the flip-aware BV adjustment to SGPM. Though it gives only small gain for screen content with a small increase of encoder run time, this is supported for consistency by one independent expert, and also by cross-checker. The template needs also to be flipped, but according to the original proponents of SGPM, this seems to be implemented efficiently (by reading samples in reverse order), as the run time increase is relatively low.

Decision: Adopt JVET-AL0188 test 2.5

Test 2.6x is supported by several experts (including crosscheckers) as it has small gain without much impact on runtime, and is asserted as a straightforward modification of MPM list modification. The combination test 2.6c indicates that the gains of the two elements are additive.

Decision: Adopt JVET-AL0125 Test 2.6c

Test 2.7 is supported by several experts as being straightforward and having similar tradeoff as other adopted proposals.

Decision: Adopt JVET-AL0108 Test 2.7

***Inter prediction***

**Test 3.1: Subblock-based spatial MVP (**[**JVET-AL0160**](https://jvet-experts.org/doc_end_user/current_document.php?id=15485)**)**

In ECM, up to 51 SbTMVP and affine candidates can be inserted into the subblock-based merge mode candidate list. After template-based reordering, 20 of these candidates are sorted out for the final merge index signalling.

In the test, subblock-based spatial MVP is included to derive the subblock motion field from spatial neighbour blocks. Possible 5 directions of the new candidates, where MVs of subblocks are inherited in a directional way, are shown in the figure below.

Up to 5 subblock-based spatial MVP candidates are added after SbTMVP candidates and before affine merge candidates. All the subblock motion candidates are reordered in the same way as in ECM and the amount of the final candidates is not changed.

If a subblock-based spatial MVP candidate is selected, the motion data, such as motion vectors, reference indices, and prediction direction, of the corresponding neighbouring subblocks is copied to the current subblocks along a predefined direction, as depicted in the next figure.

A grid of white squares with black text

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AI-generated content may be incorrect. A grid of white squares with black text

AI-generated content may be incorrect.

A screenshot of a grid

AI-generated content may be incorrect. A grid of squares with black text

AI-generated content may be incorrect.

Examples of subblock-based spatial MVP candidate types (MVs are inherited along the direction of horizontal, vertical, diagonal-top-left, diagonal-bottom-left and diagonal-top-right).

Test 3.1: Subblock based spatial MVP.

**Test 3.2: Extension on spatial and temporal merge candidates (**[**JVET-AL0151**](https://jvet-experts.org/doc_end_user/current_document.php?id=15476)**)**

In the test, additional spatial and temporal merge candidates along the CU boundary are included into merge candidate list. The positions relative to current block which are used to derive the spatial and temporal merge candidates are shown in the next figure. The additional spatial merge candidates are added into the list after adjacent spatial merge candidates and before non-adjacent spatial merge candidates. The additional temporal merge candidates are added into the list after existing temporal candidates.

|  |  |
| --- | --- |
| A black grid with blue lines  AI-generated content may be incorrect. | A black background with blue lines  AI-generated content may be incorrect. |
| spatial merge candidates | temporal merge candidates |

Test 3.2: Extension on spatial and temporal merge candidates.

**Test 3.3: Additional inter merge candidates (**[**JVET-AL0157**](https://jvet-experts.org/doc_end_user/current_document.php?id=15482)**)**

In the test, additional spatial, pairwise-average, and multiple-average candidates are introduced.

As shown in the figure below, an above-middle spatial candidate is fetched from the neighbouring block B3 or B4, and a left-middle spatial candidate is fetched from the neighbouring block A2 or A3.

Besides, pairwise candidates in the pairwise merge list can be derived with any two candidates in the initial merge candidate list after the first round of ARMC.

A black grid with blue lines

AI-generated content may be incorrect.

Additionally, multiple-average motion candidates are added after the pairwise-average motion candidates. When four candidates with the same reference picture in the reference picture list LX are available, the MV in the reference picture list LX of the multiple-average motion candidate denoted as mvLX is calculated as:

mvLX = (mvLX\_A + mvLX\_B + mvLX\_C + mvLX\_D) >>2,

wherein mvLX\_A, mvLX\_B, mvLX\_C, and mvLX\_D are MVs of the four candidates.

The multiple-average motion candidates are only introduced for non-low delay pictures.

Test 3.3a: Additional spatial merge candidates

Test 3.3b: Additional pairwise-average merge candidates

Test 3.3c: Additional multiple-average merge candidates

Test 3.3d: Test 3.3a + Test 3.3b + Test 3.3c

Test 3.3e: Test 3.2 + Test 3.3d

**Test 3.4: Joint reordering of GPM split modes and partition indices (**[**JVET-AL0134**](https://jvet-experts.org/doc_end_user/current_document.php?id=15459)**)**

In the test, split modes and partition indexes for the GPM modes, including the regular GPM and GPM-TM, are jointly reordered using template matching. When the method is applied, for each CU that is coded with GPM or GPM-TM modes, a candidate list is built with each entry containing one split mode and the MVs of the two GPM partitions. The candidate list is reordered using the template-based scheme and the selected split/motion pair is signalled to decoder.

In Test 3.4a, one additional flag is introduced to indicate whether the scheme is applied to each GPM CU. If the flag is true, one index is further signalled to indicate the selected candidate in the reordered candidate list.

In Test 3.4b, the existing GPM reordering is replaced with the scheme such that no extra signalling is needed.

Test 3.4a: Joint GPM split modes and partition indices reordering.

Test 3.4b: Test 3.4a replacing the existing GPM reordering scheme.

**Test 3.5: On affine motion compensation (**[**JVET-AL0079**](https://jvet-experts.org/doc_end_user/current_document.php?id=15404)**)**

In ECM, when an affine coded block meets the BDOF condition, BDOF is applied to the subblocks. Otherwise, regular MC is performed with adaptive subblock size. If OBMC flag is true, subblock size starts from 4x4, otherwise (OBMC flag is false) the subblock size starts from 1x1, i.e. per-pixel based. PROF is performed if the subblock size is larger than 4x4.

In the test, per-pixel based motion compensation is performed for affine coded block regardless of the OBMC flag. The inner subblock OBMC is skipped if per-pixel based motion compensation is performed. When an affine coded block meets the BDOF condition, affine BDOF is applied to the block and per-pixel based affine motion compensation is not performed.

Test 3.5: Per-pixel affine motion compensation.

**Test 3.6: MV refinement for TMVP (**[**JVET-AL0214**](https://jvet-experts.org/doc_end_user/current_document.php?id=15541)**)**

In the test, MV refinement is performed to TMVP. The refinement process is to find an MV in a reference picture (CurRefPic) which has the minimum SATD cost between a reference template in the CurRefPic and the collocated template (ColTmpl) in the collocated picture (ColPic). The size of ColTmpl is up to 16x16, which is derived from grouping similar 4x4 blocks surrounding the collocated block (ColBlk) in ColPic.

The refinement starting point (ColScaledMv) is derived from the collocated MV (ColMv) in the collocated reference picture (ColRefPic) with scaling. The scaling factor is (CurRefPoc – ColPoc) / (ColRefPoc – ColPoc).

When CurRefPic is between ColPic and ColRefPic, the search area consists of { ColBlk position, ColBlk position + ColMv }, otherwise, the search area is around ColBlk position + ColScaledMv with the search range { -SR, SR }, where SR is set to (ColMv – ColScaledMv) if ColRefPic is between CurRefPic and ColPic, otherwise, SR is set to ColScaledMv.

Next figures show two examples of deriving the refined MV (RefinedColScaledMv) in CurRefPic.





When ColBlk has two MVs, it derives each RefinedColScaledMv independently. TMVP MV is derived from RefinedColScaledMv with scaling, wherein, the scaling factor is (CurRefPoc – CurPoc) / (CurRefPoc – ColPoc).

Test 3.6: MV refinement for TMVP.

**Test 3.7: On interpolation filter for template matching (**[**JVET-AL0161**](https://jvet-experts.org/doc_end_user/current_document.php?id=15486)**)**

In ECM, a 2-tap bilinear interpolation filter with 8-bit coefficient precision is applied in the template matching based tools (e.g., TM-AMVP, TM-MRG, ARMC-TM, TM-OBMC, TM-MMVD, …) to generate the fractional samples. Additionally, the 2-tap bilinear interpolation filter is applied in the bilateral matching and DMVR with 4-bit coefficient precision.

In the test, the 2-tap bilinear interpolation filter in the template matching based tools, bilateral matching and DMVR is replaced with a 4-tap interpolation filter and two sets of DCT-based interpolation filters were tested. The first filter (set 0) is sampled from the 4-tap interpolation filter on chroma components in motion compensation in VVC. The second filter (set 1) is sampled from the 4-tap filter for intra template prediction.

Test 3.7a: 4-tap interpolation filter set 0 for template matching.

Test 3.7b: 4-tap interpolation filter set 1 for template matching.

Test 3.7c: 4-tap interpolation filter set 0 for bilateral matching and DMVR.

Test 3.7d: 4-tap interpolation filter set 1 for bilateral matching and DMVR.

**Test 3.8: CMVP extension for constructed affine merge candidates (**[**JVET-AL0162**](https://jvet-experts.org/doc_end_user/current_document.php?id=15487)**)**

In ECM, affine candidates are generated from adjacent and non-adjacent neighbours. The motion information of three adjacent vertices as well as TMVP or three non-adjacent vertices are utilized to derive CPMVs of the current CU.

In the test, chained motion vector prediction (CMVP) is introduced to construct affine merge candidates.

As shown in next figure, taking CMVP for constructed adjacent affine candidates as example, the traced motion of the top-right (MV4) and bottom-left (MV5) positions can be derived as the accumulation of source MVs (MV0, MV1) and MVs (MV2) or BVs (MV3). A similar process is repeated to derive the traced motion of the left-top position and temporal MV. The four traced MVs can thus construct additional affine candidates using the existing method in ECM.

A screenshot of a computer screen

AI-generated content may be incorrect.

Regarding the constructed non-adjacent affine candidates, the same method is applied to the motion information of the three non-adjacent positions. The extension of CMVP for constructed non-adjacent affine candidates is only applied to LDB configuration.

CMVPs are derived for unidirectional MVs, so CMVPs are traced to construct affine candidates for MVs of adjacent or non-adjacent positions from List 0 following the MVs from List 1.

In Test 3.8a, the affine merge candidate list is augmented with two additional candidates and the tested CMVP for affine is applied for the blocks whose width and height are both larger than or equal to 8.

In Test 3.8b, no additional candidates are added, where final size of the affine merge candidates list after ARMC remains unchanged.

Test 3.8a: CMVP based constructed affine merge candidates with additional candidates.

Test 3.8b: CMVP based constructed affine merge candidates without additional candidates.

**Test 3.9: Extended BDOF usage for MV refinement (**[**JVET-AL0081**](https://jvet-experts.org/doc_end_user/current_document.php?id=15406)**)**

In ECM, BDOF usage has been extended to be applicable for bi-predictive inter blocks with reference pictures from the same direction. The extended BDOF is used for adjusting luma prediction sample values for inter blocks as well as for refining MVs for affine blocks.

In the test, BDOF usage is further extended to refine MVs for regular inter merge blocks with reference pictures from the same direction.

Test 3.9: Extended BDOF usage for MV refinement

Test 3.1 is supported by several experts (including crosscheckers), results are confirmed and gain/tradeoff is attractive in particular for LB.

Decision: Adopt JVET-AL0160 test 3.1

3.2 and 3.3x are targeting improvements by adding more spatial merge candidates. The combination 3.3e is supported by several experts as being the most attractive variant (slightly higher gain in RA compared to the combination 3.3d, the latter is without test 3.2). In general, the different elements are mostly additive in gain, where some of the seem to be better contributing to RA, others to LB, such that in the end the tradeoff in both settings is attractive.

Decision: Adopt JVET-AL0157 test 3.3e

Several experts supported the adoption of test 3.4a, as it uses a similar method as SGPM and gives attractive gain in RA. Replacing the existing reordering (3.4b) does not provide benefit.

Decision: Adopt JVET-AL0134 test 3.4a

Test 3.5 applies pixel-based affine MC (except in some constrained cases). The tradeoff is attractive (small reduction of encoding time, and gain in both RA and LB). Confirmed by cross-checkers, and supported also by other experts.

Decision: Adopt JVET-AL0079 test 3.5

Test 3.6 improves the TMVP refinement, and gives attractive gain particular for LB (which may be explained by the fact that it is competing with a smaller number of refinement strategies in that case). Tradeoff with encoding time is good. According to crosscheckers, the method is straightforward to implement, and results match.

Decision: Adopt JVET-AL0214 test 3.6

Tests 3.7x are using 4-tap filters for template matching (variants c and d are using it only for DMVR and bilateral matching, therefore not applicable in case of LB, and also have almost no gain in RA). In terms of performance, filter sets 0 and 1 are almost identical (set 1 slightly better in RA), also complexity-wise there should be no difference. Encoding and decoding run times are increased, but the tradeoff with coding gain is still asserted as attractive. The additional usage of the 4-tap filter for DMVR and bilateral matching does not seem to give sufficient benefit, and would likely further increase the run time, as per tests c/d.

Decision: Adopt JVET-AL0161 test 3.7b

Test 3.8x constructs more affine candidates by using CMVP (chained MVs). 3.8a uses those as additional candidates, whereas 3.8b replaces some existing candidates. Gain is observed in both RA and LB. Method asserted as straightforward, and several proponents (including crosscheckers) supported 3.8a for its slightly better tradeoff.

Decision: Adopt JVET-AL0162 test 3.8a

Test 3.9 extends BDOF usage for MV refinement, which brings reasonable tradeoff for LB in particular, only very small gain in RA.

Decision: Adopt JVET-AL0081 test 3.9

***Transform and coefficient coding***

**Test 4.1: Advanced SBT with direction and position inference (**[**JVET-AL0181**](https://jvet-experts.org/doc_end_user/current_document.php?id=15506)**)**

In the test, the position and the direction of a subblock partition is derived for SBT in implicit manner without signalling, this mode is indicated by a flag and applied only to rectangular shape partitions. This mode can also be applied to SBT sub-partition. Implicit SBT TU is considered in the deblocking filter process.

For each subblock size and direction, the encoder evaluates the best position of the transform part (grey area) shown in the next figure. Then, based on the best position, the direction for each subdivision is determined. Eventually the encoder determines the best subdivision.

The position selected is the position of the subblock which maximizes the sum of gradients from the inter prediction. And regarding the direction (vertical or horizontal), the selected direction is the one that maximizes the sum of gradients of each best position.

A screenshot of a computer

AI-generated content may be incorrect.

To reduce complexity at encoder, early termination was added.

Test 4.1: Advanced SBT.

**Test 4.2a: Advanced SBT with simplified search method (**[**JVET-AL0227**](https://jvet-experts.org/doc_end_user/current_document.php?id=15554)**)**

In the test, the gradient search of Test 4.1 is modified , where the position with the maximum gradient values is identified first and local search around that position is performed instead of searching the whole TU as shown in the next figure.

A screen shot of a computer screen

AI-generated content may be incorrect.

The gradient value computation process is SIMD optimized, and a gradient padding is applied at block boundaries for the first and last rows/columns by repeating the gradient values from the nearest available row and column.

To reduce complexity at encoder, early termination was added.

Test 4.2: Advanced SBT with simplified search method.

**Test 4.2b: Combination test of Test 4.1 and Test 4.2a (**[**JVET-AL0229**](https://jvet-experts.org/doc_end_user/current_document.php?id=15556)**)**

In the combination test, the gradient padding and SIMD optimization from Test 4.2a is applied on top of Test 4.1.

Test 4.2b: Test 4.1 + Test 4.2a (gradient padding and SIMD optimization).

**Test 4.3: On coefficient level binarization in Transform Skip (**[**JVET-AL0158**](https://jvet-experts.org/doc_end_user/current_document.php?id=15483)**)**

The current residual coding scheme of Transform Skip (TS)-coded TUs consists of A) dividing the TU into Coefficient Groups (CGs) of size 4x4, B) scanning CGs following the diagonal scan order, C) scanning the quantized residual coefficients within each CG and coding them.

At the coefficient-level, the coding process is carried out based on one of two methods, namely *context-coding* and *Rice-coding*. The choice between the two methods is based on whether any context bin budget is left in a variable called m\_remainingContextBins. If there is still budget left, the typical binarization decomposes a coefficient level into a set of syntax element flags (i.e. coefficient significance flag, coefficient sign, gt1, parityFlag, gt2, gt4, gt6 and gt8) and codes them using CABAC contexts. Otherwise, (running out of context budget), the entire coefficient is coded in the Rice mode, without the above binarization scheme.

It is asserted that a shortcoming of the above process is that the context bin budget is determined at the TU-level and is progressively consumed while the CGs are coded in the scan order. This means that the first scanned CGs have higher priority for using CABAC contexts, while later scanned CGs are more likely to end up with no context bin budget left. The most severe case happens when the context bin budget is exhausted in a middle of CG, while the remaining CGs include several zero coefficients. In the absence of the significance flag, those zero coefficients go through bitrate-intensive Rice coding.

In the test, the binarization of residual coefficients in the TS is modified, such that the significance flags of TS-coded coefficients are always context-coded at the CG-level, the binarization of coefficient levels of TS is conditionally determined based on the context bin budget. Specifically, for each CG, if the context budget is not yet exhausted, the default binarization (i.e. sigFlag, gt1, parity flag, gtX) is used, as in the anchor. Otherwise, if the context budget is exhausted for the CG, the new binarization decomposes each coefficient level into significance flag and remaining level. Then the significance flag is context coded while the remaining level is Rice coded.

Test 4.3a: Significant flags are always context coded for TS.

Test 4.3b: Test 4.3a applied for QPs 2, 7, 12, 17

Test 4.3c: ECM-16.1 without context budget

**Test 4.4: IntraNN NSPT set (**[**JVET-AL0215**](https://jvet-experts.org/doc_end_user/current_document.php?id=15542)**)**

In ECM, NSPT kernel set is chosen based on the transform block size, prediction mode, intra mode and MTSS. NSPT primary kernel sets for each mode are summarized in the next table.

|  |  |  |  |
| --- | --- | --- | --- |
| NSPT sets | Set 1 | Set 2 | Set 3 |
| Prediction modes | Regular intra, PDP, SGPM, IntraNN | TIMD, DIMD, MIP, EIP | IntraTMP, inter |

In Test 4.4a, IntraNN-coded blocks are set to reuse the second kernel set, shared with TIMD-, DIMD-, MIP-, and EIP-coded blocks as shown in the table below.

|  |  |  |  |
| --- | --- | --- | --- |
| NSPT sets | Set 1 | Set 2 | Set 3 |
| Prediction modes | Regular intra, PDP, SGPM | TIMD, DIMD, MIP, EIP, IntraNN | IntraTMP, inter |

Test 4.4a: Using the second NSPT set for IntraNN.

Test 4.4b: ECM-16.1 with all NSPT kernels retrained.

Test 4.4c: Test 4.4a with all NSPT kernels are retrained.

Test 4.4d: Test 4.4a with the amount of output non-zero coefficients for NSPT is increased (less zero-out) for 4x8 (24), 4x16 (32), 8x32 (32) block shapes and all NSPT kernels are retrained.

In Tests 4.4b-d, the kernels are retrained specially for the configuration of each specific test, to ensure a better adaptation of the kernels.



Test 4.1 is more or less the continuation of last meeting’s EE, but with reduced encoder run time by early termination. Test 4.2a is adding another local search for the best partition position by a gradient method, which however has less attractive tradeoff. Test 4.2b simplifies the gradient computation by padding, omits the local search, combines and also reduces runtime by SIMD optimization. It was also tried to improve the consistency with the deblocking position, though this is still not yet perfectly aligned with the actual TU boundary (following the discussion in last meeting).

Test 4.1 is asserted to be best understood, as it is a slight modification of the method from last EE, now also giving acceptable tradeoff in encoding time. It is further asserted that a slightly better tradeoff of 4.2b (which includes 4.1 as well) comes by the SIMD implementation, such that the additional elements in 4.2b do not seem to provide much benefit (SIMD could also be applied to 4.1 and might improve run time, but this does not seem to be overly necessary to keep implementation simple)

Decision: Adopt JVET-AL0181 test 4.1

Test 4.3 targets to improve the performance of TS residual coding by modifying the method for limitation of context coded bins. This is effective only for screen content. Upon request made by the last meeting, also results at low QP was investigated, which was expected to demonstrate larger gain.

It was commented that, in contrast to the request in last meeting, the tests for low QP were not using a subsampling at every 8th frame, rather coding the first 100 frames of the sequences. The results still indicate the better gain in low QP, and also that the proposed limitation is relatively close to the case of giving up the budget (test 4.3c). It was remarked that the gain by giving up the budget is less than it was during VVC development, which may be due to the fact that better screen content tools are in ECM.

Some concern was raised by several experts that the actual budget limitation in the proposal is less restrictive as significance flag is always context coded independent of the limitation approach. It was asked which worst case number of context coded bins would occur when all coefficients would get a significance flag encoded? Another interesting information could be to know how the performance of the current ECM method would increase when the budget limitation was loosened. It would also be interesting to report the actual number of context coded bins for both the existing ECM method as well as the proposal (both for tests 4.3a and 4.3b). It should also be analysed/reported if cases of TUs would be found where the budget is exceeded (both overall as well as on sequence level). Further investigation in next round of EE, details to be worked out in the definition of EE description, in coordination with proponents of JVET-AL0109.

Considering the fact that ECM is not a standard under development and a budget limitation is not of highest importance, more careful study is deemed to be useful. Without doubt, in a real standard such a budget limitation would need to be implemented, and from the results it is likely that better methods than the one currently used (carried over from VVC) can be designed.

Test 4.4 investigates usage of NSPT second set for NNIntra (test 4.4a), whereas currently set 1 is used. When using the existing kernels, the effect is marginal. However, when the sets are re-trained, it becomes more evident that set 2 is better suitable for NNIntra (test 4.4c), which has more visible gain compared to 4.4b where set 1 is used for NSPT.

Test 4.4d investigates the increase of non-zero coefficients on top of 4.4c, which however comes without a penalty of memory increase (as the number of kernels is decreased for some block sizes), but increases the number of multiplications (which causes the runtime increase).

The same training set and strategy was used as in previous NSPT training.

Overall, though having less coding gain compared to 4.4d, 4.4c is asserted to have the best tradeoff encoding runtime vs. performance. It also has less modifications relative to the current design. It was also commented that the additional modifications done in 4.4d are not well documented in the contribution.

Decision: Adopt JVET-AL0215 test 4.4c

It was suggested to further study 4.4d in the upcoming EE to achieve a better tradeoff. Proponents are requested to update the contribution such that the different elements can be better understood and more specific aspects to be studied in an EE can be formulated. This was presented Thursday 3 April. There are two aspects: More non-zero transform coefficients are potential produced by increasing size of some kernels, and number of kernels is decreased to compensate for the increased number of coefficients. It was suggested to study both aspects separately, and also study a variant where only the number of kernels is decreased without modifying the current kernels. Study in comparsion and possibly in combination with JVET-AL0112.

* 1. ***In-loop filtering***

**Test 5.1: ALF-CCCM (**[**JVET-AL0153**](https://jvet-experts.org/doc_end_user/current_document.php?id=15478)**)**

In the test, an additional cross-component filtering scheme is examined where cross-component filters are derived at the decoder-side as shown in the next figure. The method is not applied to I-slices.

A diagram of a block diagram

AI-generated content may be incorrect.

Each CTU is divided into non-overlapping blocks and for each block the cross-component filter coefficients are derived using SAO/CCSAO luma and chroma outputs. The convolution is applied on the SAO/CC-SAO luma output. To obtain a correction signal, the SAO/CC-SAO chroma samples are subtracted from the convolution output samples.

The correction is weighted by 0.5 and added to the ALF chroma output, the reconstruction becomes *chromaRec =* *alfChroma + ccAlf + 0.5\*cccmCorrection*.

The encoder decides the best block size for each CTU using a rate-distortion optimization (RDO) loop. There are eight possible blocks sizes 4x4, 8x2, 2x8, 8x8, 16x16, 32x32, 64x64, 128x128.

For each CTU, the encoder’s RDO decides the best cross-component model from eight possible models, they differ in the number of samples, non-linear term, and biases. The nonlinear and bias terms are the same as in the 7-tap CCCM model.

CCCM solver is used for deriving the filter coefficients. The 6-tap down sampling filter (used in CCCM and CCLM) is used for mapping the co-located luma into the chroma grid.

For inter configurations, a picture may inherit the block sizes and model types for all CTUs from a reference picture. The reference picture is derived from the L0 and L1 lists. Only reference pictures with ALF-CCCM present in at least one CTU are considered. The reference picture with the smallest POC distance to the current POC is selected. If activated, the picture level inheritance will skip the CTU-level signalling completely for the current picture.

Test 5.1: ALF-CCCM.

**Test 5.2: CCSAO with reused CTU control (**[**JVET-AL0142**](https://jvet-experts.org/doc_end_user/current_document.php?id=15467)**)**

In ECM, band- and edge-based classifiers are supported for CCSAO. The encoder decides the best on/off control and classifier for each CTU, and signals the classifier parameters, offsets, and control information for each frame. Classifier parameters and offsets are stored for use in future frames. However, control information is not stored and cannot be reused for future frames.

In the test, CCSAO CTU control information of the current frame is stored and can be reused for future pictures, the control reuse for a picture is indicated by a flag.

At encoder, the decision on whether to reuse the CCSAO parameters and the CTU control information from a previous picture is made independently for each picture. Therefore, it does not introduce any additional latency.

Test 5.2: CCSAO with reused CTU control.

**Test 5.3: Cross-Chroma Input for Chroma-ALF and CC-ALF (**[**JVET-AL0135**](https://jvet-experts.org/doc_end_user/current_document.php?id=15460)**)**

In the current design of chroma ALF, the filter shape includes a diamond 9×9 filter and a cross 5×5 filter, as shown in the next figure. The diamond 9×9 shape takes chroma reconstruction samples before ALF as input while the cross 5×5 shape takes the fixed-filter-output samples as inputs.

图示

低可信度描述已自动生成

In the current design of CC-ALF, the filter shape includes a cross 9×9 filter and two diamond 3×3 filters, as shown in the figure below. The cross 9×9 shape takes luma reconstruction samples before ALF as input, and the two-diamond 3×3 shapes take luma residual samples and chroma reconstruction samples before ALF as input, respectively.

图示

描述已自动生成

In the test, cross-chroma design is introduced into chroma ALF and CC-ALF, where Cb reconstructed samples can be used to filter Cr samples, while Cr reconstructed samples can also be used to filter Cb samples.

In Test 5.3a, the cross-chroma method is applied to chroma ALF and the modified filter shape is shown in the next figure. Additional taps take reconstruction samples before DBF of one chroma component as input to filter the other chroma component. Other filter taps are not changed.

图示

描述已自动生成

In Test 5.3b, the same strategy is applied to CC-ALF and the modified filter shape is shown in the figure below.

图示

描述已自动生成

No additional storage is required since chroma reconstruction samples before DBF have been already stored for the fixed filter of chroma ALF in ECM. The tested methods are always applied and there is no filter shape switching design.

Test 5.3a: Cross-chroma input for chroma ALF.

Test 5.3b: Cross-chroma input for CC-ALF.

Test 5.3c: Test 5.3a + Test 5.3b.

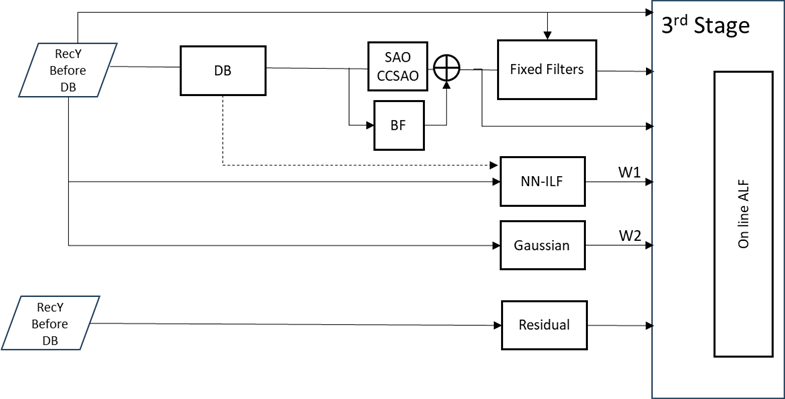
**Test 5.4: On the performance improvement of NN-based ILF in ALF (**[**JVET-AL0168**](https://jvet-experts.org/doc_end_user/current_document.php?id=15493)**)**

NNVC VLOP architecture is shown in the next figure. In that design, Y, Cb and Cr samples are being filtered jointly. Luma branch employs a cascade of 8 backbones blocks, with chroma branch comprising a single backbone block. Each backbone block implements 3D convolution with separable 1x3, 3x1 and 1x1 kernels. In the test, chroma data is not used for NN input and no chroma branch processing is performed.

A computer screen shot of a computer

AI-generated content may be incorrect.

Inference interface of NNVC ILF was implemented in ECM, with NN-ILF being introduced as an extension of the ECM ALF filter. NN-filter operates on input reconstructed pixels in parallel to existing Fixed, Residual and Gaussian filters. Simplified block diagram of the ECM-ALF extension with NN-ILF is shown below.



A flag is signalled to indicate whether the weight W1 for the NN-ILF is equal to 1 or 0, and the weight W2 for the Gaussian filter is derived as W2=1-W1.

Complexity-aware RDO was introduced, where NN filtering is disabled for blocks, if provided distortion reduction is found to be below a threshold.

EE software is configurable and includes two interface options differing in the position of the NN loop filter. In the first interface option, corresponding to the NNVC filter position, the NN loop filter is applied in parallel to Deblocking Filter and before SAO, BIF, and ALF.

The second interface option (tested in this EE) has chroma channel removed in addition to placing the NN filter in parallel to the existing Fixed, Residual, and Gaussian filters.

Proponents of the test suggest that both interfaces should be made optional in ECM for testing various NN based filters.



For test 5.1, the issue regarding latency which had been raised by the last meeting has been resolved by using SAO output. The gain in chroma is attractive, and the runtime tradeoff is acceptable. Confirmed by crosscheckers and supported by other experts.

Decision: Adopt JVET-AL0153 test 5.1

Test 5.2 needs additional memory to store the CCSAO control parameters (CTU level, not large memory). The approach is straightforward, similarly used already in ALF-CCCM. No impact on runtime, some gain by bitrate reduction. Confirmed by crosscheckers and supported by other experts.

Decision: Adopt JVET-AL0142 test 5.2

Tests 5.3x uses the unfiltered other chroma component as input for filtering the current one. Chroma components can still be filtered in parallel. This is done for chroma ALF (5.3a) and CC-ALF (5.3b), chroma gains are not fully additive in 5.3c, but there is a small luma loss in AI for 5.3a and 5.3c, and for RA in 5.3c, likely caused by additional signalling.

Decision: Adopt JVET-AL0135 test 5.3b.

Test 5.4 implements a simplified version of NN-ILF (luma only), including an interface which is more general, also supporting chroma filtering or using other filters. It is asserted than having such an interface in ECM is beneficial for further experimentation. Decoder runtime (CPU) does not represent a reasonable tradceoff, and the reduction of encoder runtime shown in the results seems to be an error in measurement. It is supported by various experts to adopt the proposal (but not in CTC), and to include the interface in the software. Cross-check report that partial results match (JVET-AL0340 and JVET-AL336) after a recent fix of the interface software.

Upon question, it was explained by proponents that in the design used in test 5.4, it is controlled at frame level whether the output of NN-ILF or of the Gaussian filter is used as input to the online ALF stage.

It was agreed to further study this in an EE, also with the goal to further reduce decoder runtime and compare the strategy of input from NN-ILF to ALF in comparison to JVET-AL0225, and also to compare the models, if possible at similar complexity. The interface from JVET-AL0228 shall be used.

It was requested to also investigate the current NNVC models as additional reference. However, as EE2 is run to compare tools on top of ECM and compare against ECM, it is not clear that this would have benefit. It was commented that reports about performance of current NNVC filters can easily be generated by interested experts (provided they have spare computing resources) by using the interface software, ans be brought as standalone inputs to the next meeting, for information (preferably as inputs both to AHG11/12).

***Other***

**Test 6.1: Adaptive picture-level vertical mirroring (**[**JVET-AL0199**](https://jvet-experts.org/doc_end_user/current_document.php?id=15524)**)**

In the test, a vertical mirroring can be applied to input pictures. Encoder performs the selection of whether mirroring is performed before encoding the whole picture. No additional in-loop optimizations or coding modes are introduced.

Input image Iorg (each component independently) is filtered using a 3x3 Sobel filter for 45-degree edges detection (resulting in image I45) and a 3x3 Sobel filter for 135-degree edges detection (resulting in image I135).

For each pixel (x,y), it is checked whether one of the edge directions is dominant, i.e., the difference between I45(x,y) and I135(x,y) greater than a threshold (set, e.g., to 160 for a 10-bit video). If so, only the dominant pixel value persists, and the other is set to zero.

Then, all the non-zero values of I45 and I135 are counted:

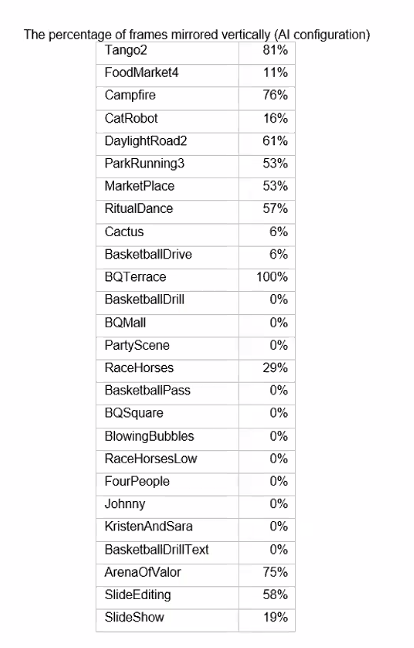
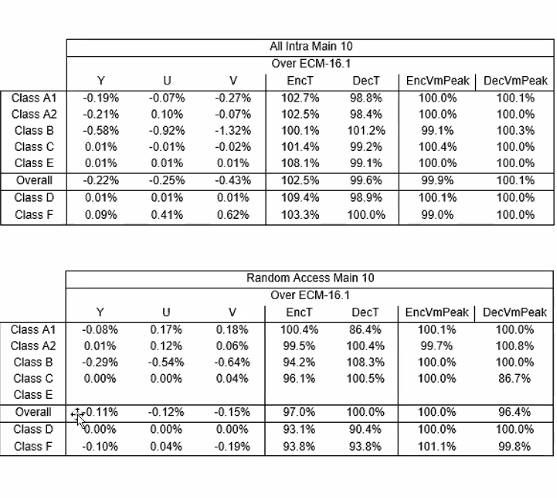
If S135 > (S45 + TH), the frame is not mirrored. Otherwise, it is mirrored vertically. TH was set to -6000.

Test 6.1: Adaptive picture-level vertical mirroring.



The decision about mirroring does not require two-pass encoding. According to cross-checker, run times in the table are unreliable and should be slightly above 100% for the encoder. However, there is still a mismatch in the cross-checked results. That was later resolved and RA results were completed. It was also requested that information is provided about usage of the method on a per-sequence basis. The cross-check also reported that encoding and decoding times were almost unchanged.

Final cross-checked results and usage:



It was further commented that the approach of mirroring could have significant impact on correctly using information from reference frame such as control information of filters in inter frames. The proponents believe this is not a problem, as the approach is only using the mirroring in intra pictures and these are written in the correct orientation into the reference buffer.

Results per sequence indicate that gain is not homogeneous – some sequences with large gains, some with losses or small gains.

It was also commented that another similar proposal (JVET-AB0165) with similar run time and gain had been rejected, including the consideration that the gain is relatively inhomogeneous over the set of sequences.

Cross-checker supported adoption, but various experts expressed concerns. No consensus reached to take action.

### EE2 contributions: Enhanced compression beyond VVC capability (31)

There was no presentation or discussion about specific proposals in this category.

For actions decided to be taken, see section 5.2.1, unless otherwise noted.

[JVET-AL0079](https://jvet-experts.org/doc_end_user/current_document.php?id=15404) EE2-3.5: On affine motion compensation [H. Huang, R. Yu, Z. Zhang, Y. Zhang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0273](https://jvet-experts.org/doc_end_user/current_document.php?id=15600) Crosscheck of JVET-AL0079 (EE2-3.5: On affine motion compensation) [C. Ma (Kwai)] [late]

[JVET-AL0081](https://jvet-experts.org/doc_end_user/current_document.php?id=15406) EE2-3.9: Extended BDOF usage for MV refinement [R. Yu, H. Huang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0252](https://jvet-experts.org/doc_end_user/current_document.php?id=15579) Crosscheck of JVET-AL0081 (EE2-3.9: Extended BDOF usage for MV refinement) [Y. Wang (Bytedance)] [late]

[JVET-AL0106](https://jvet-experts.org/doc_end_user/current_document.php?id=15431) EE2-2.4: block vector guided EIP [Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AL0307](https://jvet-experts.org/doc_end_user/current_document.php?id=15634) Crosscheck of JVET-AL0106 (EE2-2.4: block vector guided EIP) [K. Panusopone (Nokia)] [late]

[JVET-AL0311](https://jvet-experts.org/doc_end_user/current_document.php?id=15638) Crosscheck of JVET-AL0106 (EE2-2.4: block vector guided EIP) [Z. Zhang (Alibaba)] [late]

[JVET-AL0107](https://jvet-experts.org/doc_end_user/current_document.php?id=15432) EE2-2.11: a combination of EE2-2.4 and EE2-2.10 [Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO), Z. Lv, C. Zhou, G. Wang (vivo)]

[JVET-AL0296](https://jvet-experts.org/doc_end_user/current_document.php?id=15623) Crosscheck of JVET-AL0107 (EE2-2.11: a combination of EE2-2.4 and EE2-2.10) [Z. Deng (Bytedance)] [late]

[JVET-AL0108](https://jvet-experts.org/doc_end_user/current_document.php?id=15433) EE2-2.7: Block vector guided DIMD [L. Zhang, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AL0280](https://jvet-experts.org/doc_end_user/current_document.php?id=15607) Crosscheck of JVET-AL0108 (EE2-2.7: Block vector guided DIMD) [Y. Wang (Bytedance)] [late]

[JVET-AL0315](https://jvet-experts.org/doc_end_user/current_document.php?id=15642) Crosscheck of JVET-AL0108 (EE2-2.7: Block vector guided DIMD) [Z. Zhang (Alibaba)] [late]

[JVET-AL0124](https://jvet-experts.org/doc_end_user/current_document.php?id=15449) EE2-2.10: Multiple filter taps for EIP [Z. Lyu, C. Zhou, G. Wang (vivo)]

[JVET-AL0258](https://jvet-experts.org/doc_end_user/current_document.php?id=15585) Crosscheck of JVET-AL0124 (EE2-2.10 Multiple filter taps for EIP) [Z. Deng (Bytedance)] [late]

[JVET-AL0125](https://jvet-experts.org/doc_end_user/current_document.php?id=15450) EE2-2.6: Improvement on MPM [G. Wang, C. Zhou, Z. Lv (vivo)]

[JVET-AL0262](https://jvet-experts.org/doc_end_user/current_document.php?id=15589) Crosscheck of JVET-AL0125 (EE2-2.6a/c: Improvement on MPM) [J. Fu, Z. Li (PKU)] [late]

[JVET-AL0295](https://jvet-experts.org/doc_end_user/current_document.php?id=15622) Crosscheck of JVET-AL0125 (EE2-2.6b/c: Improvement on MPM) [Y. Liu, Y. Huo (Transsion)] [late]

[JVET-AL0126](https://jvet-experts.org/doc_end_user/current_document.php?id=15451) EE2-2.3: CCP merge mode with adjustment [Y. Wang, K. Zhang, W. Yin, Z. Deng, N. Zhang, L. Zhao, M. Salehifar, L. Zhang (Bytedance)]

[JVET-AL0274](https://jvet-experts.org/doc_end_user/current_document.php?id=15601) Crosscheck of JVET-AL0126 (EE2-2.3: CCP merge mode with adjustment) [C. Ma (Kwai)] [late]

[JVET-AL0134](https://jvet-experts.org/doc_end_user/current_document.php?id=15459) EE2-3.4: Joint reordering of GPM split modes and partition indices [C. Ma, X. Xiu, X. Wang (Kwai)]

[JVET-AL0316](https://jvet-experts.org/doc_end_user/current_document.php?id=15643) Crosscheck of JVET-AL0134 (EE2-3.4: Joint reordering of GPM split modes and partition indices) [K. Jia (Alibaba)] [late]

[JVET-AL0135](https://jvet-experts.org/doc_end_user/current_document.php?id=15460) EE2-5.3: Cross-Chroma Input for Chroma-ALF and CC-ALF [W. Yin, K. Zhang, H. Liu, Y. Wang, Z. Deng, N. Zhang, L. Zhao, M. Salehifar, L. Zhang (Bytedance), C. Ma, X. Xiu, C.-W. Kuo, X. Wang (Kwai)]

[JVET-AL0277](https://jvet-experts.org/doc_end_user/current_document.php?id=15604) Crosscheck of JVET-AL0135 (EE2-5.3: Cross-Chroma Input for Chroma-ALF and CC-ALF)) [N. Hu (Qualcomm)] [late]

[JVET-AL0142](https://jvet-experts.org/doc_end_user/current_document.php?id=15467) EE2-5.2: CCSAO with reused CTU control [C.-W. Kuo, X. Xiu, X. Wang (Kwai)]

[JVET-AL0253](https://jvet-experts.org/doc_end_user/current_document.php?id=15580) Crosscheck of JVET-AL0142 (EE2-5.2: CCSAO with Reused CTU Control) [W. Yin (Bytedance)] [late]

[JVET-AL0143](https://jvet-experts.org/doc_end_user/current_document.php?id=15468) EE2-1.1: Chroma partition prediction in separate tree condition [P.-H. Lin, J.-L. Lin, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0279](https://jvet-experts.org/doc_end_user/current_document.php?id=15606) Crosscheck of JVET-AL0143 (EE2-1.1: Chroma partition prediction in separate tree condition) [R.-L. Liao (Alibaba)] [late]

[JVET-AL0285](https://jvet-experts.org/doc_end_user/current_document.php?id=15612) Crosscheck of JVET-AL0143 (EE2-1.1: Chroma partition prediction in separate tree condition) [C.-W. Kuo (Kwai)] [late]

[JVET-AL0149](https://jvet-experts.org/doc_end_user/current_document.php?id=15474) EE2-2.12: Non-adjacent DIMD for TMRL [V. Rufitskiy, A. Filippov, T. Dong, H. Qin, J. Konieczny, K. Ding (TCL)]

[JVET-AL0151](https://jvet-experts.org/doc_end_user/current_document.php?id=15476) EE2-3.2: Extension on spatial and temporal merge candidates [J.-L. Lin, P.-H. Lin, Z. Zhang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0293](https://jvet-experts.org/doc_end_user/current_document.php?id=15620) Crosscheck of JVET-AL0151 (EE2-3.2: Extension on spatial and temporal merge candidates) [L. Zhang (OPPO)] [late]

[JVET-AL0153](https://jvet-experts.org/doc_end_user/current_document.php?id=15478) EE2-5.1: ALF-CCCM [P. Astola, I. Jumakulyyev, D. Bugdayci Sansli, J. Lainema (Nokia)]

[JVET-AL0238](https://jvet-experts.org/doc_end_user/current_document.php?id=15565) Crosscheck of JVET-AL0153 (EE2-5.1: ALF-CCCM) [R. G. Youvalari (Xiaomi)] [late]

[JVET-AL0157](https://jvet-experts.org/doc_end_user/current_document.php?id=15482) EE2-3.3: Additional inter merge candidates [N. Zhang, K. Zhang, Z. Deng, L. Zhao, Y. Wang, W. Yin, M. Salehifar, L. Zhang (Bytedance), J.-L. Lin, P.-H. Lin, Z. Zhang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0269](https://jvet-experts.org/doc_end_user/current_document.php?id=15596) Crosscheck of JVET-AL0157 (EE2-3.3: Additional inter merge candidates) [[X. Li (Alibaba)](mailto:sid.lxw@alibaba-inc.com)] [late]

[JVET-AL0294](https://jvet-experts.org/doc_end_user/current_document.php?id=15621) Crosscheck of JVET-AL0157 (EE2-3.3e: Additional inter merge candidates) [[L. Zhang (OPPO)](mailto:zhanglai@oppo.com)] [late]

[JVET-AL0158](https://jvet-experts.org/doc_end_user/current_document.php?id=15483) EE2-4.3: On coefficient level binarization in Transform Skip [M. Abdoli, R. G. Youvalari, F. Plowman, A. Tissier (Xiaomi)]

[JVET-AL0240](https://jvet-experts.org/doc_end_user/current_document.php?id=15567) Crosscheck of JVET-AL0158 (EE2-4.3: On coefficient level binarization in Transform Skip) [P. Astola (Nokia)] [late]

[JVET-AL0160](https://jvet-experts.org/doc_end_user/current_document.php?id=15485) EE2-3.1: Subblock-based spatial MVP [Z. Deng, K. Zhang, N. Zhang, L. Zhao, Y. Wang, W. Yin, M. Salehifar, L. Zhang (Bytedance)]

[JVET-AL0251](https://jvet-experts.org/doc_end_user/current_document.php?id=15578) Crosscheck of JVET-AL0160 (EE2-3.1: Subblock-based spatial MVP) [Z. Lyu (vivo)] [late]

[JVET-AL0161](https://jvet-experts.org/doc_end_user/current_document.php?id=15486) EE2-3.7: On interpolation filter for template matching [Z. Dai, R.-L. Liao, J. Chen, X. Li, Y. Ye (Alibaba)]

[JVET-AL0255](https://jvet-experts.org/doc_end_user/current_document.php?id=15582) Crosscheck of JVET-AL0161 (EE2-3.7: On interpolation filter for template matching)) [L. Xu (OPPO)] [late]

[JVET-AL0162](https://jvet-experts.org/doc_end_user/current_document.php?id=15487) EE2-3.8: CMVP extension for constructed affine merge candidates [C. Li, R.-L. Liao, J. Chen, Y. Ye (Alibaba)]

[JVET-AL0261](https://jvet-experts.org/doc_end_user/current_document.php?id=15588) Crosscheck of JVET-AL0162 (EE2-3.8: CMVP extension for constructed affine merge candidates) [L. Zhao (Bytedance)] [late]

[JVET-AL0168](https://jvet-experts.org/doc_end_user/current_document.php?id=15493) EE2-5.4: On the performance improvement of NN-based ILF in ALF [Y. Li, M. Karczewicz, J. Wang, L. Kerofsky, H. Wang, N. Hu, R. Yu, M. Coban, V. Seregin (Qualcomm), T. Poirier, F. Galpin, F. Le Léannec, E. François (InterDigital), D. Rusanovskyy, K. Panusopone, S. Hong, L. Wang (Nokia)]

[JVET-AL0319](https://jvet-experts.org/doc_end_user/current_document.php?id=15646) Crosscheck of JVET-AL0168 (EE2-5.4: On the performance improvement of NN-based ILF in ALF - interface 2) [T. Poirier (InterDigital] [late]

[JVET-AL0336](https://jvet-experts.org/doc_end_user/current_document.php?id=15663) Crosscheck of JVET-AL0168 (EE2-5.4: On the performance improvement of NN-based ILF in ALF) [V. Rufitskiy, Z. Xu (TCL)] [late]

[JVET-AL0340](https://jvet-experts.org/doc_end_user/current_document.php?id=15667) Crosscheck of JVET-AL0168 (EE2-5.4: On the performance improvement of NN-based ILF in ALF) [Z. Xie (OPPO)] [late]

[JVET-AL0343](https://jvet-experts.org/doc_end_user/current_document.php?id=15670) Cross-check of EE2-5.4: On the performance improvement of NN-based ILF in ALF (JVET-AL0168) [D. Rusanovskyy (Nokia)] [late]

[JVET-AL0181](https://jvet-experts.org/doc_end_user/current_document.php?id=15506) EE2: Tests 4.1 on Advanced SBT with direction and position inference [G. Laroche, P. Onno (Canon)]

[JVET-AL0188](https://jvet-experts.org/doc_end_user/current_document.php?id=15513) EE2-2.5: Flip-aware BV prediction in SGPM [J. Huo, Y. Fei, L. Wang, Y. Ma, F. Yang (Xidian Univ.)]

[JVET-AL0237](https://jvet-experts.org/doc_end_user/current_document.php?id=15564) Crosscheck of JVET-AL0188 (EE2-2.5: Flip-aware BV prediction in SGPM) [X. Li (Alibaba)] [late]

[JVET-AL0191](https://jvet-experts.org/doc_end_user/current_document.php?id=15516) EE2-2.2: On cross-component intra prediction [Y.-J. Chang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0268](https://jvet-experts.org/doc_end_user/current_document.php?id=15595) Crosscheck of Test 2.2c and d in JVET-AL0191 (EE2-2.2: On cross-component intra prediction) [H. Huang (OPPO)] [late]

[JVET-AL0283](https://jvet-experts.org/doc_end_user/current_document.php?id=15610) Crosscheck of JVET-AL0191 (EE2-2.2: On cross-component intra prediction) for tests EE2-2.2a and EE2-2.2b [J. Lainema (Nokia)] [late]

[JVET-AL0199](https://jvet-experts.org/doc_end_user/current_document.php?id=15524) EE2-6.1: Adaptive picture-level vertical mirroring [D. Mieloch, J. Stankowski, M. Lorkiewicz, A. Dziembowski, D. Karwowski (PUT)]

[JVET-AL0236](https://jvet-experts.org/doc_end_user/current_document.php?id=15563) Crosscheck of JVET-AL0199 (EE2-6.1: Adaptive picture-level vertical mirroring) [M. Abdoli (Xiaomi)] [late]

[JVET-AL0205](https://jvet-experts.org/doc_end_user/current_document.php?id=15530) EE2-2.1: EIP filters with diagonal shapes [K. Panusopone, M. He, S. Hong, L. Wang, J. Lainema, D. Rusanovskyy (Nokia)]

[JVET-AL0313](https://jvet-experts.org/doc_end_user/current_document.php?id=15640) Crosscheck of JVET-AL0205 (EE2-2.1: EIP filters with diagonal shapes) [Z. Xie (OPPO)] [late]

[JVET-AL0206](https://jvet-experts.org/doc_end_user/current_document.php?id=15531) EE2-2.9: Test 2.1 + Test 2.4 [K. Panusopone, M. He, S. Hong, L. Wang, J. Lainema, D. Rusanovskyy (Nokia), Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AL0264](https://jvet-experts.org/doc_end_user/current_document.php?id=15591) Crosscheck of JVET-AL0206 (EE2-2.9: Test 2.1 + Test 2.4) [P. Andrivon (Ofinno)] [late]

[JVET-AL0309](https://jvet-experts.org/doc_end_user/current_document.php?id=15636) Crosscheck of JVET-AL0206 (EE2-2.9: Test 2.1 + Test 2.4) [Z. Lyu (vivo)] [late]

[JVET-AL0214](https://jvet-experts.org/doc_end_user/current_document.php?id=15541) EE2-3.6: MV refinement for TMVP [Z. Zhang, J.-L. Lin, Y. Zhang, H. Huang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0257](https://jvet-experts.org/doc_end_user/current_document.php?id=15584) Crosscheck of JVET-AL0214 (EE2-3.6 MV refinement for TMVP) [Z. Deng (Bytedance)] [late]

[JVET-AL0215](https://jvet-experts.org/doc_end_user/current_document.php?id=15542) EE2-4.4: IntraNN NSPT set [G. Verba, M. Coban, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0244](https://jvet-experts.org/doc_end_user/current_document.php?id=15571) Crosscheck of JVET-AL0215 (EE2-4.4cd: IntraNN NSPT set) [M. Abdoli (Xiaomi)] [late]

[JVET-AL0281](https://jvet-experts.org/doc_end_user/current_document.php?id=15608) Crosscheck of JVET-AL0215 (EE2-4.4ab: IntraNN NSPT set) [T. Dong, V. Rufitskiy (TCL)] [late]

[JVET-AL0227](https://jvet-experts.org/doc_end_user/current_document.php?id=15554) EE2-4.2a: Advanced SBT with simplified search method [Y. Zhang, E. Ye, H. Wang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0259](https://jvet-experts.org/doc_end_user/current_document.php?id=15586) Crosscheck of JVET-AL0227 (EE2-4.2a: Advanced SBT with simplified search method) [G. Laroche (Canon)] [late]

[JVET-AL0229](https://jvet-experts.org/doc_end_user/current_document.php?id=15556) EE2-4.2b: Combination test of EE2-4.1 and EE2-4.2a [G. Laroche, P. Onno (Canon), Y. Zhang, E. Ye, H. Wang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AL0260](https://jvet-experts.org/doc_end_user/current_document.php?id=15587) Crosscheck of JVET-AL0229 (EE2-4.2b: Combination test of EE2-4.1 and EE2-4.2a) [L. Zhao (Bytedance)] [late]

### EE2 related contributions (7)

Contributions in this area were discussed during 0630–0700 Friday 28 March 2025 and during 1300–1445 Tuesday 1 April 2025 (chaired by JRO).

[JVET-AL0109](https://jvet-experts.org/doc_end_user/current_document.php?id=15434) EE2-related: On binarization of a coefficient level in TSRC [Y. Yu, L. Xu, J. Gan, H. Yu, D. Wang (OPPO)]

A coefficient level is binarized and bypass-coded with truncated Rice-Golomb with Rice parameter 1 when the CABAC bin budget is exhausted in the TSRC. Two bins are needed for coding a coefficient level 0. This contribution proposes to use a flag to indicate if the coefficient level is zero or not and then binarize the coefficient level minus 1 with Rice parameter 0 for non-zero coefficient levels. Simulation results of the proposed method on top of ECM-16.1 are reported below:

All-Intra:

Natural content: { 0.00%, 0.02%, 0.01%, 99.8%%, 99.9%}

Class F: {-0.10%, -0.05%, -0.17%, 99.6%, 100.4 %}

Class TGM: {-0.16%, -0.22%, -0.19%, 99.9 %, 100.4 %}

Random-Access:

Class F: {-0.06%, 0.26%, -0.06%, 99.8 %, 98.7 %}

Class TGM: {-0.09%, -0.07%, -0.06%, 99.8 %, 99.5 %}

Similar to 4.3, the binarization is changed when the budget would be reached, but does not exceed the budget. Though having less gain (likely due to the fact that less priority is given to the significance flag), this is an interesting concept.

It was agreed to study this in an EE. Also results for higher rates should be provided (as in test 4.3, but observing the test conditions that were requested in last meeting – see the notes for the EE review).

[JVET-AL0299](https://jvet-experts.org/doc_end_user/current_document.php?id=15626) Crosscheck of JVET-AL0109 (EE2-related: On binarization of a coefficient level in TSRC) [K. Panusopone (Nokia)] [late]

[JVET-AL0110](https://jvet-experts.org/doc_end_user/current_document.php?id=15435) EE2-related: On ALF-CCCM [N. Song, L. Xu, Y. Yu, H. Yu, D. Wang (OPPO)]

This contribution proposes a method of applying an adaptive factor for ALF-CCCM (Adaptive Loop Filter Based CCCM) in EE2-5.1 to replace a fixed factor. In addition, the usage of multi-models is also updated. On top of ECM-16.1, the test results are summarized as follows:

AI: {not applicable}

RA: -0.xx%(Y), -0.xx%(U), -0.xx%(V), xx.x%(EncT), xx.x% (DecT))

LDB: -0.xx%(Y), -0.xx%(U), -0.xx%(V), xx.x%(EncT), xx.x% (DecT))

LDP: -0.xx%(Y), -0.xx%(U), -0.xx%(V), xx.x%(EncT), xx.x% (DecT))

Compare with the EE result:

AI: {not applicable}

RA\*: 0.01%(Y), -0.52%(U), -0.48%(V), xx.x%(EncT), xx.x% (DecT))

LDB: -0.05%(Y), -1.01%(U), -0.84%(V), xx.x%(EncT), xx.x% (DecT))

LDP: -0.04%(Y), -1.26%(U), -1.10%(V), xx.x%(EncT), xx.x% (DecT))

Straightforward extension of the method from EE2-5.1, giving additional gain. According to cross-checkers. Impact on runtime should be marginal. It was agreed to study this in an EE.

[JVET-AL0276](https://jvet-experts.org/doc_end_user/current_document.php?id=15603) Crosscheck of JVET-AL0110 (EE2-related: On ALF-CCCM) N. Hu (Qualcomm)

[JVET-AL0192](https://jvet-experts.org/doc_end_user/current_document.php?id=15517) EE2-related: Harmonization of SGPM-BV and LIC [J. Huo, Y. Fei, L. Wang, Y. Ma, F. Yang (Xidian Univ.)]

In ECM 16.1, SGPM employs BV-based prediction in which BV is from neighbouring blocks. The harmonization of SGPM-BV and RRIBC flipType is investigated in EE2-2.5. Besides BV information and RRIBC flipType, the LIC flag is also important information from neighbouring blocks. In the current SGPM, the LIC flag is not inherited which hampers efficient BV prediction. To harmonize SGPM-BV and LIC, it is proposed to inherit the LIC flag and model parameters of neighbouring blocks when SGPM from a merge candidate.

On top of ECM16.1, simulation results of the proposed method + EE2-2.5 are reported as below:

The proposed method + EE2-2.5 over ECM-16.1 :

AI:

Class F: { -0.26%, -0.18%, -0.21%, 100.5%, 99.2% }

Class TGM: { -0.10%, -0.11%, -0.03%, 100.7%, 100.8% }

RA:

Class F: { -0.19%, -0.12%, -0.46%, 99.9%, 98.0% }

Class TGM: { -0.01%, -0.02%, -0.04%, 100.2%, 100.3% }

On top of the ECM-16.1, simulation results of the proposed method are reported as below:

AI:

Class F: { -0.18%, -0.23%, -0.27%, 99.7%, 100.4% }

Class TGM: { -0.05%, -0.10%, -0.09%, 99.7%, 99.9% }

RA:

Class F: { -0.14%, 0.04%, -0.15%, 100.2%, 98.8% }

Class TGM: { -0.04%, -0.03%, -0.03%, 99.9%, 100.1% }

In CTC (all classes), some gain in RA (preliminary results). Has additional benefit also in combination with EE2-2.5.

It was asked if also applied when non-local LIC is used in neighbouring block? In IBC, non-local is not used.

There was support for studying this in an EE.

[JVET-AL0270](https://jvet-experts.org/doc_end_user/current_document.php?id=15597) Crosscheck of JVET-AL0192 (EE2-related: Harmonization of SGPM-BV and LIC) [X. Li (Alibaba)] [late]

[JVET-AL0202](https://jvet-experts.org/doc_end_user/current_document.php?id=15527) EE2-related: Adaptive picture-level vertical mirroring based on decimated video [D. Mieloch, M. Lorkiewicz, A. Dziembowski (PUT)]

The document proposes a method for improving video coding by introducing adaptive picture-level vertical mirroring based on encoding of decimated video. The method involves a frame pre-encoding step to determine whether the mirroring should be applied. The proposed method was tested using the ECM-15.0 software and achieved an average BD-rate change of -0.22%, -0.30%, and -0.41% for Y, U, and V components in AI configuration, with an estimated <2% increase of encoding runtime and no change in a decoder runtime.

Video is always downsampled to 256x256, independent of the original size, and then 2-pass encoding is conducted.

It is claimed by the proponents that the method using 2-pass encoding might be more robust when other tools are changed in the ECM than the one investigated in the EE.

This would be a replacement to the encoder method investigated in the EE. It is commented that the results are quite inhomogeneous – only small gain for A classes, loss in classes C and E. Due to this, it was commented that the method is not preferable compared to the method investigated in the EE.

The encoding run times are not measured, more “theoretical” as proof of concept.

No Excel sheets are provided. How would be results for screen content.

No action was taken on this.

[JVET-AL0225](https://jvet-experts.org/doc_end_user/current_document.php?id=15552) EE2-related: On In-Loop Filtering in ECM [D. Rusanovskyy, M. Santamaria, N. Le, F. Cricri, K. Panusopone, S. Hong, L. Wang, J. Lainema (Nokia), Y. Li, M. Karczewicz, J. Wang, L. Kerofsky (Qualcomm)]

An integration of NN-ILF into ECM have been originally proposed in JVET-AJ0210 and being studied in JVET-AK0183 and JVET-AK0184. This contribution presents a development of the loop filtering proposed in JVET-AK0183. Loop filtering is being constrained by encoder to minimize the complexity-aware cost function and thus reducing the encoder and decoder run-times.

Proposed method was tested with ECM16 CTC, and reportedly provides the following BD-rate PSNR {Y, Cb, Cr} changes against the respective anchor:

* AI: {-0.3%, -0.9% and -0.7%} and approximately 92.3% of encoder and 200% decoder run time.
* RA: {-0.4%, -0.6% and -0.1%} and approximately 92.8% of encoder and 151% decoder run time.

It was proposed to study this method in EE2.

The difference compared to the method in EE2-5.4 is that the inputs to the online ALF can be more flexibly selected, such that also fixed filter can be replaced by NN-ILF (frame-level switching). The input of NN-ILF is identical to EE2-5.4.

It was commented that the decoder runtime is significantly higher than for EE2-5.4. Not exactly known why – likely due to use of a different NN-ILF model and less optimum implementation.

It was asked why the encoding runtime is decreased (also in comparison with EE2-5.4)? At the encoder, the checking of fixed filter is sometimes skipped.

Interface has some aspects different from previous EE, and encoding runtime reduction is interesting – to be studied in next EE. The interface of JVET-AL0228 should be used.

[JVET-AL0228](https://jvet-experts.org/doc_end_user/current_document.php?id=15555) EE2-related: NNLF interface in ECM [T. Poirier, F. Galpin, G. Boisson (InterDigital), Y. Li, M. Karczewicz, J. Wang, L. Kerofsky, H. Wang, N. Hu, R. Yu, M. Coban, V. Seregin (Qualcomm), D. Rusanovskyy, K. Panusopone, S. Hong, L. Wang (Nokia)]

This contribution reports the results of the integration of NN-based in-loop filters in ECM-16.1. Two different NNLF interfaces are studied. The first interface design is the same as in AHG14, NN loop filter output is combined with the output of the Deblocking Filter. then SAO, BIF and ALF are applied. The second interface design follows that of EE2 Test 5.4 where the NN loop filter is applied parallel to the Fixed, Residual, and Gaussian filters. 3 models from AHG14 are tested, VLOP3, LOP5 and HOP5.

The following results are reported:

AHG14 interface

VLOP3 as from NNVC12:

AI: -0.81%,-1.90%, -1.78% (Y, Cb, Cr) with 94% EncT and 306% DecT.  
RA: -1.17%, -1.83%, -1.34% (Y, Cb, Cr) with 94% EncT and 296% DecT.

LOP5 as from NNVC12:

AI: -1.88%, -5.90%, -5.90% (Y, Cb, Cr) with 95% EncT and 760% DecT.  
RA: -2.52%, -6.11%, -5.11% (Y, Cb, Cr) with 95% EncT and 667% DecT.

HOP5 as from NNVC12:

AI: -4.88%, -0.96%%, -2.16% (Y, Cb, Cr) with 110% EncT and 25076% DecT.  
RA: -6.99%, -2.83%, -3.70% (Y, Cb, Cr) with 121% EncT and 21065% DecT.

EE2 Test 5.4 interface

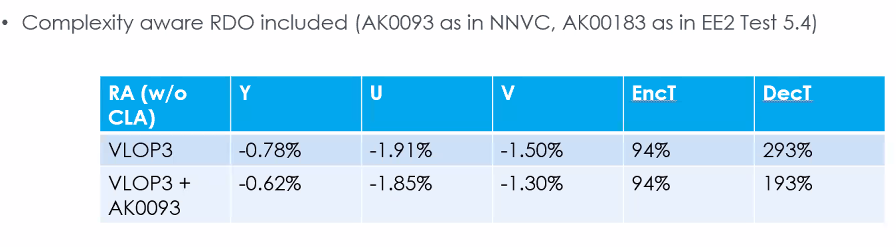
VLOPx modification without chroma channels:

AI: -0.56%, 0.02%, 0.06% for the (Y, Cb, Cr) with 98.9% EncT and 151.4% DecT.

RA: -0.73%, -0.04%, 0.01% for the (Y, Cb, Cr) with 98.3% EncT and 122.5% DecT.

The interface also has a mechanism for block-level switching.

The proposal of the interface also includes an approach for complexity-aware RDO (from JVET-AK0093, used in NNVC, but off by default) – reducing both gain and decoding time as follows:



Relative lower runtime in the EE2-5.4 interface is likely by using a different model, some more optimization of encoder and decoder implementation, and different position of the model.

Some doubt is raised about accuracy of the reported reduction of encoder runtimes reported in contributions related to using NN-ILF variants in ECM. At least for contribution JVET-AL0228, proponents confirm that encoder runtimes are not accurate due to inhomogeneous cluster.

It appears that this interface is more flexible for experimentation than those used in EE2-5.4 or JVET-AL0225, which are more optimized for runtime. It was developed as a joint effort.

Decision(SW): Adopt JVET-AL0228 to ECM. Shall be disabled by default (via macro, or establishing a separate branch). Also include description of interface in JVET-AL2025.

[JVET-AL0234](https://jvet-experts.org/doc_end_user/current_document.php?id=15561) EE2-related: affine bilateral matching merge mode [H. Huang, V. Seregin, M. Karczewicz (Qualcomm)]

This contribution proposes an affine bilateral matching merge mode, wherein per-pixel based motion compensation is performed to generate the prediction block. It is reported that {-0.04%(Y), -0.01(U)%, -0.02%(V)} BD-rate change with 100.7% EncT and 100.6% DecT can be achieved over EE2 Test 3.5 under RA CTC.

Additional gain over test 3.5 (which had been adopted for ECM). Merge list is not modified.

Interest was expressed by other experts to study this in an EE.

### ECM modifications and software improvements beyond EE2 (26)

#### Intra and CIIP (8)

Contributions in this area were discussed during 1600–1800 on Tuesday 1 April 2025 (chaired by Y. Ye).

[JVET-AL0111](https://jvet-experts.org/doc_end_user/current_document.php?id=15436) Non-EE2: Matrix-based position dependent intra prediction for GPM/CIIP [Z. Sun, Y. Yu, L. Xu, H. Yu, D. Wang (OPPO)]

This contribution proposes modifications to the Geometric Partition Mode (GPM) and Combination Inter and Intra Prediction (CIIP) in ECM. First, non-MPDIP modes in the GPM-IPM may be substituted by the MPDIP modes. Second, the MPDIP prediction instead of conventional angular prediction is used to calculate the template matching cost for the MPDIP modes in sorting the GPM candidate list. In addition, only TIMD derived intra mode is used for the CIIP block when the MPDIP is eligible for the current block. Simulation results of the proposed method on top of ECM-16.0 are reported below:

RA\*: 0.00%, 0.03%, 0.02%, EncT 100.1%, DecT 100.2%

LB: -0.06%, 0.06%, -0.13%, EncT 100.3%, DecT 100.1%

Cross checker reports matched results, and no encoding runtime increase.

It was asked if the proposed method is applied to regression GPM – currently not, but the proposed method could be extended to regression GPM.

It was commented that there are two components in this contribution, one to apply MPDIP to GPM and the other to apply it to CIIP. It was asked how much gain comes from each component - this has not been tested yet.

It was commented that the gain in LB is not large, and class B shows some loss. RA also shows coding loss for class B and class C.

The proponent commented that coding performance could be improved due to GPM-related adoptions in this meeting.

Several experts expressed interest in this proposal.

It was agreed to study this in an EE. To study the two components (GPM and CIIP) separately, and also test extension to regression GPM. Better performance (no per-class loss) is necessary for this to be considered for adoption.

[JVET-AL0272](https://jvet-experts.org/doc_end_user/current_document.php?id=15599) Crosscheck of JVET-AL0111 (Non-EE2: Matrix-based position dependent intra prediction for GPM/CIIP) [X. Li (Alibaba)] [late]

[JVET-AL0174](https://jvet-experts.org/doc_end_user/current_document.php?id=15499) Non-EE2: TIMD fusion with neural network based intra prediction [Y.-H Lin, K.-W Liang, C.-Y Teng, Y.-C Yang (Sharp), K. Naser, T. Dumas, E. François, F. Le Léannec (InterDigital)]

This contribution proposes to replace the non-angular predictor (Planar or DC) with the neural network based intra prediction (NNIP) predictor in the template-based intra-mode derivation (TIMD) fusion process.

On top of ECM-16.1, simulation results of the proposed method areAI : -0.02% 0.03% 0.01%, EncT: 100.3%, DecT: 100.6%.

The proposal replaces (instead of as an addition) Planar or DC with NNIP. This replacement is only applied to default TIMD, but not to TIMD merge and TIMD SAD.

It was commented that the increase in runtime is likely due to NNIP being more complex than planar and DC prediction.

This contribution is related to JVET-AL0195, JVET-AL0241, and JVET-AL0290, with the last contribution being the combination of this proposal with JVET-AL0195 and JVET-AL0241. See the notes under JVET-AL0290.

[JVET-AL0179](https://jvet-experts.org/doc_end_user/current_document.php?id=15504) Non-EE2: Intra Merge Mode Enhancements [M. Blestel, P. Andrivon (Ofinno), Y. Chang, V. Seregin, M. Karczewicz (Qualcomm)]

The method proposes to extend the Decoder-side Intra-Mode Derivation (DIMD) process by introducing the generation of an INTRA merge list. The INTRA merge list is built by reusing available information from spatial adjacent and non-adjacent neighbouring blocks with DIMD, TIMD, Intra Merge, and extended to Adaptive HoG for DIMD, OBIC, TIMD SAD, TIMD Merge, SGPM, TRML, and ITMP modes.

On top of ECM-16.1, the reported PSNR-Y, Cb, Cr, BD-rate and {EncT, DecT, EncVmPeak, DecVmPeak} results are as follows:

* -0,06%, 0,06%, 0,14%, {100.2%, 98.2%, 100,3%, 100,2%}

Information in the merge candidate list:

* Up to 8 intra-prediction modes, Intra-prediction weights, Intra-prediction location dependency (top, left or top-left), Block vectors, MTS transform types

The merge list size is 5 in this proposal. Template matching is performed to select the smallest cost to be further considered by the encoder, hence the encoder runtime increase is limited.

It was commented that the proposal blends up to 8 predictions, which seems to be excessive. It was commented by the proponent that this proposal uses the same process as used in DIMD, which also blends up to 8 predictions.   
It was commented that complexity study should be performed. The adjacency map used in this proposal is from inter, and it should be studied what performance will be if adjacency map from intra (e.g. the one used by OBIC, or intraTMP, or IBC) is used.

It was commented that intra merge has been studied before. The difference between this proposal and the previous proposal is that this proposal uses available DIMD and TIMD information from more intra-predicted neighbouring blocks. Compared to previous intra merge proposal, this contribution has higher gain and less runtime increase.

It was agreed to study this in an EE. Performance should be tested using the current adjacency map as well as another adjacency map from an intra mode (e.g. OBIC, or intraTMP, or IBC).

[JVET-AL0183](https://jvet-experts.org/doc_end_user/current_document.php?id=15508) Non-EE2: Block Vector-based Intra Mode Derivation [J.-K Lee, D. Ruiz Coll, M. Blestel (Ofinno)] [late]

This contribution proposes a block vector-based intra mode derivation (BVIMD). The proposed method derives the 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.

Experimental results for the proposed method, implemented on top of the ECM-16.1, are reported as follows:

AI: Overall {-0.05%, 0.02%, 0.09%, 101.4%(EncT), 100.9%(DecT)}.

Cross checker reported matched results, and suggested that encoder runtime be further reduced.

It was commented that decoder runtime increase should be reduced. The proponent commented that currently, all 22 MPM modes are tested, and testing a subset of these modes could reduce decoder runtime.

It was commented that similar technology in EE2-2.7 (block vector-guided DIMD) has been adopted, which the gain could be overlapped with this proposal.

It was agreed to study this in an EE. Encoder and decoder runtime should be reduced to obtain more favorable performance vs. runtime trade-off.

[JVET-AL0329](https://jvet-experts.org/doc_end_user/current_document.php?id=15656) Crosscheck of JVET-AL0183 (AHG12: Block Vector-based Intra Mode Derivation) [Y. Kidani (KDDI)] [late]

[JVET-AL0195](https://jvet-experts.org/doc_end_user/current_document.php?id=15520) Non-EE2: TIMD-BV extension with enhanced IntraTMP merge list [J. Fu, J. Zhang, Y. Zhao, S. Ma (PKU), C. Huang (ZTE), K. Naser, M. Radosavljević, S. Puri, T. Dumas (InterDigital), D. Ruiz Coll, J.-K Lee (Ofinno)] [late]

The block vector-based prediction is highly used for intra blocks in ECM. In addition to the regular block-vector based prediction modes of IBC and IntraTMP, the block vectors are used in SGPM, DIMD and OBIC mode to enhance the prediction. This contribution further proposes using block vectors for TIMD mode on top of the TIMD/TIMD-SAD mode. Furthermore, an enhanced IntraTMP merge list sampling strategy is introduced in order to fully explore the potential of the IntraTMP-merge list.

Experimental results for the proposed method, implemented on top of the ECM-16.1, are reported as follows:

AI: Overall {-0.08%, -0.06%, -0.01%, 101.1.%, 101.0%}.

Proposal contains two elements: 1) Block vector-TIMD and 2) enhanced IntraTMP merge list, which can be exercised separately.

Some complexity reduction (refinement window is dynamically adjusted based on template cost) is performed in this proposal.

It was commented by several experts that the gain is interesting. To potentially further reduce runtime, the proponent commented that the refinement window adjustment parameter can be further fine-tuned.

The block vector-TIMD aspect of this proposal has some interaction with JVET-AL0174, this is addressed in the combination test in JVET-AL0290.

Cross checker confirmed the reported results (performance and runtime).

See the notes under JVET-AL0290.

[JVET-AL0271](https://jvet-experts.org/doc_end_user/current_document.php?id=15598) Crosscheck of JVET-AL0195 (Non-EE2: TIMD-BV extension with enhanced IntraTMP merge list) [X. Li (Alibaba)] [late]

[JVET-AL0231](https://jvet-experts.org/doc_end_user/current_document.php?id=15558) Non-EE2: On interpolation filter for TIMD [Y. Wang, W. Yin, K. Zhang, Z. Deng, N. Zhang, L. Zhao, M. Salehifar, L. Zhang (Bytedance)]

This contribution improves the interpolation filter for template-based intra mode derivation (TIMD) with two aspects. In Aspect #1, a cubic interpolation filter is used in block prediction for TIMD, instead of switching between a cubic filter and a gaussian filter. In Aspect #2, a 6-tap cubic interpolation filter is used in template prediction for TIMD to replace the 4-tap cubic interpolation filter. On top of ECM-16.1, the simulation results are reported as below:

Test 1 (Aspect #1):

AI: {-0.02%, 0.01%, -0.02%; 100.1%, 99.9%}.

Test 2 (Aspect #1 + Aspect #2):

AI: {-0.03%, -0.07%, -0.02%; 99.8%, 98.0%};

RA: {-0.01%, 0.00%, 0.07%; 99.8%, 99.5%}.

Aspect #1 replaces switching between Guassian and cubic with always using 8-tap cubic filter (which already exists in ECM).

Aspect #2 uses 6-tap cubic (which already exists in ECM) to replace 4-tap cubic in template prediction.

A (very) late contribution JVET-AL0333 is related to this proposal. It was agreed to review this contribution after other contributions have been reviewed.

A cross checker verbally confirmed the results, and said that the code change is relatively simple.

It was agreed to study this in an EE. Study the two aspects separately and in combination.

[JVET-AL0325](https://jvet-experts.org/doc_end_user/current_document.php?id=15652) Crosscheck of JVET-AL0231 (Non-EE2: On interpolation filter for TIMD) [C. Ma (Kwai)] [late]

[JVET-AL0241](https://jvet-experts.org/doc_end_user/current_document.php?id=15568) Non-EE2: Intra TMP sub-modes depending on the template type information [T. Dumas, K. Naser, M. Radosavljević, F. Le Léannec (InterDigital)] [late]

This contribution proposes to tailor each sub-mode of Intra Template Matching Prediction (IntraTMP) to the type(s) of template of the candidate reconstructed block(s) involved in this sub-mode. The type of template of a candidate reconstructed block involved in a IntraTMP sub-mode indicates whether this candidate reconstructed block results from the ITMP search via “top-only” template matching or “left-only” template matching or “full” template matching.

The proposed adaptation of IntraTMP sub-modes to the template type information leads to the following performance on top of ECM-16.1.

* AI (Y / Cb / Cr): -0.04% -0.01% 0.03% | 100.2% EncT and 100.1% DecT.

The proposed fusion is always performed when certain conditions are met in IntraTMP – no additional signalling.

The reported peak memory reduction in the proposal is not reliable (due to some errors).

It was commented that the gain is interesting given little further complexity is introduced. See the notes under JVET-AL0290.

[JVET-AL0290](https://jvet-experts.org/doc_end_user/current_document.php?id=15617) [AHG12] Combination of JVET-AL0174, JVET-AL0195 and JVET-AL0241 on Enhanced TIMD with NNIP and Optimized Block Vector Derivation [K. Naser, S. Puri, T. Dumas, M. Radosavljević, F. Le Léannec, E. François (InterDigital), J. Fu, Y. Zhao, J. Zhang, S. Ma (PKU), C. Huang (ZTE), D. Ruiz Coll, J.-K. Lee (Ofinno), Y.-H. Lin, C.-Y. Teng, K.-W. Liang, Y.-C. Yang (Sharp)] [late]

This contribution provides the combined results of the three contributions JVET-AL0174, JVET-AL0195, which are about TIMD improvement with NN-Intra and optimized block vector derivation.

The following results are obtained over ECM-16.1:

JVET-AL0195+ JVET-AL0241+ JVET-AL0174: AI: {-0.13%, -0.04%, -0.04%}

JVET-AL0195+ JVET-AL0241: AI: {-0.12%, -0.06%, -0.08%}

The following shows AI results in the individual contributions vs. the combination:

* Natural sequences

|  |  |  |  |
| --- | --- | --- | --- |
| Contribution | Luma Performance | EncT | DecT |
| JVET-AL0174 (TIMD+NNIP) | -0.02% | 100.3% | 100.6% |
| JVET-AL0195 (TIMD+BV) | -0.08% | 101.1% | 101.0% |
| JVET-AL0241(ITMP template type adaptation) | -0.04% | 100.2% | 100.1% |
| JVET-AL0195+JVET-AL0241 | -0.12% | 101.0% | 101.8% |
| JVET-AL0174+JVET-AL195+JVET-AL0241 | -0.13% | 100.4% | 100.5% |

* Class F and Class TGM averaged

|  |  |  |  |
| --- | --- | --- | --- |
| Contribution | Luma Performance | EncT | DecT |
| JVET-AL0174 (TIMD+NNIP) | N/A | N/A | N/A |
| JVET-AL0195 (TIMD+BV) | -0.29% | 102.2% | 103.6% |
| JVET-AL0241(ITMP template type adaptation) | -0.19% | 99.55% | 100.65% |
| JVET-AL0195+JVET-AL0241 | -0.48% | 98.9% | 100.0% |
| JVET-AL0174+JVET-AL0195+JVET-AL0241 | -0.47% | 97.6% | 98.6% |

It was asked if the runtime is reliable, as the combination shows reduction in enc/dec runtime whereas some individual tests show some runtime increase. According to the proponents, the combination runtime may not be reliable.

It was commented that, looking at the combination tests, the performance contribution from NNIP seems to be the least interesting.

For the BV-TIMD + NNIP combination, BV is applied at the template matching stage along with planar and DC, whereas NNIP is applied in the prediction stage when certain conditions are met (DC or planar is selected).

It was commented that detailed descriptions are not available in the proposals, and the proponents are requested to write clear EE descriptions on how tests are to be conducted in detail.

It was agreed to study this in an EE; within which the following tests should be conducted:

* NNIP to replace planar and DC in TIMD (from JVET-AL0174)
* BV replacing regular intra in TIMD (from JVET-AL0195)
* IntraTMP merge list improvement (from JVET-AL0195)
* Template adaptation for LIC + fusion for intraTMP mode (from JVET-AL0241)
* Combination of all of the above except the NNIP elementCombination of all of the above

[JVET-AL0333](https://jvet-experts.org/doc_end_user/current_document.php?id=15660) Non-EE2: Interpolation filter switching based on filter types and template matching cost estimation [V. Rufitskiy, T. Dong, A. Filippov (TCL)] [late]

Very late contribution (uploaded Tuesday 1 April). Review was deferred to the next meeting, as no time was left by the end of the current meeting after performing all business of higher urgency.

#### Inter (2)

Contributions in this area were discussed during 1445–1500 Tuesday 1 April 2025 (chaired by JRO).

[JVET-AL0248](https://jvet-experts.org/doc_end_user/current_document.php?id=15575) AHG12: On Motion Vector Prediction [D. Bugdayci Sansli, P. Astola, J. Lainema (Nokia)] [late]

This contribution proposes changes to the candidate derivation processes in AMVP, affine AMVP and chain MV of merge modes. In AMVP, proposed chained MV candidates are created by one-step tracing of motion vectors obtained from spatial neighbours. In merge, new chained MV candidates are proposed to be traced starting from the source block position the initial motion is fetched, in addition to existing chained MV candidates.

Proposed method is implemented in ECM-16.1, performance under the Common Test Conditions is reported to be:

RA : -0.04%, -0.02%, 0.02% for Y, U, V respectively, EncT 100.4% DecT 99.4%

LDB : -0.09%, -0.12%, -0.07%, for Y, U, V respectively, EncT 101.0% DecT 99.8%

It was agreed to study this in an EE.

Results were confirmed, and the proposal was supported by a cross-checker.

The two aspects (update of the AMVP check and additional chained candidates) should be reported separately.

[JVET-AL0330](https://jvet-experts.org/doc_end_user/current_document.php?id=15657) Crosscheck of JVET-AL0248 (AHG12: On Motion Vector Prediction) [Y. Kidani (KDDI)] [late]

[JVET-AL0287](https://jvet-experts.org/doc_end_user/current_document.php?id=15614) AHG12: Generated Merge Candidates [D. Bugdayci Sansli, P. Astola, J. Lainema (Nokia)] [late]

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-16.0, performance under the Common Test Conditions is reported to be:

RA : X%, X%, X% for Y, U, V respectively, EncT X% DecT X%

Only partial results available, tradeoff not yet attractive.

Further study recommended (not EE).

#### GPM (2)

Contributions in this area were discussed during 1520–1545 on Wednesday 2 April 2025 (chaired by JRO).

[JVET-AL0193](https://jvet-experts.org/doc_end_user/current_document.php?id=15518) Non-EE2: Extension of Template Types in Regression-Based GPM [Y. Yao, J. Huo, W. Zhang, F. Yang (Xidian Univ.), B. Li, F. Xing, P. Han, Z. Wang (Hisense)]

This contribution proposes an extension of the template types used in the regression-based GPM. Specifically, a two line above and two column left template is utilized for computing the affine linear model parameters.

The impact on coding efficiency and runtimes over ECM-16.1 is reportedly {for Y, U, V, EncT, DecT}:

RA: {XXX, XXX, XXX, XXX, XXX}

LDB: { -0.02%, 0.10%, -0.36%, #NUM!, #NUM! }

According to proponents, encoding time is increased by additional RDO checks. This is not justified by the relatively small coding gain.

Further study recommended to improve the tradeoff. Not mature for EE.

[JVET-AL0082](https://jvet-experts.org/doc_end_user/current_document.php?id=15407) AHG12: Modifications to regression-based GPM with intra and inter prediction [R. Yu, V. Seregin, M. Karczewicz (Qualcomm)]

In ECM-16.0, regression-based GPM has been extended to allow combination of intra and inter prediction. However, it is found that the blending matrix derivation is performed using intra and inter prediction samples of the template from different domains when LMCS is enabled. Furthermore, when generating the final GPM prediction samples, the derived blending matrix is used to combine the current intra and inter prediction samples in a domain different from the domain where the blending matrix was derived.

This contribution addresses the asserted inconsistencies and proposes two alternative modifications. The first alternative performs the blending matrix derivation and the final GPM prediction sample blending in the original domain. The second alternative performs the blending matrix derivation and the final GPM prediction sample blending in the LMCS domain.

The proposed modifications are reported to be implemented on top of ECM-16.1. The BD-rate PSNR and run-time numbers under ECM RA common test configurations for the two alternative modifications are reported as follows:

Alternative 1:

RA: -0.03% , -0.03%, 0.06% for Y, U, V respectively, EncT 100.0% DecT 99.8%

Alternative 2:

RA: -0.03%, -0.05%, -0.02% for Y, U, V respectively, EncT 99.9% DecT 99.8%

There is obviously some suboptimality in the current design, as intra prediction is done in LMCS domain and inter prediction in original domain. For example, in CIIP this is corrected by converting the inter prediction into the LMCS domain.

For alternative 2, only the derivation of the blending matrix is changed, for alternative 1 also the prediction itself.

It was commented that the gain might likely be due to more frequent usage. This was also observed by proponent.

There is not necessarily a bug, but headroom for improvement. Both methods require additional processing, method 2 may be somewhat simpler. It was agreed to study this in an EE.

[JVET-AL0256](https://jvet-experts.org/doc_end_user/current_document.php?id=15583) Crosscheck of JVET-AL0082 (AHG12: Modifications to regression-based GPM with intra and inter prediction) [K. Jia (Alibaba)] [late]

#### In-Loop Filters (5)

Contributions in this area were discussed during 1545–1650 on Wednesday 2 April 2025 (chaired by JRO).

[JVET-AL0182](https://jvet-experts.org/doc_end_user/current_document.php?id=15507) AhG-12: On TALF reference picture extensions [P. Onno, B. Galmiche, G. Laroche (Canon)]

This contribution presents the results of a TALF tool modification in the ECM-16.1. In this proposal, the samples filtered by the TALF process are extended in order to use the samples located in the padded area of the reference frames.

The results by enabling the use of up to 24 samples for TALF extension are the following:

-0.02% 0.00% 0.07% 99.6% 100.2% for the RA configuration,

-0.04% -0.17% 0.01% 99.6% 100.1% for the Low Delay B configuration.

It is proposed to use MC padded samples (which are generated anyway) instead of repetitive padding.

Results and simplicity of the change confirmed by cross-checkers.

It was asked why 24 samples are used? Gave better results than 16.

Would it also be possible to use TM padding? In principle, yes.

Several experts expressed interest in the method, and also supported adoption due to the simplicity, and no questions appeared to need to be investigated in an EE.

Decision: Adopt JVET-AL0182.

[JVET-AL0254](https://jvet-experts.org/doc_end_user/current_document.php?id=15581) Crosscheck of JVET-AL0182 (AhG-12: On TALF reference picture extensions) [L. Xu (OPPO)] [late]

[JVET-AL0220](https://jvet-experts.org/doc_end_user/current_document.php?id=15547) AHG12: Reuse of ALF control information [N. Hu, H. Wang, M. Karczewicz, V. Seregin (Qualcomm)]

In ECM-16.1, for each picture, ALF control information is signalled at both picture and CTB levels. In this proposal, CTB-level information chroma ALF and CCALF can be used by future frames. On top of ECM-16.1 following common test conditions, simulation results of the proposed method are reported below:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| RA | -0.04% | -0.03% | 0.06% | 100.0% | 99.9% | 100.1% | 100.2% |
| LDB | -0.04% | 0.71% | 0.67% | 99.7% | 100.1% | 100.0% | 100.0% |

It was commented that similar methods are used in other loop filters. Some additional storage would be necessary, but there is some gain. The loss in chroma for LB is mostly due to class E, which may be due to further lowering the bit rate.

It was agreed to study this in an EE.

[JVET-AL0230](https://jvet-experts.org/doc_end_user/current_document.php?id=15557) AhG11/AhG12: Performance of the NNVC ILF in ECM [D. Rusanovskyy, K. Panusopone, S. Hong, L. Wang (Nokia)]

An integration of NN-ILF into ECM targeting luma-only filtering have been proposed in JVET-AJ0210 and further studied in JVET-AK0183 and JVET-AK0184. In this contribution, implementation of JVET-AK0183 has been modified and NNVC ILF filters (VLOP, LOP and HOP) have been placed in parallel to deblocking filter and tested for joint YCbCr filtering.

The VLOP1 filter the following results are reported:

* AI: {-0.7%, -1.8% and -1.8%} and 101% of encoder and 306% decoder run time.
* RA: {-0.9%, -1.7% and -1.2%} and 101% of encoder and 284% decoder run time.

The LOP2 filter the following results are reported:

* AI: {-1.3%, -4.9% and -5.2%} and 102% of encoder and 527% decoder run time.
* RA: {-1.7%, -5.8% and -5.3%} and 102% of encoder and 468% decoder run time.

The HOP3 filter the following results are reported:

* AI: {-3.4%, -10.3% and -11.1%} and 110% of encoder and 6533% decoder run time.
* RA: {-5.2%, -13% and -12.9%} and 108% of encoder and 5646% decoder run time.

Contribution for information, no specific action requested. Also uses the interface from JVET-AL0228, and using (older) models from NNVC unmodified which were using VTM as basis for training.

It was commented that it might be interesting to report decoding run time with GPU.

[JVET-AL0232](https://jvet-experts.org/doc_end_user/current_document.php?id=15559) Non-EE2: on TALF input extension [C. Ma, X. Xiu, X. Wang (Kwai)]

In ECM16.1, temporal adaptive loop filter (TALF) takes the samples in the reference picture as inputs. This contribution proposes to additionally utilize the reconstructed samples in the current picture right before adaptive loop filter (ALF) as the additional input to the TALF. On top of ECM-16.1, simulation results are reported as below:

RA : {-0.02%, 0.04%, 0.06%, 100.3%, 100.2%},

LDB : {-0.03%, 0.00%, 0.17%, 100.0%, 99.5%};

9 additional luma samples are filtered, which might not explain the increase of encoder and decoder runtime in RA. With the numbers reported here, the tradeoff would not be convincing.

It was commented that the additional usage of samples from the current frame appears not necessary, as TALF is operated in parallel with ALF which does filtering of the same samples anyway. The proponent believes that it might be useful as the optimization of the spatial filtering is considering its combined effect with the temporal filtering, whereas ALF and TALF are currently optimized independently.

Several experts supported to study the proposal in an EE.

[JVET-AL0275](https://jvet-experts.org/doc_end_user/current_document.php?id=15602) Non-EE2: Non-linear clipping for CCALF [N. Song, L. Xu, Y. Yu, H. Yu, D. Wang (OPPO)] [late]

This contribution proposes to extend the usage of adaptive non-linear clipping of ALF to the intermediate luma reconstruction input value used for CCALF. On top of ECM-16.1, the test results are summarized as follows:

AI: 0.01%(Y), -0.17%(U), -0.22%(V), 100.8%(EncT), 100.6% (DecT))

RA\*: 0.00%(Y), -0.20%(U), -0.21%(V), 100.6%(EncT), 100.2% (DecT))

LDB: -0.01%(Y), -0.68%(U), -0.46%(V), 100.7%(EncT), 100.3% (DecT))

Crosscheckers confirm results and would support the proposal. The relatively large increase of encoding and decoding time is not well explained, according to crosscheckers it my be due to the comsideration of clipping during computation of covariance matrices.

One expert also comments that the encoder runtimes reported by cross-check are even higher.

This did not show a good tradeoff, considering there is no luma gain, and chroma gain comparably low.

Further study was encouraged (not in an EE).

[JVET-AL0331](https://jvet-experts.org/doc_end_user/current_document.php?id=15658) Crosscheck of JVET-AL0275 (Non-EE2: Non-Linear Clipping for CCALF) [W. Yin (Bytedance)] [late]

#### Entropy coding, transforms, quantization, and transform coefficient coding (7)

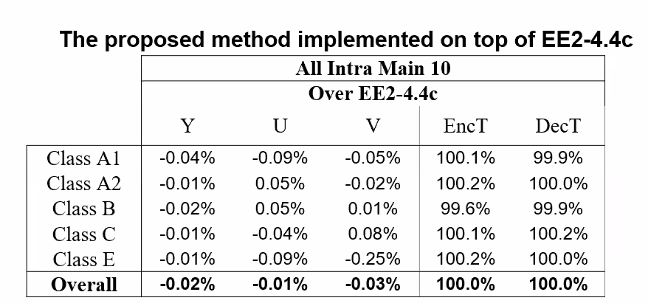
Contributions in this area were discussed during 1650–1815 on Wednesday 2 April 2025 (chaired by JRO).

[JVET-AL0112](https://jvet-experts.org/doc_end_user/current_document.php?id=15437) Non-EE2: Third transform set selection for intraNN [Z. Xie, F. Wang, Y. Yu, H. Yu, D. Wang (OPPO)]

In this contribution, a third transform set selection method for neural network based intra prediction is proposed. In addition to the 1st DIMD IPM and PLANAR, the 2nd DIMD IPM as the third selection is used to select a LFNST/NSPT transform set. On top of ECM-16.1, the simulation results are summarized as below:

AI: -0.03% (Y), 0.05% (U), 0.07% (V), 100.0% (EncT), 100.2% (DecT)

RA: (incomplete)



Only applied to blocks larger than 256 samples.

Several experts expressed interest in the proposal as being a straightforward extension.

It was agreed to study this in an EE.

[JVET-AL0314](https://jvet-experts.org/doc_end_user/current_document.php?id=15641) Cross-check of JVET-AL0112 (Non-EE2: third transform set selection for intraNN) [T. Dumas (InterDigital)] [late]

[JVET-AL0328](https://jvet-experts.org/doc_end_user/current_document.php?id=15655) Cross-check of JVET-AL0112 (Non-EE2: Third transform set selection for intraNN) M.Coban (Qualcomm)

[JVET-AL0150](https://jvet-experts.org/doc_end_user/current_document.php?id=15475) Non-EE2: CABAC context switch of sig\_coeff\_flag and abs\_level\_gtx\_flag for LFNST/NSPT [T. Kusakabe, K. Abe, T. Sugio, T. Nishi (Panasonic)]

In this contribution, it is proposed to introduce the process of switching the set of context models for CABAC coding of syntax elements sig\_coeff\_flag and abs\_level\_gtx\_flag based on the prediction mode of the CU when LFNST/NSPT is used. In this proposal, a 2nd set of context models for LFNST/NSPT is added for CABAC coding of sig\_coeff\_flag and abs\_level\_gtx\_flag, and selected based on the prediction mode of the CU. Two tests were conducted with different initial values for the context models for LFNST/NSPT. Test 1 used the same initial values for the new context models as the already existing context models for LFNST/NSPT in ECM-16.0, while Test 2 used initial values retrained with the CTC sequences for both the existing 1st set and the new additional 2nd set of context models for LFNST/NSPT. The following results were achieved compared to ECM-16.0:

Test 1: AI {Y 0.00%, U -0.02%, V 0.01%, EncT 100.2%, DecT 99.5%},   
 RA {Y -0.04%, U 0.04%, V 0.08%, EncT 99.7%, DecT 99.2%},   
 LDB {Y -0.01%, U -0.16%, U 0.16%, EncT 100.3%, DecT 99.4%}

Test 2: AI {Y -0.02%, U 0.01%, V 0.09%, EncT 100.7%, DecT 99.7%},   
 RA {Y -0.06%, U 0.01%, V 0.03%, EncT 100.0%, DecT 99.4%},   
 LDB {Y 0.01%, U 0.31% V 0.22%, EncT 99.9%, DecT 98.7%}

Basically, the second set has conceptually the same contexts as the first set, but they may adapt differently depending on the mode when they are used. Same initialization for both sets is used in test1 whereas the initialization of set 2 is retrained in test 2.

Number of additional context models would be 266.

There was some debate if the gain justifies the addition of new context models. It was commented that the gain by introducing mode-dependent switching for non-LFNST was higher.

Adding additional contexts is known to be a common way of getting somewhat more coding gain, but at this stage of exploration does not lead to substantial new insight.

No immediate aspect was identified to take action; this might be interesting for further study within a standards development.

[JVET-AL0198](https://jvet-experts.org/doc_end_user/current_document.php?id=15523) Non-EE2: Optimization of probability estimation in CABAC [D. Karwowski, D. Mieloch, M. Lorkiewicz, J. Stankowski (PUT)]

The document proposes a method for improving video coding by introducing optimization of probability estimation in CABAC. This proposal introduces a new adaptation strategy for the parameters of the data statistics model, using the history of encoded symbols for a more accurate estimation of probabilities of symbols. The proposed method was implemented in the ECM-16.1 software and achieved no change in AI results and -0.02%, -0.04%, -0.06% for Y, U, and V components (partial results from B and C classes) in RA.

Current implementation uses floating-point computations which might be necessary at every bin.

Also for RA, no gain in luma for class B.

The gain was not significant enough to justify such a fundamental change in CABAC. Further study was considered necessary.

[JVET-AL0087](https://jvet-experts.org/doc_end_user/current_document.php?id=15412) AHG12: Predictive transform coefficient coding [T. N. Canh, F. Pu, P. Yin, S. McCarthy (Dolby)]

This contribution proposes a predictive transform coefficient coding (PTCC) method to modify the residual coding of ECM. The proposed PTCC consists of: (1) coefficient magnitude prediction to predict the entry flag, and (2) a generalized coefficient coding to skip unnecessary signalling and correction, as follows:

* Forward: when gt\_x = 1, PTCC skips signalling of unnecessary flags (sig\_flag to gt\_x-1), which are inferred as 1
* Backward: when gt\_x = 0, PTCC corrects the prediction error by encoding backward toward the significant flag or until a flag of value 1 is encoded

By eliminating redundant flag signalling in the forward path, PTCC effectively conserves bin budget for CABAC encoding. The conventional residual coding is considering a special case of PTCC where the entry flag is always a significant flag. On top of ECM16.1, the BD-rate achieved of PTCC over ECM-16.1 are as follows:

AI (Y/ Cb/ Cr): {-0.02%, 0.04%, 0.00%, 100.0%, 99.9%}

RA (Y/ Cb/ Cr): {-0.01,-0.02%, 0,04%, X,XX%, X,XX%}

One rate point of A2 class in RA is replaced with the reference point and runtime of RA is unreliable.

The magnitude is predicted based on current probability state of the significance flag. This is asserted an interesting idea, even though it was commented it might have some issues in a real implementation where the CABAC engine is often running independently of the remaining decoding process.

It was explained that the concept in the results reported is only applied to the gt1 flag. It would be possible to also apply to other gtx flags, but the gain currently found was low.

It was agreed to study this in an EE.

It was suggested that also results in the low QP range should be reported, and the max budget is reached more frequently. Also the effect on higher-level flags should be reported.

[JVET-AL0306](https://jvet-experts.org/doc_end_user/current_document.php?id=15633) Cross-check of JVET-AL0087 AhG12: Predictive transform coefficient coding [F. Le Léannec (InterDigital)] [late]

[JVET-AL0113](https://jvet-experts.org/doc_end_user/current_document.php?id=15438) AHG12: Directional sign prediction [L. Xu, Y. Yu, Z. Sun, L. Zhang, H. Yu, D. Wang (OPPO)]

This contribution proposes to measure the boundary continuity for sign prediction based on the derived directions. The directions for sub-boundaries are derived by the histogram of gradient analysis. The proposed method is implemented on top of the ECM-16.1 reference software. The simulation results are reported below:

AI {-0.03%/0.06%/0.00%, 100.4%/101.8%} for {Y/U/V, EncT/DecT}

RA {-0.02%/0.03%/0.01%, 99.8%/100.6%} for {Y/U/V, EncT/DecT }

LDB {-0.02%/-0.37%/-0.25%, 99.6%/100.2%} for {Y/U/V, EncT/DecT }

The determination of angles requires additional computations, however some of these are redundant, such that the decoding time might be reduced.

It was commented that sign prediction was already proposed in HEVC, which might be worthwhile to study.

HoG is derived from groups of 16 samples (coming from 2 rows above, or 2 columns left), areas are overlapping, by which duplicate calculations occur.

Cross-checkers confirmed the results and runtimes.

It was agreed to study this in an EE. Decoding complexity should be largely reduced, and the necessary number of operations should be documented.

[JVET-AL0305](https://jvet-experts.org/doc_end_user/current_document.php?id=15632) Crosscheck of JVET-AL0113 (on directional sign prediction) [P. Onno (Canon)] [late]

[JVET-AL0334](https://jvet-experts.org/doc_end_user/current_document.php?id=15661) Non-EE2: On virtual intra prediction mode (VIPM) derivation for transform selection [K. Ding, A. Filippov, V. Rufitskiy, J. Zhang (TCL)] [late]

This was a very late contribution (uploaded Tuesday 1 April). Review was deferred to the next meeting, as no time was left by the end of the current meeting after performing all business of higher urgency

[JVET-AL0342](https://jvet-experts.org/doc_end_user/current_document.php?id=15669) Cross-check of JVET-AL0344: Non-EE2: On virtual intra prediction mode (VIPM) derivation for transform selection [D. Mieloch, J. Stankowski, A. Dziembowski (PUT)] [late]

[JVET-AL0335](https://jvet-experts.org/doc_end_user/current_document.php?id=15662) Non-EE2: VIPM Adjustment for Multiple Transform Set Selection [J. Zhang, A. Filippov, K. Ding, J. Konieczny (TCL)] [late]

This was a very late contribution (uploaded Tuesday 1 April). Review was deferred to the next meeting, as no time was left by the end of the current meeting after performing all business of higher urgency.

#### Other (0)

This section is kept as template for future use.

### CTC for EE2/ECM and general ECM improvements (0)

Section kept for future use.

See also the discussion under section 4.4.

# High-level syntax (HLS) and related proposals (78)

## AHG9: Additions for HEVC and AVC (7)

Contributions in this area were discussed during 0515–0615 on Tuesday 1 April 2025 (chaired by JRO).

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

This contribution proposes to add the encoder optimization information SEI message into HEVC through a reference to the VSEI standard.

The encoder optimization information (EOI) SEI message is one of the new SEI messages specified in VSEI version 4. The EOI SEI message is asserted to be useful for HEVC, for example for indicating optimizations performed for machine consumption. Therefore, it is proposed to include the EOI SEI message into HEVC.

The proposed specification text changes relative to JVET-AK1006-v1 are presented with change marks in the accompanying document. The changes can be summarized as follows:

1. Addition of the payload type value of the EOI SEI message for both prefix and suffix SEI NAL units.
2. Addition of a subclause specifying the use of the EOI SEI message in HEVC, including the derivation of the PicQuant interface variable.
3. Similarly to the proposal in JVET-AL0056, item 2b for VVC, addition of constraints for the value of eoi\_quant\_threshold\_delta so that the resulting QP threshold is within the valid QP range of HEVC, namely in the range of −QpBdOffsetY to +51, inclusive.

It was agreed in principle to include this.

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

This contribution proposes to add the packed regions information SEI message into HEVC through a reference to the VSEI standard. Proposed interface text for HEVC is provided.

The packed regions information (PRI) SEI message is one of the new SEI messages specified in VSEI version 4. The PRI SEI message is asserted to be useful for HEVC, as demonstrated in the showcase in JVET-AK0140. Therefore, it is proposed to include the PRI SEI message into HEVC.

The proposed specification text changes relative to JVET-AK1006-v1 are presented with change marks in the accompanying document. The changes can be summarized as follows:

1. Addition of the payload type value of the PRI SEI message for prefix SEI NAL units.
2. Providing interface text to define the variables used in the PRI SEI message specified in VSEI

The SEI message is referring to picture as a whole, independent of structuring it into slices, tiles etc. Therefore the proposed text is asserted to be appropriate, and the definition of variables specifically for HEVC is appropriate as well.

Software is intended to be provided by proponents.

It is expected that merge requests for the JM and HM software would be submitted before the finalization of the standards.

Decision: Adopt JVET-AL0059 for JVET-AL1006.

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

The encoder optimization information (EOI) SEI message is used to indicate optimizations that may have been applied during pre-processing or encoding. This SEI message has been developed and incorporated into VSEI V4 draft and also the interface for its use in VVC is available. It is asserted that EOI SEI message can also be used and beneficial for contents coded with codecs earlier than VVC such as AVC and HEVC.

This contribution proposes to include EOI SEI message in the new edition of AVC and HEVC specification.

Agreed in principle to include this. The proposal does not include the restriction concerning QP range of JVET-AL0057 which is asserted to be necessary for both AVC and HEVC.

A merge request for software was already submitted for JM and HM.

ID 215 is proposed to be used for all standards.

Proponents of JVET-AL0057 and JVET-AL0061 are requested to make a joint proposal for texts in AVC and HEVC, and also check if the QP range constraint needs to be implemented in software. A follow-up review based on JVET-AL0061 v2 was done on Friday 4 April (it was reported by proponents that it appeared not necessary to submit a formal joint contribution). This includes text for similar QP range constraints for AVC and HEVC. Checking of the constraint also needs software implementation, and new merge requests will be submitted by proponents of JVET-AL0057.

Decision: Adopt JVET-AL0061v2 for JVET-AL1006 and JVET-AL-1017.

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

As AI-driven applications continue to expand, concerns over the use of video content in AI-based processing are increasing. The AI usage restrictions (AUR) SEI message provides a standardized method for indicating restrictions on AI usage and has been developed and incorporated into the VVC and VSEI draft texts. It is asserted that AUR SEI message can also be beneficial for content coded with codecs earlier than VVC such as AVC and HEVC.

This contribution proposes to include AUR SEI message in the new edition of AVC and HEVC specification.

A merge request for software was already submitted for JM and HM.

Decision: Adopt JVET-AL0062 for JVET-AL1006 and JVET-AL1017.

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

The generative face video and generative face video enhancement SEI messages were adopted into the draft text of VSEI version 4 at the 36th JVET meeting, and the corresponding interface text for VVC was adopted at 37th JVET meeting. This contribution proposes to add the generative face video and generative face video enhancement SEI messages to the next version of HEVC and AVC.

Software is intended to be provided by proponents. This will enable using to generate the content of the SEI message from the GFVC software, encode the base picture and write it along with the SEI message into the bitstream, decode the base picture and extract the parameters from the SEI message, and synthesize the face using the GFVC software.

It is expected that merge requests for the JM and HM software would be submitted before the finalization of the standards.

Decision: Adopt JVET-AL0148 for JVET-AL1006 and JVET-AL1017.

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

This contribution proposes to add the SEI processing order SEI message and the processing order nesting SEI message to HEVC and AVC specifications and provides interface text to add these SEI messages to the next editions of HEVC and AVC.

It was asked whether AVC and HEVC would have other SEI messages that might be used along with SPO and PON. This is kept for further study. It is noted that adding more payload types to the list would anyway be appropriate for SPO, e.g. in case when new SEI messages would be defined.

Software is intended to be provided by proponents.

It is expected that merge requests for the JM and HM software would be submitted before the finalization of the standards.

Decision: Adopt JVET-AL0210 for JVET-AL1006 and JVET-AL1017.

[JVET-AL0317](https://jvet-experts.org/doc_end_user/current_document.php?id=15644) On CLVS and SEI messages in HEVC [D. Podborski, A. Tourapis (Apple)] [late]

The current definition of a coded layer-wise video sequence (CLVS) in HEVC seems to only refer to the base layer and does not mention its possible association with any other layers in a bitstream. This appears to be incorrect and the definition likely should be updated. Furthermore, the proponents feel that the current handling of SEI messages in multi-layer scenarios may lack clarity regarding whether certain metadata should be repeated across layers or if they could be signalled in a base layer with applicability to others. Clarifying these aspects is essential for consistent implementation and interoperability.

This contribution was presented Thursday 3 April in a morning session.

The different definition of CVLS was asserted as anomaly due to the later development of layered extensions in HEVC, and need for compatibility with legacy base layer devices. Due to the definition in Annex F, this is asserted to be correct. It might however be confusing for somebody not aware of the definitions in the annex.

The aspect of layer association of SEI messages would require a case-by-case study. MDCV and AMVE mentioned in the document could be taken as an example.

Clarification might also be necessary whether an SEI message implicitly applies to all layers if it is present in layer 0.

It was agreed to add content from section 2 of JVET-AL0317 into JVET-AL1004.

## AHG9: Aspects on SEI messages in VSEIv4 and related (51)

### Film grain characteristics SEI message (3+1)

Contributions in this area were discussed in section 4.11.

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

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

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

*Aspect on FGC SEI – JVET-AL0211 also relates to section 6.4 on potential needs for additional SEI message*

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

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

Contributions in this area were discussed during 0500–0730 on Thursday 27 March 2025 (chaired by J. Boyce).

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

This contribution proposes the following changes to the SPO SEI message.

1. Exclude user data registered by ITU-T T.35 SEI message and user unregistered SEI message from SPO prefix indication boundary constraint to be consistent with SEI prefix indication SEI message.
2. Constrain the value of po\_for\_human\_viewing\_idc and po\_for\_machine\_analysis\_idc shall be equal to the value of nnpfc\_for\_human\_viewing\_idc and nnpfc\_for\_machine\_analysis\_idc of the associated NNPFC SEI message when NNPFC is the last stage of processing chain. Constrain the value of po\_for\_human\_viewing\_idc shall not be equal 3 when AR SEI message with the value of ar\_not\_optimzed\_for\_viewing\_flag equal to 1 is the last stage of the processing chain.
3. Add a constrain that the same type of SEI message indicated by the SPO SEI message shall have the same value of po\_sei\_processing\_order, or an alternative constraint that requires the uniqueness of the SEI message type in SPO SEI message.

v2 removes two proposed constraints and adds one alternative constraint option from v1.

Item 1 agreed.

Item 2 is a sensibility constraint. A concern was expressed about the phrasing when some of the relevant SEI messages are not present.

A suggestion was made that a note could be used instead of a constraint.

Discussed item 2 after reworded as per v4 on 1 April at 17:00 chaired by S. Deshpande.

The revised constraint is more detailed and conditioned on some syntax elements and is asserted o be more accurate.

Agreed to revised item 2 as per v4 version

For Item 3, option 1 was not preferred. A suggestion was made that option 2 was unnecessarily strict.

Discussed item 3 after reworded as per v4 on 1 April at 17:06 chaired by S. Deshpande.

The revised text change is asserted to be simpler.

Agreed to revised item 3 as per v4 version

[JVET-AL0064](https://jvet-experts.org/doc_end_user/current_document.php?id=15370) AHG9: On the SPO SEI message complexity signalling [Y. He, M. Karczewicz (Qualcomm)]

This contribution proposes to add additional complexity information of mandatory processing stages and sub-chains besides the complexity information of processing chain in the SPO SEI message. It is asserted that a decoder may not be able to support entire processing chain due to the complexity concern, the decoder may process mandatory processing stages with zero or more sub-chains if the complexity information is present for the mandatory processing stages and sub-chains.

A large number of syntax elements are proposed, which seems to go beyond the “minor necessary changes” guidance.

Are there any implications for extensibility? An extension must be backwards compatible, and would need to provide improvement for new decoders without breaking older decoders.

A suggestion was raised to signal complexity for minimum rather than mandatory.

A concern was raised with using the word “mandatory” within SEI message syntax or semantics.

Decision (ed): delegate to the editors to replace existing “mandatory” wording in the semantics.

Further discussion requested for consideration for TuC after restructuring to be an extension and to reword to avoid using “mandatory” wording.

The V2 version further discussed 1 April 2025.

V2 includes following changes:

1. Add extension to current SPO SEI message
2. Restructure the proposed complexity information of root process to be an extension of SPO SEI message and replaces “mandatory” with “root”.

It was suggested that the extension bits are unnecessary, according to the guidelines provided in JVET-T0048, for which extensions use this format:

     if( more\_data\_in\_payload( ) )  
          if( payload\_extension\_present( ) ) {  
              SeiExtensionBitsPresentFlag = 1  
              **use\_alt\_cpb\_params\_flag** u(1)  
          }  
}

It was questioned if a new length field is required, or if the earlier length field could be used.

It was suggested that the semantics use of “root process” should be “root processes”.

It was suggested that “root process” is not adequately defined. Further study encouraged on properly defining root process.

Decision: add to TuC.

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

This contribution proposes to remove pon\_processing\_order[ i ] in the PON SEI message. It is asserted that a PON-nested SEI message may be duplicated multiple times in a PON SEI message when it is associated with different SPO SEI messages with different pon\_processing\_order value. Removing pon\_processing\_order[ i ] also simplifies the parsing process.

A question was raised if removing pon\_processing\_order[ i ] affects functionality of the PON SEI message.

The contribution suggests that removing the pon\_processing\_order[ i ] syntax element simplifies parsing. It was suggested that removing the syntax element would require more operations to determine the order by matching payload types.

It was suggested that nesting in a PON with the current design allows distinguishing between SEI messages by the order.

It was suggested to keep the current design for design stability.

No action was taken on this.

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

This contribution proposes to enhance the SEI processing order (SPO) SEI message with information indicating whether the SPO chain was optimized for energy savings purposes.

When energy consideration comes to play, such information can for example be used by a receiver to decide whether or not to apply the processing chain specified by the SPO SEI message. It can also be used to choose one SPO chain against another, depending on the energy status of the receiver.

Different use case scenarios can be envisioned which leverage the energy savings information. This contribution proposes to describe three of them.

The contribution is being proposed for VSEI v4.

Essentially the same syntax and semantics is proposed as in JVET-AK0156 are proposed, but additional use case information is provided.

The contribution is providing new functionality, which may not be suitable for VSEI v4 at this stage. It could be considered for TuC if done as an extension.

It was suggested that the location of syntax elements should be move to be backwards compatible for an extension if it were included in the TuC.

It was suggested that it is difficult for the encoder to know if all decoder implementations would have energy savings.

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

This contribution proposes to constrain the usage of a "root" process (i.e., poSubChainIdx[ j ] equal to 0 and po\_sei\_importance\_flag[ PoSeiTypeIdx[ j ] ] equal to 1 and po\_sei\_processing\_degree\_flag[ PoSeiTypeIdx[ j ] ] equal to 1) when preceded by any open-ended sub-chain. The latter can cause early termination of PoSeiList without the inclusion of such root process, which generates ambiguity in the intended behavior of such critical process.

Proposes adding a constraint.

Decision: Adopt. The exact wording of the language can be fine-tuned during editing.

### NNPF SEI extensions (5)

Contributions in this area were discussed during 0730–0930 on Thursday 27 March 2025 (chaired by S. Deshpande).

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

Chaired by S. Deshpande on 27 March 2025 at 07:30

It is asserted that an NNPF that is not the initial process of the processing chain is invoked, in turn, to the corresponding picture of the current cropped decoded picture (currCdoPic) to which the NNPF is activated and each associated inserted picture of currCdoPic. However, it is asserted that when an NNPFA SEI message including the nnpfa\_num\_input\_pic\_shift syntax element persists to currCdoPic, the intent is to invoke the NNPF only once among the corresponding picture of currCdoPic and the associated inserted pictures of currCdoPic using the indicated shift when selecting input pictures to the NNPF. It is also asserted that a decision in relation to JVET-AJ0114 was to require inclusion an NNPFA SEI message with nnpfa\_num\_input\_pic\_shift into a PON SEI message, but this decision has not been implemented.

The proposals of this contribution can be summarized as follows:

1. It is proposed to add a gating flag nnpfa\_selected\_input\_flag for nnpfa\_num\_input\_pic\_shift.
2. It is proposed to add a constraint: when an NNPFA SEI message is not included in a PON SEI message, nnpfa\_selected\_input\_flag shall be absent or equal to 0.
3. When an NNPFA SEI message is included in a PON SEI message and nnpfa\_selected\_input\_flag is absent or indicates the absence of nnpfa\_num\_input\_pic\_shift, the NNPF is invoked, in turn, to the corresponding picture of currCdoPic and each associated inserted picture of currCdoPic.
4. When an NNPFA SEI message is included in a PON SEI message and nnpfa\_selected\_input\_flag is present and indicates the presence of nnpfa\_num\_input\_pic\_shift, the NNPF is invoked to the picture selected according to the value of nnpfa\_num\_input\_pic\_shift.

The problem statement 1 is agreed and as per decision at the previous meeting, this should be implemented and that can be done by adding a constraint.

Decision (BF): Agreed to add the constraint (which was already agreed in previous meeting but not implemented)

It was asked if the purpose of the proposed flag is to specify which pictures the shift should be applied to (e.g. to all or just non-interpolated pictures). It was asked if when the proposed flag is 0, the shift is still also applied to the current picture and where will the shift information be obtained from in that case. It was answered that conceptually the NNPF is invoked multiple times with different shifts. Two participants commented that it was not clear that there is a need to add a flag. Offline discussion amongst interested parties was planned.

Discussed on 2 April 2025 at 06:20 after offline discussion.

In v2 more background information is added, but the proposal is unchanged compared to v1. The use case examples for the proposal were described during v2 presentation along with the proposed specification text changes.

It was commented that the proposed approach introduces different mode of operation such that same filter may get invoked multiple times. Depending on the value of the new syntax element, the filter may get invoked at a particular picture and then on pictures that are inserted, or it may be invoked only on the current picture. It was commented that there may be additional other modes possible and this should be further studied.

It was commented that it might be desirable that the example operations can be done in a very efficient manner, but unless there is some light and reasonable change that can enable that, it is OK that the example operations cannot be done in a very efficient manner. Also using information from inside NNPFC/NNPFA SEI messages for controlling of processing chain handling may not be architecturally the best option.

Overall there was a concern due to the amount of changes at this stage and affecting of processing change from inside the NNPFC/A messages.

No action for v4.

Further study recommended for future version.

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

Chaired by S. Deshpande on 27 March 2025 at 08:00

This contribution proposes changes to avoid the need to define multiple NNPFs and NNPF cascades by enabling the adaptive use of NNPF models that include bypass connections so that filtering for a particular purpose among multiple purposes of the NNPF can be skipped. For example, in an NNPF that supports both resolution upsampling and quality enhancement, where only the last few layers perform upsampling (common architectural choice for memory and computational saving), the proposal enables skipping such last few layers in the NNPF inference when only quality enhancement is desired.

This contribution includes the following proposed items:

1. nnpfa\_target\_purposes\_present\_flag, indicating if nnpfa\_target\_purposes\_idc is present.
2. nnpfa\_target\_purposes\_idc indicating a bit-field where the enabled bits are a subset of the enabled bits in nnpfc\_purpose; thus, a subset of the NNPFC-indicated purposes can be indicated in an NNPFA SEI message.
3. nnpfPurpose is set equal to nnpfa\_target\_purposes\_idc (if present) or nnpfc\_purpose (otherwise). The purpose-dependent variables (ChromaUpsamplingFlag, ResolutionResamplingFlag, etc.) are derived from nnpfc\_purpose for NNPFC SEI message syntax parsing and from nnpfPurpose for constraints and NNPF operation.
4. A bit of nnpfc\_auxiliary\_inp\_idc, namely nnpfc\_auxiliary\_inp\_idc & 8, is defined to indicate that a purpose is input to the NNPF as a part of the input tensor.
   1. When nnpfc\_auxiliary\_inp\_idc & 8 is equal to 0, nnpfa\_target\_purposes\_present\_flag shall be equal to 0. Since legacy VSEI decoders would not process NNPFs with nnpfc\_auxiliary\_inp\_idc & 8 greater than 0, they would not parse NNPFA SEI messages with the new syntax elements present and hence legacy compatibility is not compromised.
   2. The purpose is included in the input tensor as an additional matrix, similarly to the strength control value (QP), the text prompt, and the seed value.

It was commented by the proponents that this is not a bug-fix proposal.

It was commented if the memory requirement for a single NNPF with two purposes will be necessarily significantly lower than having two separate single purpose NNPFs. The proponent commented that rather than the memory aspect, the complexity of having two separate NNPFs in this case may be a more important issue to consider. Another participant commented that the memory requirement for a single filter was likely to be lower.

It was asked if the proposals here also allows a case where nnpfc purpose is a subset and nnpfa purpose adds more purposes. The proponents had only considered the case where nnpfc purpose is a superset. The proposal already includes such a constraint (to make nnpfc a superset). It was commented by a participant that if additional purposes are added in nnpfa, some additional syntax elements would need to be signalled in nnpfa.

One participant commented that this does not necessarily add new functionality as the use case can be realized by existing syntax. Also it was commented that this proposal may be thought of as adding alternative option for a functionality that is already supported, albeit possibly for better efficiency. Some examples with memory savings and bit rate savings were requested to consider if this should be considered for TuC.

It was asked if this proposal would also require some changes or may have some impact to handling of processing chains (e.g. if input pictures are different for different purposes). It was commented that the proposal text handles this aspect.

The proponent may request a revisit if additional data can be provided at this meeting.

Further study is recommended (on providing example savings as mentioned above, and also to consider if this may affect handling of processing chains).

Discussed on 2 April 2025 at 06:45

Additional data was provided in v2 via example of benefit and the specification text was slightly updated. The previous conclusion was not to include the proposed aspect in VSEI v4, but to decide if it should be included in TuC.

An example was provided showing possible % of data that can be skipped using the proposed approach.

It was asked for the example if NNR compression is used how much size reduction will happen compared to the 46MB uncompressed data size. The size of compressed data was not available/ known at this time.

It was asked if changing the connections requires a new SEI message.

As per added note, some purposes which affect output tensor arrangement cannot be supported by the proposed approach.It was commented that the proposal makes a number of specification text changes and likely more changes will be added which may not be desirable and better judgment may be made if all changes are seen together.

It was commented that some unification of the approach between this proposal and the backbone and tail approach (JVET-AL0159) or comparison with that approach and this one may be useful. this topic if this proposal in combination with JVET-AL0292 is available.

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

Chaired by S. Deshpande on 27 March 2025 at 08:30

The current design of the NNPFA SEI message in VSEI V4 determines the presence of extended syntax elements using more\_data\_in\_payload( ). It is asserted that using only that function may cause backward compatibility such that a VSEI V4 decoder may misinterpret byte alignment bits in a VSEI V3 bitstream as extended syntax elements.

This contribution proposes to add additional check using payload\_extension\_present() to distinguish between byte alignment bits and extended syntax elements, ensuring backward compatibility.

The proponent commented that this is an asserted bug-fix.

It was commented that what is proposed is needed but not sufficient. JVET-T0048 provides an example to use the extension correctly and that meeting’s minutes capture the decision to do it correctly. Thus it is proposed to add SeiExtensionBitsPresentFlag = 1 inside the two if statements.

Decision: Agreed to fix the bug as proposed with additional change which makes the bug-fix as follows:

 if( more\_data\_in\_payload( ) )

          if( payload\_extension\_present( ) ) {

              SeiExtensionBitsPresentFlag = 1

… }

[JVET-AL0159](https://jvet-experts.org/doc_end_user/current_document.php?id=15484) AHG9: On backbone and tail of NNPFs [F. Cricri, M. M. Hannuksela (Nokia)]

Chaired by S. Deshpande on 27 March 2025 at 08:45

This contribution proposes additions to the metadata extension of the NNPFC SEI message that allow to identify a backbone and a tail which make up a complete NNPF, via two distinct URIs. When the backbone is shared among two (or more) NNPFs, the backbone needs to be downloaded only once, by using its URI. For any subsequent NNPF using that same backbone, the decoding system can skip downloading it again, and can use the backbone’s URI to retrieve it from memory or local storage.

This contribution includes the following proposed items:

1. nnpfc\_backbone\_info\_flag, indicating whether nnpfc\_backbone\_uri and nnpfc\_tail\_uri are present.
2. nnpfc\_backbone\_uri and nnpfc\_tail\_uri, specifying URIs identifying the backbone and the tail of the NNPF, respectively.

A non-proponent thought the functionality was interesting and should be considered for TuC (not VSEI v4). A participant requested additional information regarding how often NNPF is implemented as a backbone and a tail. Another participant asked typically how much typically is the % of data for backbone versus tail. The proponent gave a ballpark that backbone will be around 80% with tail being 20%. Some concrete data for this % was requested – maybe for the example included in the document.

The proponent may request a revisit if additional data can be provided at this meeting.

Discussed on 2 April 2025 at 07:20

Additional data was provided in v2. In the example provided, backbone is about 97% of the data.

A participant commented that this approach requires less changes to specification text and may be preferred compared to JVET-AL0076, if it can capture most of the use cases addressed by that approach.

It was asked if this backbone phenomenon is common why it was not done by NNR. It was suggested that from JVET point of view it may be good to communicate with NNR regarding this aspect.

It was commented that may be the goal of NNR was a monolithic bitstream. Also the proposed approach of this proposal is for fetching any URI based NN and applies to NNR and other formats.

It was commented that once we get a feedback/ confirmation of commonality of the backbone tail approach and NNR group’s comments on this approach and if we get positive or neutral (any not negative) comments then we should put this in TuC.

The proponent may request a revisit if the above aspect is resolved during this meeting.

Discussed again at 3 April 2025 at 18:50. The response from NNR group was shared by proponents. Personal opinion of NNR group chair was : “Having a fixed shared backbone and heads specific to a task, finetuned to particular data, etc. is a fairly common approach. Most object detection, segmentation etc. networks build on a more general backbone (in the past, pretrained on a classification task, today mostly trained in a self-supervised way)”

It was asked why NNR group did not make use of this in NNR design. This was not asked to NNR group so far. Also it was asked if NNR has any feature to already support this. It was suggested to hear their opinion on this. And once that is known the comment above regarding putting this in TuC applies.

It was also pointed that the proposal also applies to non NNR formats (e.g. ONNX) as it is via URI signalling.

Regarding the shared response, it was pointed that it was not clear if backbone shares weights. A participant thought that it may not be clear as there may be retraining which may change the backbone. It was commented that the backbone may remain same or change.

It was asked if backbone and tail can be considered two separate NNPFs and SPO can handle this generically to put them in cascade. It was commented that this would require more changes. Also NNPF output is a picture but NNPF backbone output is floating point tensor.

Further study encouraged.

[JVET-AL0292](https://jvet-experts.org/doc_end_user/current_document.php?id=15619) AHG9: On Signalling NNPF Characteristics in NNPFA upon Updates of Purposes [C.-H. Demarty, E. François, F. Aumont, O. Le Meur (InterDigital)] [late]

Chaired by S. Deshpande on 27 March 2025 at 09:00

Contribution JVET-AL0076 proposes to update the NNPF purposes in the NNPFA SEI message in the case of multipurpose NNPFs.

Updating the purposes of an NNPF implies that some characteristics of the NNPF need also to be updated, in particular characteristics related to the output of the NNPF.

This contribution proposes to add signalling of updated values of such characteristics in the NNPFA SEI message.

The discussion was focused on if for resolution resampling update of parameters would be needed in the nnpf update. It was asked why new parameters need to be signalled in NNPFA in this case. Proponents specified that the variables used would be from nnpfa purpose and so the resolution will be that of the input picture. It was commented by proponents that this type of text may be missing in JVET-AL0076. This needs to be double-checked.

Further study recommended.

### Encoder optimization information SEI message *(*4)

Contributions in this area were discussed during 0910–0920 and 1300–1600 on Thursday 27 March 2025 (chaired by S. Deshpande).

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

Chaired by S. Deshpande on 27 March 2025 from 09:10 to 09:20 and 13:00 onwards.

The contribution proposes the following changes relating to the encoder optimization information (EOI) SEI message:

1. It is proposed to change the semantics of eoi\_type to allow extensions in future VSEI versions as follows:
2. The value of eoi\_type shall be in the range of 0 to 63, inclusive, in bitstreams conforming to this version of this Specification.

Decision: Agreed to this sensibility range value.

1. When the value of eoi\_type is greater than or equal to 64, VSEI v4 decoders are required to parse the EOI SEI message syntax until the last syntax element specified in VSEI v4 and ignore all remaining syntax elements.

This relates to requiring that any possibly added new elements in V5 should go after current syntax elements.

This item is related to item 1 in JVET-AL0123 and was discussed together.

Decision: Agreed

1. It is proposed to specify the value range of eoi\_quant\_threshold\_delta as follows:
2. To limit the count of bytes needed to store the value of eoi\_quant\_threshold\_delta, it is proposed to constrain its value to be in the range of 0 to 65 535, inclusive, in the VSEI text.
3. It is proposed to constrain the value of eoi\_quant\_threshold\_delta in the VVC interface text of the EOI SEI message so that the resulting QP threshold is within the valid QP range of VVC, namely in the range of −QpBdOffset to +63, inclusive.

This item is related to item 12 in JVET-AL0123 and was discussed together.

It was asserted that max range for AVC, HEVC is 0-99 and for VVC 0-111 and so JVET-AL0123 proposes range 0-255. The proponent had considered reserving a larger value range for a potential future codec. Another comment was to use an upper range value between 255 to 65535.

It was commented that giving a more neutral name to such an syntax element is what we had done for another similar syntax (e.g. nnpfc strength value) i.e. not name it with the word “quant” in the name. This was delegated to the editors.

Regarding the item 2b here and item 12, the exact proposed language is slightly different but is similar in spirit, with one difference being if the upper bound value is included or excluded. Was discussed again on 1 April 2025 at 17:15 to confirm if the upper bound value is included or excluded. Two participants independently confirmed that the upper bound is included.

Decision: Agreed to use range of 0 to 1023 in VSEI specification. Also agreed to specifying the range in VVC, with exact language delegated to the editors. The aspect of syntax element renaming is delegated to the editors.

1. It is proposed to replace "access unit" with "picture unit" in the semantics of eoi\_src\_pic\_flag.

It is asserted that the term “the capture unit in the same access unit” is ambiguous.

This is same as item 8 of JVET-AL0123.

Decision: Agreed

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

Chaired by S. Deshpande on 27 March 2025 at 13:25

This contribution proposes the following changes for the encoder optimization information (EOI) SEI message:

1. Specify a valid range for eoi\_type.

See the notes under item 1 of JVET-AL0056.

1. Signal original source picture width minus 1 and original source picture height minus 1.
2. Specify a constraint on the original source picture width and height to avoid conflicts in semantics.

It was commented that this is to avoid a case where encoder does something redundant and it does not seem harmful. The exact wording regarding meaning of variable EoiSpatialResamplingFlag was discussed and was asserted to indicate that resampling had taken place. It was commented that may be this can be described in a note with a slightly softer language, also the use of “cropped decoded picture width/ height” seems to refer to codec characteristics. There was some confusion if the proposed language covers both cases. It was asked if we should have interface variables defined to make the constraint very specific. Editors to handle the exact language.

1. Clarify the semantics of eoi\_object\_based\_idc.

It was commented by two participants that any optimization done by EOI can be prior to encoding or during encoding. Also encoder implementation may not be clear about what is before and during encoding. It was thus agreed to remove the words “prior to encoding” from bitmask 0x01 semantics.

1. Specify a constraint on eoi\_object\_based\_idc to disallow some conflicts.

It was commented that adding it for ( eoi\_object\_based\_idc & 0x01) combination is not necessary. Constraint for the values ( eoi\_object\_based\_idc & 0x04 ) and ( eoi\_object\_based\_idc & 0x08 ) makes sense but it was asked if this should be a note.

Decision (ed.): Delegated to the editors to add a note as describe above.

1. Clarify the semantics of eoi\_privacy\_protection\_method\_idc.

It was commented that “privacy information” is not be better than “personal information”. The change about “prior to encoding” should not be done as discussed related to item 4 above.

No action on this aspect except change the word “undiscernible” to “unidentifiable”.

1. Change the values of different privacy protection methods.

There were use cases described to allow combinations, so no action was taken.

1. Fix the semantics of eoi\_src\_pic\_flag.

See the notes under item 3 of JVET-AL0056.

1. Enable signalling of eoi\_src\_pic\_flag when eoi\_num\_int\_pic is equal to 0.

It was commented that for the value 0 for eoi\_num\_int\_pics the eoi\_src\_pic\_flag may not be meaningful. It was asked if encoder always knows which is the original source picture if temporal interpolation was done before encoder. It was answered that in that case eoi\_num\_int\_pics can be set to 0 and current if condition does not need to signal eoi\_src\_pic\_flag. A participant thought that the encoder should still know in this case which is the original source picture. It was commented that in general the encoder might or might not know instead of does or does not know.

It was delegated to the editors to clarify the meaning of the semantics of eoi\_num\_int\_pics equal to 0 to clarify that encoder might not know which pictures are the source pictures.

1. Signal two flags to indicate horizontal and vertical spatial resampling type.

JVET-AL0310 is related and provides another option and was discussed together with this.

In JVET-AL0310 instead of using 2 flags, 2 idcs are used providing more information.

First question is if we want to allow indicating different resampling factors in horizontal and vertical dimensions and what are the use cases for that. It was questioned if there are practical use cases that picture is stretched in one spatial dimension and contracted or kept the same in the other dimension.

It was commented that this is a bit of a feature change and it was agreed by a proponent that this is not a bug-fix. It was asked if this can be done after v4 and it was commented that the syntax for that would be a bit different. It was commented by proponents that this can be considered a necessary change.

Decision: agreed to implement as per JVET-AL0310.

1. Extend eoi\_privacy\_info\_type by 1 bit.

It was commented that the “object” as proposed here is very general. It was also asked if we should only define specific types of objects (e.g. computer screen). It was commented if this would make people not specify type of privacy values defined by just setting this bit to 1 instead.

It was asked if background blurring would set this bit to 1. It was commented that the current bit 0x04 could be used for that.

No action taken at this meeting.

1. Specify range constraint for eoi\_quant\_threshold\_delta.

See the notes under item 2 of JVET-AL0056.

Decision: Agreed on items 2, 3 and other items as noted above.

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

Chaired by S. Deshpande on 27 March 2025 at 15:25

The contribution proposes to include the TuC design of luma range adaptation for the encoder optimization information (EOI) SEI message into VSEI v4 with the following changes:

1. Addition of eoi\_luma\_adaptation\_idc, which specifies the type or method for luma range adaptation and for which the following values are specified:
   1. Value 0 specifies that the luma value range has been adapted for display power saving.
   2. Value 1 specifies that luma sample values have been pre-processed by multiplying with lumaRatioMult, which is derived from eoi\_ratio\_luma\_value and eoi\_ratio\_luma\_sign\_flag.
2. Gating of the presence of eoi\_display\_model by eoi\_luma\_adaptation\_idc equal to 0.
3. When eoi\_luma\_adaptation\_idc is equal to 1, addition of eoi\_backscale\_ratio\_value, which indicates whether and by which factor the decoded luma sample values were scaled back in the encoding system when deriving performance metrics (e.g., mAP) used for optimizing the luma range. Decoding systems can use the same back-scaling ratio in their operation.

The contribution provides experiment results as a showcase for demonstrating the usefulness of the proposed signalling for machine analysis tasks. Experiments on the OpenImages dataset on object detection and segmentation task show that the proposed adaptive luma down-scaling and back-scaling predictions achieve -28.6% and -25.0% BD-rate reduction. Version 2 of the contribution adds showcase results on the SFU dataset on object detection task, with -13.2% (LD), -11.7% (RA), and -9.7% (AI) BD-rate reductions.

V2 was discussed.

It was commented that for SFU the back-scaling was computed on the first picture and used for entire sequence.

It was commented that for machine analysis, whether chroma should also be used. The proponent commented that use of chroma has not been tried in this contribution and in JVET-AH0115.

It was asked if this adaptation should be done as bit-depth truncation or more fine grained as proposed here. It was commented by proponents that bit-depth truncation is special case and NN chose more fine grained values and not just 1 bit truncation.

It was asked with the additional changes the purpose description should clarify the additional aspect supported.

It was asked if nonlinear luma adaptation or other ways of doing luma adaptation should be studied and if this is added to VSEI v4, how that would work. It was commented by proponent that the eoi\_luma\_adaptation\_idc can provide further extensibility in future.

Multiple participants commented that this is interesting, but more suitable for TuC at this stage.

Decision: agreed to add to TuC

It was asked by proponent of JVET-AH0115 to consider including that document also in TuC. It was commented that the addition of JVET-AL0221 is a superset of JVET-AH0115 and the additional aspect which is for chroma did not have any results. It was suggested to do further study of JVET-AH0115 which has similar motivation.

[JVET-AL0310](https://jvet-experts.org/doc_end_user/current_document.php?id=15637) AHG 9: On signalling of resampling type for EOI SEI message [C. Kim, H. Tan (LGE), J. Xu, Y.-K. Wang (Bytedance)] [late]

This contribution provides a solution option for the problem assertd by contribution JVET-AL0123 item 10. It is asserted that the problem of different resampling types for different dimensions is a valid problem.

This contribution proposes to use two indications for signalling the resampling types (i.e., for horizontal and vertical dimensions) in encoder optimization information (EOI) SEI message. The detail of the suggested modification is as follows:

1. Replace the current syntax element eoi\_spatial\_resampling\_type\_flag with two 2-bits indication syntax elements called eoi\_spatial\_hor\_resampling\_type\_idc and eoi\_spatial\_ver\_resampling\_type\_idc.
2. For each idc, the semantics of the values is as follows:
   * 0 means no resampling is applied in that dimension.
   * 1 means subsampling is applied in that dimension.
   * 2 means upsampling is applied in that dimension.
   * 3 is reserved.
3. Add a constraint such that when these two indications are present, their values shall not both be equal to 0.

Compared with the modification suggested in JVET-AL0123, where two flags are used to indicate resampling type in two dimensions, the solution described in this contribution provides more resampling information.

See the notes under JVET-AL0123 item 10.

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

Contributions in this area were discussed during 1600–1700 Thursday 27 March 2025, with follow-up on Friday 28 March (chaired by S. Deshpande).

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

Chaired by S. Deshpande on 27 March 2025 at 16:00

The process described in the OMI SEI message to map sample positions to mask ID values compares the decoded auxiliary picture samples to signalled sample values. The process requires an exact match between the decoded sample value and the omi\_aux\_sample\_value[ i ][ j ], which is not robust to lossy compression. It is proposed to modify the OMI SEI message to add robustness to lossy compression by adding syntax elements for an exact match flag and a tolerance value.

It was asked by a participant if encoder needs to give an indication to the decoder about exact match and separately to signal the tolerance range.

Proponent commented that it is also possible to consider an option where encoder signals exact match flag only and a note is added regarding how decoder could handle it in that case. It was commented that exact match flag by itself is not that helpful as it is just an indication. The proponent commented that the tolerance value can also be signalled unconditionally.

It was asked if decoder can figure out if it is lossy or lossless compression. One participant commented that the tolerance still can’t guarantee exact match. It was commented by proponent that exact match flag is just a recommendation and does not guarantee exact match. It was commented that tolerance value of 0 can indicate same information as exact match flag.

Decision: agreed (editors to consider renaming exact match flag to another name)

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

Chaired by S. Deshpande on 27 March 2025 at 16:25

Based on a study of the text of the OMI SEI message, a number of small changes are proposed to improve clarity of the design, summarized as follows.

* Item 1: Require non-zero width and height of bounding boxes:

It was commented that for AR SEI regions width and height could be 0 (e.g. for cursors or something similar). It was commented by proponent that this SEI may not be supporting such use cases. It was commented that cursor example may be a bounding box of size 1 instead of zero-sized bounding box.

Decision: Agreed

It was suggested to add an editorial note to AR SEI for zero-size bounding boxes.

* Item 2: Clarify that bounding box parameters are in units of chroma samples:

It is asserted that the mapping process does not use chroma sample units, but ranges of some syntax are considering chroma samples.

It was asked how the software implements this. It was commented that the original design intent was to do this in luma domain.

Instead of making the proposed change, the range values highlighted in cyan could be modified to do things in luma sample value units.

A non-proponent thought doing this in chroma sample units may be better.

Another participant commented that in multiple places in specification we have text defining things in units of luma sample and putting constraints in other places and so it was preferred to do it that way. This was supported by multiple participants. It was commented that AR SEI seems to use a multiplication by SubWidthC and SubHeightC.

An example text from AR SEI was:

The identified object rectangle contains the luma samples with horizontal picture coordinates from SubWidthC \* ( ConfWinLeftOffset  + ar\_bounding\_box\_left[ ar\_object\_idx[ i ] ] ) to SubWidthC \* ( ConfWinLeftOffset  + ar\_bounding\_box\_left[ ar\_object\_idx[ i ] ] + ar\_bounding\_box\_width[ ar\_object\_idx[ i ] ] ) − 1, inclusive, and vertical picture coordinates from SubHeightC \* ( ConfWinTopOffset + ar\_bounding\_box\_top[ ar\_object\_idx[ i ] ] ) to SubHeightC \* ( ConfWinTopOffset + ar\_bounding\_box\_top[ ar\_object\_idx[ i ] ] + ar\_bounding\_box\_height[ ar\_object\_idx[ i ] ] ) − 1, inclusive.

Also VVC cropping window may be doing it similarly.

Virtual boundaries were specified differently for a reason (of being divisible by 8).

Initially there was support to modify the change the cyan highlighted constraints instead to be consistent with using units of luma samples. Additionally add a constraint that relevant bounding box parameters mod width or height is equal to 0.

Subsequent discussion resulted in more support to make this consistent with AR SEI and cropping in VVC.

Decision: Agreed to make the change as proposed, but not to use the words “chroma samples”.

* Item 3: Clarify that the mask mapping process uses luma samples

Decision: Agreed, add word “luma” as proposed.

* Item 4: Require that cropped width and height of the auxiliary pictures be equal to those of the primary picture

About the first proposed constraint: It was asked if the first proposed constraint is too strict. The OMI SEI is associated with primary layer. Multiple auxiliary picture layers correspond to the use case of object overlap. It was agreed instead to add a language to say that the entire OMI SEI should be ignored if any of the auxiliary picture layers that are referred are not present.

About the second proposed constraint: It was asked if the second proposed constraint is too strict. It was asked if it is not sufficient that the mask is smaller the primary picture size. It was agreed to do this by requiring that the mask is within the auxiliary picture size and it can be smaller than primary picture size and exact wording is delegated to the editors.

* Item 5: Allow different luma bit-depths for the primary layer and the object mask auxiliary layers. Change it proposed to VSEI and VVC interface text. It was asked if it is allowed currently to have different bit depths for auxiliary and primary pictures. It was commented that this is only allowed if it is scalably coded. It was commented that currently the VSEI spec text does not explicitly prohibit having different bit depth values. It was suggested to define a higher value range for omi\_mask\_sample\_value\_length\_minus8 instead in VSEI and to specify it to be less than BitDepthY in VVC interface text.

Discussed items 4 and 5 to review the text in v2 of the document on 1 April 2025 at 17:20.

For item 4: Agreed as per v2 with additionally changing “all values of i” to “any value of i”.

For item 5: In previous discussion constraint for item 5 was considered too strict and was relaxed in v2. Also interface variables related changes were made in v2. Agreed as per v2.

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

Chaired by S. Deshpande on 28 March 2025 at 05:00

This contribution proposes the following constraints for the OMI SEI message in VSEIv4.

1. Constrain the i-th auxiliary layer object mask identifiers, omi\_mask\_id[ i ][ j ] and omi\_mask\_id[ i ][ k ], shall be different when j is not equal to k.

There was a discussion regarding usefulness of allowing the repetition of mask id as currently supported in our specification, within the same SEI message. A participant commented that usually ids should be unique. Another participant commented that in the current design id values are unique. A participant commented that repeating an SEI message is ok but repeating same information in one SEI message is not common and not desirable.

Decision: agreed.

1. Add constraint that the value of omi\_num\_mask\_in\_pic[ i ] shall be greater than 0, for at least one value of i, when OMI SEI message is the first OMI SEI message. Such constraint prevents the first OMI SEI message from containing no object mask.

Some possible corner cases which may desire the behavior as per the current specification were discussed. It was commented that the current related constraint which is in the specification was added in the last meeting to do correct initialization of OMI masks. The current design intent is to allow a first OMI SEI with empty masks and this constraint will prevent that. So no action was taken on this item.

1. Add constraint to avoid empty object mask. It requires at least one sample pI[ i ] [ x ][ y ] at location (x, y) in the cropped object mask picture in the i-th auxiliary layer associated with the current primary layer is associated with the object mask with the identifier of MaskId [ i ][ j ]

Multiple participants commented that doing this may be unnecessary and lossy compression or the case where objects may appear and disappear may cause issues if this constraint is imposed. Also checking this constraint may be cumbersome for an encoder. So no action was taken on this item.

### Generative face video SEI messages (3)

Contributions in this area were discussed during 0515–0645 on Friday 28 March 2025 (chaired by J. Boyce).

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

This contribution provides further experiments incorporating SEI messaging into the QP-adaptive GFVC framework (JVET-AK0069) on 256x246 and 512x512 test sequences from Classes A, B, C and D, in accordance with JVET AHG16's feedback. The results on the 256x256 test set in SEI mode reveal that the QP-adaptive GFVC achieves BD-rate reductions of 11.32% in DISTS and 10.3% in LPIPS. Moreover, when evaluated on both the 256×256 and 512×512 test sets, the QP-adaptive GFVC demonstrates BD-rate reductions of 16.57% in DISTS and -1.89% in LPIPS. The results verify the robustness and effectiveness of the QP-adaptive GFVC in enhancing perceptual quality and compression efficiency across different resolutions and compression conditions.

The proposal aims to improve quality. The provided syntax and semantics seem incomplete. A change to the software is proposed.

A question was raised about the experimental results for the 512x512 and how bitrate was reduced given that additional syntax was signalled.

The proposal seems to not fit within our guidelines of changes to be made to VSEI v4 at this meeting.

It was suggested to have side discussion with the original proponents of GFVC.

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

Aspect 1: remove the inference for the syntax elements gfv\_num\_matrices\_equal\_to\_num\_kps\_flag[ i ], gfv\_num\_matrices\_info[ i ], gfv\_matrix\_width\_minus1[ i ], gfv\_matrix\_height\_minus1[ i ] gfv\_num\_matrices\_minus1[ i ] and gfv\_matrix\_for\_3D\_space\_flag[ i ] in case of prediction being enabled.

Aspect 2: modify the inference for the syntax element gfv\_matrix\_for\_3D\_space\_flag[ i ] to align the semantics and simplify the inference for the syntax elements gfv\_matrix\_width\_minus1[ i ] and gfv\_matrix\_height\_minus1[ i ].

Aspect 3: modify the inference condition for the syntax elements gfv\_matrix\_element\_precision\_factor\_minus1 and gfv\_num\_matrix\_types\_minus1 for text cleanup.

Aspect 4: remove redundant process in the derivation of variable numMatrices[ i ].

Aspect 5: remove unnecessary constraint on gfv\_num\_matrix\_types\_minus1

Aspect 6: remove unnecessary constraint on numMatrices[ i ], matrixWidth[ i ] and matrixHeight[ i ].

Aspect 7: add the inference for the syntax elements gfve\_matrix\_element\_precision\_factor\_minus1, gfve\_num\_matrices\_minus1, gfve\_matrix\_height\_minus1[ i ] and gfve\_matrix\_width\_minus1[ i ] which is currently missing from the text.

Aspect 8: change a constraint in VVC spec. to allow signalling multiple GFV and GFVE SEI messages with different content within one picture unit.

Aspect 1, Aspect 2, Aspect 4 agreed. (Editorial)

For aspect 3, the change to semantics of gfv\_matrix\_element\_precision\_factor\_minus1 is agreed, with addition of removing “when gfv\_matrix\_present\_flag is equal to 1”. For the semantics of gfv\_num\_matrix\_types\_minus1, can just say when “gfv\_matrix\_pred\_flag is equal to 1". Aspect 3 agreed with noted changes and editorial cleanup delegated to the editors.

Further discussion requested onaspect 5, aspect 6.

Aspect 7, Aspect 8 agreed.

Further discussed on 1 April 2025.

Regarding aspect 5 and 6, the meaning of the word “each” in the constraint that is being removed was unclear.

Aspects 5 and 6 agreed.

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

This contribution proposes to add a colour calibration process on the generated face pictures as an optional post-processing to solve the occasional colour shift issue observed in some generated pictures by the proponent. Three options are provided in the contribution as follows.

Option 1: add a calibration flag in the GFV SEI message and perform colour calibration on the generated picture based on the distribution parameters derived from the current decoded picture when the calibration flag is on.

Option 2: add a calibration flag in the GFV SEI message and signal the colour distribution parameters when the flag is on, and perform the colour calibration on the generated pictures based on the distribution parameters signalled.

Option 3: add an indication flag in GFV SEI message to indicate whether the current generated picture can be used for the colour calibration of the current generated picture.

This contribution proposes a new feature for quality improvement.

It was questioned if this change could be done in an extension rather than in VSEI v4.

It was suggested to just add a note in the v4 semantics that a decoder may choose to apply colour calibration.

Some sample images for option 1 were provided. Video examples can be provided.

No comparison of the three options was provided.

A suggestion was made to clarify in which colour space the colour calibration should be performed.

Some support was expressed for option 3 with some modifications to the language, because it was the simplest option with least change to the specification. Suggested language to consider: ".. the current decoded picture is suitable for colour correction …"

It was suggested to study calibration using the previous reconstructed or source picture.

See the follow-up discussion in section 4.15.

### Digitally signed content SEI messages (12)

Contributions in this area were discussed during 0645–1030 and 1300–1630 on Friday 28 March 2025 and 1500-1515 on Monday 31 March 2025 (chaired by J. Boyce).

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

The following is proposed related to digital signing:

* Proposal 1: Signalling is proposed to allow digitally signing a SEI message.
* Proposal 2: A syntax rearrangement is proposed for syntax elements in the digitally signed content initialization SEI message.
* Proposal 3: It is proposed to signal a tag URI as an identifier in digitally signed content initialization, digitally signed content selection and digitally signed content verification SEI messages. Alternatively, a modification is proposed to the inference of dscs\_id.

Additional syntax elements would be added to any SEI message that was desired to be signed. It would be possible to add these syntax elements to newly defined SEI messages. For existing SEI messages, it may be possible to include the additional syntax elements in an extension of the SEI message.

It is proposed to apply proposal 1 to the AI usage restrictions SEI message in VSEI v4.

It is proposed to individually sign each SEI message separately from the rest of the bitstream. It was suggested that it would be possible to remove the SEI message and its signature which would not be able to be detected. A signed SEI message could be added to a completely different bitstream but would still appear valid. It would be unclear what VCL that a signed SEI message applied to.

It was suggested that it would be preferable to associate the SEI message signature with the rest of the bitstream.

Further study is encouraged on proposal 1.

Proposal 2 rearranges some syntax elements to group key related syntax elements. Proposal 2 is agreed for VSEI v4, with the change of moving the substream information to the end of message.

Proposal 3 proposes signalling a tag URI to replace or add to the dscs\_id.

The use case proposed for the dscs\_id in JVET-AK0206 differs from than the use case described in this contribution. In this contribution, a use case is described for having multiple parties sign.

It was noted that signalling a tag URI would add significant overhead.

It was suggested that an attacker could rewrite the tag URI.

It was suggested that having the ID just indicates and enables that different, independent signing systems could be in use at the same time, while there is sufficient other information in the DSCI SEI messages to identify the different signers. I.e., the ID was not intended to provide sufficient differentiation information for different signers.

The existing semantics of the DSC IDs could be improved to make the intended purpose more clear. This is delegated to the editors. Perhaps can remove “has been produced by a content provider”.

A change is proposed for inference of DSCS verification substream ID, to be equal to the value of dsci\_id in the preceding DSCI SEI message, rather than to be equal to 0. JVET-AL0118 also has a related proposal.

It was suggested that if multiple different DSCI SEI messages with different values of DSCI ID are present, the the inference value of DSCS ID will be equal to the DSCI ID of the the DSCI SEI message that is being processed.

Further discussion requested after after side activity led by Y.-K. Wang on inference of DSCS ID.

See the notes on JVET-AL0327.

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

The changes are summarized as follows:

1. Include the three DSC SEI messages in one umbrella subclause, just like the two NNPF SEI messages, or the SPO and PON SEI messages.the definitions of verification period, verification NAL unit, and verification substream, and use them throughout the semantics of the three SEI messages.
2. Various other asserted editorial changes.

The detailed proposed text changes, marked relative to JVET-AK2005-v1, are included in an attachment to this contribution.

In -v2 of this contribution, the spec text changes have been updated, revoking the removal of the two constraints on relative order, between DSCI and DSCV SEI messages in an AU, and between DSCS and a DSCV SEI messages in a PU, and editorially modifying the reinstated constraints. It was later realized that although the constraints are not needed for VVC and HEVC, wherein the DSCV SEI message is specified to be contained in suffix SEI NAL units, but they are still needed for standards such as AVC wherein there is no specification of suffix SEI NAL units.

Proposal 1 editorial change to put all three DSC SEI messages in one umbrella subclause is agreed for VSEI v4.

Proposal 2 provides definitions of key terms.

Support expressed for having definitions, but the name of the verification NAL unit is suggested to be changed to verification inclusion NAL unit.

It was noted that the DSCI SEI message does not need to be changed if sub-bitstream extraction is performed because it can describe more than what is contained in the bitstream – DSCI describes a maximum number of substreams.

A -v3 to be uploaded, which is expected to include only editorial changes.

The -v3 version was agreed (editorial).

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

It is asserted that the substream dependency signalling in the DSCI SEI message though the two loops of the reference substream flag syntax element has redundancy. For example, if substream ss2 depends on substream ss1, and substream ss3 depends on ss2, then it is known that ss3 depends on ss1 and thus that dependency does not need to be signalled but can be inferred.

This contribution proposes a change to the DSCI SEI message syntax to avoid such redundancy, through a derived variable flag to condition the presence of the reference substream flag syntax element.

The detailed proposed text changes are provided in an attachment to this contribution. The changes are marked relative to the spec text provided in JVET-AL0103, which includes asserted purely editorial changes to the DSC SEI messages based on JVET-AK2006-v1.

The goal of the proposal is to save bits. No data is provided on the amount of bitrate savings.

It was suggested that the proposed change would require more analysis of dependencies to parse the SEI message.

In was suggested that in HLS designs we often try to avoid signalling redundancies.

No action was taken on this.

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

Currently, the content UUID is required to be present when there is at least one independent non-base layer (INBL). The motivation can be seen from the JVET-AK meeting minutes for JVET-AK0287: "*For independent non-base layer, uuid is required to be included for verification to avoid tampering.*" However, if an INBL is depended by a higher layer, then tempering of the INBL can be detected. Therefore, it is asserted that dependency by higher layers should also be taken into consideration on requiring the presence of content UUID.

This contribution proposes such changes to the DSCI SEI message semantics.

The changes are summarized as follows:

1. Replace the variable IndependentNonBaseSubstreams with NumFullyIndependentSubstreams, which is derived to be equal to the number of substreams that do not depend on other substreams and are not depended by other substreams.
2. When dsci\_key\_retrieval\_mode\_idc is equal to 0 or NumFullyIndependentSubstreams is greater than 0, dsci\_content\_uuid\_present\_flag shall be equal to 1.

The detailed proposed text changes are provided in an attachment to this contribution. The changes are marked relative to the spec text provided in JVET-AL0103, which includes asserted purely editorial changes to the DSC SEI messages based on JVET-AK2006-v1.

A fully independent substream does not have any other substreams that depend on it, in addition to not depending on another substream.

It was suggested that the original design intent for requiring the UUID for independent non-base layers was to avoid tampering.

The proposal relaxes the requirements for presence of UUID so that it doesn’t apply in as many cases as the existing design.

No action was taken on this.

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

Currently, relevant NAL units are associated to a verification substream either explicitly by signalling the verification substream ID in a DSCS SEI message present in a PU, or implicitly by inferring the verification substream ID equal to 0. Therefore, for bitstream with multiple layers and/or multiple temporal sublayers where each operation point corresponds to one verification substream, for each PU in a non-base layer or non-base sublayer, a DSCS SEI message needs to be included in the PU. However, when each operation point corresponds to one verification substream, which is asserted to be a typical case, the verification substream ID values can be inferred thus avoid sending lots of DSCS SEI messages.

This contribution proposes changes that supports such an implicit association of relevant NAL units to verification substreams.changes are summarized as follows:

1. Add three interface variables (LayerId, SubLrId, and MaxNumSubLrs), in both the SEI message semantics and the VVC interface text, for layer ID, sublayer ID, and the maximum number of sublayers.
2. Add a flag dsci\_vss\_implicit\_association\_mode\_flag to the DSCI SEI message to indicate whether the inference of verification substream ID is according to the values of MaxNumSubLrs, LayerId, and SubLrId, or is simply inferred to be equal to 0.
3. In the DSCS SEI message semantics, specify that, if dsci\_vss\_implicit\_association\_mode\_flag is equal to 1, the verification substream ID value is inferred to be equal to MaxNumSubLrs \* LayerId + SubLrId, and otherwise inferred to be equal to 0.

The detailed proposed text changes to VSEI and to VVC are separately provided in two attachments to this contribution. The VSEI changes are marked relative to the spec text provided in JVET-AL0103, which includes asserted purely editorial changes to the DSC SEI messages based on JVET-AK2006-v1. The VVC changes are marked relative to JVET-AK2005-v2.

Interface text for AVC is not provided, and will likely require some changes vs. the VVC interface.

It is noted that the temporal ID of non-VCL NAL units may not be known until VCL NAL units are available, so may require a change in decoder operation.

A single flag is added to the syntax, and additional changes to the inference semantics of the DSCS SEI.

This approach could not easily be added later as an extension.

The proposal has bitrate savings for every PU when multiple substreams are present, which may be substantial.

Decision: Adopt to VSEI v4

Text provided in -v2 version reviewed on 1 April 2025 and was agreed.

It was noted that the number of substreams is coded in DSCI SEI is restricted to be less than or equal to 255, and may want to check if a constraint is needed on the derived substream ID when the DSCS SEI is not present. Further study encouraged on this issue.

[JVET-AL0118](https://jvet-experts.org/doc_end_user/current_document.php?id=15444) AHG9: Miscellaneous changes for the three DSC SEI messages [Y.-K. Wang, J. Xu (Bytedance), Y. Li, K. Yang, Y. Xu (SJTU)]

This contribution proposes the following changes for three digitally signed content (DSC) SEI messages, namely the digitally signed content initialization (DSCI) SEI message, the digitally signed content selection (DSCS) SEI message, and the digitally signed content verification (DSCV) SEI message:

1. Add definitions of GDR picture and GDR AU, update the definition of IRAP AU accordingly, and change the constraint on presence of DSCI SEI messages to be: When a DSCI SEI message with a particular dsci\_id value dscIdVal is present in any AU of a CVS, a DSCI SEI message with dsci\_id equal to dscIdVal shall be present in each IRAP or GDR AU in the CVS.
2. Replace the asserted unclear constraint on content of DSCI or DSCV SEI messages with the following: All DSCV SEI messages having a particular value of dscv\_id and a particular value of dscv\_vss\_id in a verification period for dsci\_id equal to the particular value of dscv\_id shall have the same content.
3. Add the DSC ID aspect to the constraint on presence of DSCS SEI messages so that it becomes the following: When a CVS does not contain a DSCI SEI message with a particular dsci\_id value dscIdVal, the CVS shall not contain a DSCS SEI message with dscs\_id equal to dscIdVal.
4. Infer the value of dscs\_id to be equal to the dsci\_id of the associated DSCI SEI message (instead of to be equal to 0) when a DSCS SEI message is not present in a PU.
5. Add the following constraint on relative order between DSCS and DSCV SEI messages in an AU: When an AU contains a DSCS SEI message with dscs\_id equal to dscIdA and dscs\_vss\_id equal to vssIdA and a DSCV SEI message with dscv\_id equal to dscIdA and dscv\_vss\_id equal to vssIdA, the DSCS SEI message shall precede the DSCV SEI message in decoding order.
6. Change the constraint on absence of relevant verification NAL units after the current DSCV SEI message to be after the current PU, such that the constraint becomes the following: Within the current verification period, there shall be no verification NAL unit of the verification substream with verification substream ID equal to dscv\_vss\_id succeeding the current PU in decoding order.
7. Change the derivation of reference digests for fixing two asserted bugs.
8. Clarify that all concatenation operations of verification NAL units and, when needed, reference digests, for obtaining a message used for calculating the message digest, or for constructing the identification string for a verification substream, are performed in decoding order for verification NAL units and in increasing order of refIdx for reference digests.

The discussions and the detailed proposed changes are based on the spec text provided in JVET-AL0103, which includes asserted purely editorial changes to the DSC SEI messages based on JVET-AK2006-v1.

In -v2 of this contribution, for item 7 a different proposed change was included for fixing the two asserted bugs.

Proposal 1 agreed, with the wording of the definition of IRAP is suggested to be changed to replace “and” with “such that when”. The exact language is delegated to the editors.

Proposal 2 identifies an unclear constraint on content of DSCI or DSCV SEI messages. Related proposals in JVET-AL0222 and JVET-AL0131 identify the same problem but propose a different spec change to address.

Agreed to remove the constraint.

Proposal 3 agreed.

Proposal 4 is related to side activity.

Proposal 5 agreed.

Proposal 6 is already covered in JVET-AL0103-v3.

For proposal 7, it is suggested that some constraint may be needed, and to possibly add language “in the current verification period” in the determination of the reference digest.

Further discussion requested on proposal 7.

Proposal 8 agreed.

Decision: adopt to VSEI v4 as noted above.

Proposal 7 further discussed 1630 on Tuesday 1 April 2025.

Decision: Adopt proposal 7.

[JVET-AL0119](https://jvet-experts.org/doc_end_user/current_document.php?id=15443) AHG9: Support of low-delay DSC verification process [Y.-K. Wang, J. Xu (Bytedance), Y. Li, K. Yang, Y. Xu (SJTU)]

Currently, within a verification period (the period between two consecutive DSCI SEI messages), it is not allowed to have multiple DSCV SEI messages for a particular substream while between some of these DSCV SEI messages there are verification NAL units for the verification substream. It is asserted that this results in a delay issue, as the verification of any substream can only be performed at the end of a verification period.

This contribution proposes changes to allow verifying a subset of a substream while the verification NAL units are being received, before the reception of the entire substream.

The changes are summarized as follows:

1. Within a verification period, it is allowed to have multiple DSCV SEI messages for a particular substream while between two consecutive DSCV SEI messages there are verification NAL units for the verification substream.
2. It is specified that dscv\_signature contains the digital signature for the current verification substream subset, which consists of only those verification NAL units for the verification substream present in the current PU or in PUs earlier in decoding order in the current verification period, and the derivation of the current and reference digests is updated accordingly.

The detailed proposed text changes to VSEI are provided in an attachment to this contribution. The VSEI changes are marked relative to the spec text provided in JVET-AL0103 plus the asserted bug fix proposed in JVET-AL0118 item 7. The spec text provided in JVET-AL0103 includes asserted purely editorial changes to the DSC SEI messages based on JVET-AK2006-v1.

In -v2 of this contribution, the basis text for detailed proposed text changes to VSEI has been updated for using the updated asserted bug fix for JVET-AL0118 item 7 in JVET-AL0118-v2. The actual changes proposed in the contribution itself have not been changed.

The proposal allows to send multiple DCSV SEI messages for a substream for the same DSCI SEI, without requiring repeating of the DSCI SEI.

It was noted that the existing design has alignment of verification of all substreams when a new DSCI is present, and was suggested that this proposal does not require alignment of verification of all substreams.

It was suggested to do a comparison of tradeoffs between shortening the verification period using the existing design vs. the proposed design with multiple DSCV SEI messages in a verification period, including understanding the practical amount of delay needed and understanding the implementation burden. It was suggested that sub 1 second delay may not be required.

It is noted that the DSCV SEI message is large compared to the DSCI SEI message.

No action was taken on this.

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

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

See the notes on JVET-AL0118 for aspect 1.

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

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

This contribution proposes several editorial modifications for VSEI v4 draft. The proposed modifications are as follows:

(Related to DSC SEI messages)

1. Clarify the semantics related to IDs

See the notes on JVET-AL0103 for aspect 1.

[JVET-AL0186](https://jvet-experts.org/doc_end_user/current_document.php?id=15511) AHG9: Subpicture support for digitally signed content SEI messages [M. Pettersson, R. Sjöberg, M. Damghanian (Ericsson)]

This contribution proposes changes to the digitally signed content SEI messages to support content verification of extracted coded picture segments, where a picture segment is a subpicture for VVC.

It is asserted by the proponents that although the solution of the digitally signed content SEI messages supports verification of the digital signature when pictures in higher temporal sublayers or layers are pruned from the bitstream, the current solution does not support verification of the digital signature for extracted subpictures.

An additional mode is proposed to be added, and three different options are presented:

1. When the proposed mode is enabled, a picture segment ID is added to the digitally signed content selection SEI message that indicates which coded picture segments to associate with the verification substream.
2. When the proposed mode is enabled, a flag for each VCL NAL unit in the PU is signalled in the digitally signed content selection SEI message. The flag indicates whether or not the corresponding VCL NAL unit is included in the verification substream.
3. When the proposed mode is enabled, the content selection SEI message indicates that the first PH, APS, or VCL NAL unit that follows the SEI message in decoding order is included in the verification substream.

For all options above, the proposed mode may be enabled for VVC if sps\_subpic\_info\_present\_flag is equal to 1 but is always disabled for AVC and HEVC.

In all of the options, SPS and PPS are not associated with any verification substream when the proposed mode is enabled, since it is asserted that SPS and PPS need to be rewritten when extracting coded subpictures from a bitstream.

It was questioned if use of the scalable nesting or regional nesting SEI messages could address the use case.

It was suggested that if all coded subpictures are available at the decoder, signatures for the full coded pictures can be used to verify the subpictures. However, if sub-bitstream extraction is performed prior to transmission of the bitstream by the decoder, it may be desirable to separately verify the subpictures.

Option 1 proposes excluding the SPS and PPS from the ref digest calculation, to handle rewriting. It was questioned if that would impact tamper resistance.

The proposed Option 2 DSCS SEI message has a parsing dependency on the DSCI SEI message

Option 3 proposes adding a DSCS SEI for each NAL unit, which has more overhead.

Some concern was expressed about including in VSEI v4.

It was suggested that region based verification may be of interest beyond sub-bitstream extraction. It might be interesting to sign groups of subpictures.

The proposal is written for VSEI v4 and not as an extension.

Decision: Add to the TuC including all options, but based on a JVET-AL2006 document as the base text.

[JVET-AL0222](https://jvet-experts.org/doc_end_user/current_document.php?id=15549) AHG9: On Digitally Signed Content SEI messages [K. Sühring, T. Hinz, Y. Sanchez, J. Pfaff, H. Schwarz, D. Marpe, T. Wiegand (Fraunhofer HHI)]

This contribution proposes to add two new flags to the digitally signed content SEI messages indicating the first and last signed segment. This allows to intentionally interrupt the signature chaining between CVSs, e.g. to allow splicing. Signalling the last signed segment also allows detection of removed access units at the end of the signed content.

The contribution also proposes a modification of the AVC interface text for improved multi-layer support.

In v2 a third aspect is added proposing a fix for a bitstream constrain on digitally signed content verification SEI.

Proposal 1 agreed.

Slides are presented and not available yet. Will be uploaded in a new version.

Regarding proposal 2, the existing design is able to detect manipulation (added or removed pictures) at the beginning or middle of a CVS but cannot detect removal of pictures at the end of the CVS. The proposal also addresses splicing and ad insertion.

Proposal 2 adds a flag to the DSCI SEI and a flag to the DSCV SEI. It also proposed including the signing status in the IdString used to calculate the reference digest.

It was suggested that Note 1 may also need updating.

It was suggested to improve the semantics for dscv\_signed\_content\_end\_flag. This is delegated to the editors.

For proposal 3, see the notes for JVET-AL0118.

Decision: Adopt Proposals 1 and 2 to VSEI v4.

[JVET-AL0327](https://jvet-experts.org/doc_end_user/current_document.php?id=15654) AHG9: Handling of multiple DSC systems [Y.-K. Wang (Bytedance), S. Deshpande (Sharp), H. Tan (LGE), K. Sühring (Fraunhofer HHI)]

This contribution proposes changes to address handling of multiple DSC systems, each identified by a particular value of dsci\_id, in particular, on the inference of the value of dscs\_id. The inference of the value of dscs\_id is a follow-up of the related proposal aspects in JVET-AL0078 and JVET-AL0118.

The detailed proposed text changes to VSEI are provided in an attachment to this contribution. The VSEI changes are marked relative to the spec text provided in JVET-AL0103-v3.

Decision: Adopt.

### Packed regions information SEI message *(*8+2)

Contributions in this area were discussed during 1630–1730 on Friday 28 March 2025 and 1300-1500 on Monday 31 March 2025 (chaired by J. Boyce) .

[JVET-AL0070](https://jvet-experts.org/doc_end_user/current_document.php?id=15376) AHG9: On packed regions information SEI message [T. Chujoh, Z. Fan, R. Ishimoto, T. Ikai (Sharp)]

1. The loop's variable i has been started from 1. An index equal to 0 is not used.
2. The syntax element pri\_resampling\_ratio\_idx[ i ] in the array is misspelled.
3. In the syntax table of pri\_multilayer\_flag, pri\_region\_layer\_id[ i ] and pri\_region\_is\_a\_layer\_flag[ i ] are related. But, in the semantics of pri\_multilayer\_flag, pri\_region\_is\_a\_layer\_flag is not described.
4. When pri\_num\_resampling\_ratios\_minus1 equals 0, the syntax element pri\_resampling\_ratio\_idx[ i ] does not exist; however, the inferred value is not defined.
5. When pri\_target\_pic\_params\_present\_flag equals 0, the syntax elements pri\_target\_pic\_width\_minus1 and pri\_target\_pic\_height\_minus1 do not exist; however, the inferred values are not defined.
6. When pri\_targe\_pic\_params\_present\_flag equals 0, the syntax elements pri\_target\_region\_top\_left\_x[i] and pri\_target\_region\_top\_left\_y[i] do not exist. However, the target picture cannot be reconstructed without those syntax elements.
7. The regions in the input picture are packed, not overlapped. It is believed that the target regions should be defined.
8. The values of pri\_target\_pic\_width\_minus1 and pri\_target\_pic\_height\_minus1 should be constrained depending on the chroma format.
9. Depending on the chroma format, the values of the top-left sample position, the width, and the height of the rectangle regions should be constrained. However, those specifications are incomplete.
10. When pri\_multilayer\_flag equals 1, multiple layers exist. However, the basic semantics of PRI SEI seem to consider a single layer.

Regarding Item 1, the loop index is intentionally started from 1 with values for index 0 inferred.

JVET-AL0129 is also related. Further discussion after JVET-AL0129 is reviewed.

Item 2 agreed.

Item 3 agreed. JVET-AL0132 Item 2 also proposes.

Regarding Item 4, it was questioned if inference is needed, because the syntax element is not used. JVET-AL0122 Item 2 also proposes. Further discussion after checking if an inference value is needed.

Regarding Items 5 and 6, it was suggested that it isn’t always necessary to reconstruct a target picture, in which case reconstruction of the target picture isn’t needed. No action on items 5 and 6.

Item 7 is related to JVET-AL0129 item 3 and JVET-AL0122 Item 11. A bug has been identified in that the position in the target picture rather than the coded picture should be used. Should look at all proposals to select how to fix. Further discussion.

Item 8 is related to JVET-AL0122 item 10 and JVET-AL0098 item 4. If no action is taken there, this item should be agreed. Further discussion.

Item 9 proposes 3 solution options to enforcing chroma alignment. JVET-AL0122 item 7 relates to the second part of solution 1. JVET-AL0129 item 11 is related to the first part of solution 1.

Y.-K. Wang to provide a summary of related PRI proposals to make it easier to compare the alternative related proposals.

[JVET-AL0072](https://jvet-experts.org/doc_end_user/current_document.php?id=15378) AHG9: On PRI SEI message [Y. He, M. Karczewicz (Qualcomm)]

See the notes on JVET-AL0324.

[JVET-AL0098](https://jvet-experts.org/doc_end_user/current_document.php?id=15423) AHG9: On target picture in packed regions information SEI message [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

See the notes on JVET-AL0324.

[JVET-AL0120](https://jvet-experts.org/doc_end_user/current_document.php?id=15445) AHG9: On the packed regions information SEI message - part 1 [Y.-K. Wang, J. Xu (Bytedance)]

See the notes on JVET-AL0324.

[JVET-AL0122](https://jvet-experts.org/doc_end_user/current_document.php?id=15447) AHG9: On the packed regions information (PRI) SEI message - part 2 [J. Xu, Y.-K. Wang (Bytedance)]

See the notes on JVET-AL0324.

[JVET-AL0129](https://jvet-experts.org/doc_end_user/current_document.php?id=15454) AHG9: On signalling of regions in PRI SEI message [J. Lee, H. Tan, J. Nam, C. Kim, J. Lim, S. Kim (LGE)]

See the notes on JVET-AL0324.

[JVET-AL0131](https://jvet-experts.org/doc_end_user/current_document.php?id=15456) AHG9: Proposed changes for miscellaneous aspects of SEIs in VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*Aspects on PRI – JVET-AL0131 also relates to the digitally signed content and AI usage restrictions SEI messages*

See the notes on JVET-AL0324.

[JVET-AL0132](https://jvet-experts.org/doc_end_user/current_document.php?id=15457) AHG9: Editorial updates for VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*Aspects on PRI – JVET-AL0132 also relates to the digitally signed content and image format metadata SEI messages*

See the notes on JVET-AL0324.

[JVET-AL0303](https://jvet-experts.org/doc_end_user/current_document.php?id=15630) AHG9: Editorial fixes to the packed regions information SEI message [F. Urban, E. François, D. Doyen, C.-H. Demarty (InterDigital)] [late]

See the notes on JVET-AL0324.

[JVET-AL0324](https://jvet-experts.org/doc_end_user/current_document.php?id=15651) AHG9: A summary of proposals on the PRI SEI message [Y.-K. Wang (Bytedance)]

1. On the PRI SEI message being a layer-specific or cross-layer SEI message
   1. Since the persistence is currently specified in a layer-specific manner, remove pri\_multilayer\_flag, pri\_region\_layer\_id[ i ], and pri\_region\_is\_a\_layer\_flag[ i ] to make the entire design layer-specific. (JVET-AL0070 item 10)
   2. 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)
   3. Specify the persistence of the PRI SEI message in a cross-layer manner. (JVET-AL0120 item 3, JVET-AL0303 item 2)
   4. Make the interface variables for chroma format, luma bit depth and chroma bit depth layer specific (JVET-AL0122 item 9, JVET-AL0303 item 5)

An alternative to d would be to constrain that they were all equal.

Adopt Item 1 b and c. Add the constraint that chroma format, luma bit depth and chroma bit depth layer are all equal.

1. Change pri\_num\_resampling\_ratios\_minus1 to pri\_num\_resampling\_ratios. (JVET-AL0129 item 8)

No action was taken on this.

1. Change "i = 1" below to "i = 0": (JVET-AL0070 item 1)

No action was taken on this.

1. Modify the derivation process of resampling ratios to cover ratio=1 cases

No action was taken on this.

1. Specify the value range for pri\_num\_resampling\_ratios\_minus1 to be in the range of 0 to pri\_num\_regions\_minus1, inclusive. (JVET-AL0120 item 5)

Adopt item 5.

1. (In JVET-AL\_notes\_d3: Further discussion requesed after checking if an inference value is needed) Add the following inference: When not present, the value of pri\_resampling\_ratio\_idx[ i ] is inferred to be equal to 0. (JVET-AL0070 item 4 and JVET-AL0122 item 2)

Adopt Item 6.

1. Require uniqueness of resampling ratios by adding the following constraint: (JVET-AL0131 item 4)

For any two different integer values of m and n in the range of 1 to pri\_num\_resampling\_ratios\_minus1, inclusive, when value of ( pri\_resampling\_width\_num\_minus1[ m ] + 1 ) \* ( pri\_resampling\_width\_denom\_minus1[ n ] + 1 ) is equal to ( pri\_resampling\_width\_num\_minus1[ n ] + 1 ) \* ( pri\_resampling\_width\_denom\_minus1[ m ] + 1 ), the value of ( pri\_resampling\_height\_num\_minus1[ m ] + 1 ) \* ( pri\_resampling\_height\_denom\_minus1[ n ] + 1 )  
and ( pri\_resampling\_height\_num\_minus1[ n ] + 1 ) \* ( pri\_resampling\_height\_denom\_minus1[ m ] + 1 ) shall not be the same.

No action was taken on this.

1. Require uniqueness of region IDs: pri\_region\_id[ i ] shall not equal to pri\_region\_id[ j ] when i is not equal to j. (JVET-AL0072 item 1, JVET-AL0129 item 4, JVET-AL0122 item 3)

Adopt item 8.

1. On the value range for pri\_region\_id[ i ]
2. In VSEI, specify the value range for pri\_region\_id[ i ] to be in the range of 0 to 2 047, inclusive. (JVET-AL0120 item 10)
3. Specify the value range for pri\_region\_id[ i ] to be in the range of 0 to 127, inclusive. (JVET-AL0129 item 2)

Adopt a value range limit of 1023.

1. Disallow out-of-cropped-decoded-picture boundary regions.
   1. By adding the following constraints: (JVET-AL0072 item 2)

priRegionTopLeftX[ i ] + priRegionWidth[ i ] shall be less than or equal to MaxPicWidth, and priRegionTopLeftY[ i ] + priRegionHeight[ i ] shall be less than or equal to MaxPicHeight.

* 1. By adding the following constraints: (JVET-AL0122 item 5)

The sum of priRegionTopLeftX[ i ] and priRegionWidth[ i ] shall be less than or equal to PicWidthInLumaSamples[ pri\_region\_layer\_id[ i ] ] and the sum of priRegionTopLeftY[ i ] and priRegionHeight[ i ] shall be less than or equal to PicHeightInLumaSamples[ pri\_region\_layer\_id[ i ] ].

Adopt item 10 option b.

1. Add a note to describe that when target picture is not present, the resampled regions in the current PRI SEI message are unsuitable for human viewing. (JVET-AL0098 item 1)

No action was taken on this.

1. Add an update mechanism for target pic size and region position and size, by adding two flags, pri\_target\_pic\_size\_update\_flag and pri\_region\_param\_update\_flag[ i ]. pri\_target\_pic\_size\_update\_flag specifies that pri\_target\_pic\_width\_minus1 and pri\_target\_pic\_height\_minus1 syntax elements are present or not. pri\_region\_param\_update\_flag[ i ] specifies that pri\_region\_top\_left\_in\_units\_x[ i ], pri\_region\_top\_left\_in\_units\_y[ i ], pri\_region\_width\_in\_units\_minus1[ i ], and pri\_region\_height\_in\_units\_minus1[ i ] syntax elements are present or not. (JVET-AL0098 item 2)

Proposes a partial update mechanism for coding efficiency, which adds dependency on previously signalled SEI messages.

No action was taken on this.

1. Enable signalling of target region position when pri\_target\_pic\_params\_present\_flag is 0, by adding a flag pri\_target\_region\_pos\_present\_flag to specify that pri\_target\_region\_top\_left\_x[ i ] and pri\_target\_region\_top\_left\_y[ i ] syntax elements are present or not. (JVET-AL0098 item 3)

No action was taken on this.

1. Add derivation of the region parameters for the i-th region when pri\_region\_is\_a\_layer\_flag[ i ] is equal to 1. (JVET-AL0120 item 2, JVET-AL0303 item 4)

Adopt item 14.

1. Change pri\_num\_regions\_minus1 to pri\_num\_regions\_minus2. (JVET-AL0131 item 7)

This disallows having a single region.

No action was taken on this.

1. Specify the value range for pri\_num\_regions\_minus1 to be in the range of:
2. 0 to 1 023, inclusive. (JVET-AL0120 item 4)
3. 0 to 127, inclusive. (JVET-AL0129 item 1)

Agreed to add a value range of 0 to 255.

1. On coding and value range of pri\_region\_layer\_id[ i ]
   1. In VSEI, specify the value range for pri\_region\_layer\_id[ i ] to be in the range of 0 to 2 047, inclusive, and in VVC interface text, specify the value range to be in the range of 0 to 63, inclusive, in general, and be in the range of 0 to 55, inclusive, in bitstreams conforming to this VVC version. (JVET-AL0120 item 6)
   2. Change the descriptor of pri\_region\_layer\_id[ i ] from ue(v) to u(6). (JVET-AL0129 item 6)

It was suggested that treatment of layer ID should be consistent for messages defined in VSEI v4 and the TuC.

It was agreed to adopt item 17 option a.

1. When the syntax element pri\_region\_layer\_id[ i ] is not present, inferred the value to be equal to the layer identifier of the PU containing the PRI SEI message. (JVET-AL0120 item 7)

Adopt item 18.

1. Signal pri\_region\_is\_a\_layer\_flag[ i ] regardless of whether pri\_multilayer\_flag is equal to 0. (JVET-AL0129 item 7)

The proposal would reduce bitrate for a use case with only a single region in a single layer. It was suggested that the same goal could be accomplished with setting the pri\_multilayer\_flag to 1 even for a single layer.

No action was taken on this.

1. Specify the value range for pri\_rsampling\_ratio\_idx[ i ] to in the range of 0 to pri\_num\_resampling\_ratios\_minus1, inclusive. (JVET-AL0120 item 8)

Already addressed in the last version of the spec.

1. Specify a range for the resampling ratio, as follows: (JVET-AL0122 item 1)

( pri\_resampling\_width\_num\_minus1[ i ] + 1 ) ÷ ( pri\_resampling\_width\_denom\_minus1[ i ] + 1 ) shall be in the range of 1 ÷ 16 to 16, inclusive.

( pri\_resampling\_height\_num\_minus1[ i ] + 1 ) ÷ ( pri\_resampling\_height\_denom\_minus1[ i ] + 1 ) shall be in the range of 1 ÷ 16 to 16, inclusive.

The proposed range is consistent with VVC RPR resampling ratios. It was suggested to impose the constraint only when target picture parameters are present.

Adopt item 21 with a modification that it is imposed only when pri\_target\_pic\_params\_present\_flag equal to 1.

1. Disallow overlapping regions in cropped decoded pictures by adding the following constraint: (JVET-AL0122 item 4)

It is a requirement of bitstream conformance that any sample (x, y) in the cropped decoded picture of a specific layer belongs to at most one region.

It was suggested that this is contrary to the original design intention.

No action was taken on this.

1. Clarify the unit and coding length of pri\_target\_region\_top\_left\_x and pri\_target\_region\_top\_left\_y by making the following changes: (JVET-AL0122 item 6), as follows:

**pri\_target\_region\_top\_left\_x**[ i ] and **pri\_target\_region\_top\_left\_y**[ i ], when present, indicate the horizontal and vertical positions, respectively, of the top left sample position in units of the i-th region in the reconstructed target picture. The length, in bits, of the syntax elements are pri\_region\_size\_len\_minus1 + 1.

(This replaces “luma samples” with “units”, and adding the second sentence)

Adopt item 23. The editors can also consider if the syntax element should be renamed.

1. Disallow (re)constructed target picture samples out of the target picture.
2. By adding the following constraint: (JVET-AL0072 item 3)

pri\_target\_region\_top\_left\_x[ i ] shall be in the range of 0 to pri\_target\_pic\_width\_minus1, inclusive. pri\_target\_region\_top\_left\_y[ i ] shall be in the range of 0 to pri\_target\_pic\_height\_minus1, inclusive.

1. By adding the following constraint: (JVET-AL0122 item 8)

When pri\_target\_pic\_params\_present\_flag is equal to 1, the sum of ( pri\_target\_region\_top\_left\_x[ i ] \* priUnitSize ) and priTargetRegionWidth[ i ] shall be less than or equal to ( pri\_target\_pic\_width\_minus1 + 1 ), and the sum of ( pri\_target\_region\_top\_left\_y[ i ] \* priUnitSize ) and priTargetRegionHeight[ i ] shall be less than or equal to ( pri\_target\_pic\_height\_minus1 + 1 ).

1. By adding the following constraint: (JVET-AL0129 item 12)

pri\_target\_region\_top\_left\_x[ i ] + priTargetRegionWidth[ i ] and pri\_target\_region\_top\_left\_y[ i ] + priTargetRegionHeight[ i ] shall be less than or equal to pri\_target\_pic\_width\_minus1 + 1 and pri\_target\_pic\_height\_minus1 + 1, respectively

Options b and c are similar.

Adopt Item 24 option b.

1. Move pri\_region\_id\_present\_flag to include it only when target picture parameters are present. It is asserted that when target picture isn’t reconstructed, there is no need to signal the pri\_region\_id[ i ] syntax element. (JVET-AL0129 item 5)

No action was taken on this.

1. (No action in JVET-AL\_notes\_d3) Add the following inference: When not present, the values of pri\_target\_pic\_width\_minus1 and pri\_target\_pic\_height\_minus1 are inferred to be equal to MaxPicWidth − 1 and MaxPicHeight − 1, respectively. (JVET-AL0070 item 5)
2. (No action in JVET-AL\_notes\_d3) Un-condition target picture position signalling. (JVET-AL0070 item 6)
3. Add the following constraint to ensure that an entire target region is not covered by another target region: (JVET-AL0131 item 5)

No action was taken on this.

1. Signal chroma format and bit depth for the target picture. (JVET-AL0098 item 4 and JVET-AL0122 item 10)
2. As follows: (JVET-AL0098 item 4)
3. As follows: (JVET-AL0122 item 10)

No action was taken on this.

1. (In JVET-AL\_notes\_d3: Further discussion requested: If no action is taken on JVET-AL0098 item 4 and JVET-AL0122 item 10, this item should be agreed.) Add the following constraint: ( pri\_target\_pic\_width\_minus1 + 1 ) % SubWidthC shall be equal to 0 and ( pri\_target\_pic\_height\_minus1 + 1 ) % SubHeightC shall be equal to 0. (JVET-AL0070 item 8)

Adopt item 30.

1. On signalling of region parameters in a chroma-aligned manner
2. Add one of the following two constraints:
   * 1. priRegionTopLeftX[ i ] % SubWidthC shall be equal to 0 and priRegionTopLeftY[ i ] % SubHeightC shall be equal to 0. (JVET-AL0070 item 9 solution 1 part 1)
     2. priRegionTopLeftX[ i ] % SubWidthC[ pri\_region\_layer\_id[ i ] ] shall be equal to 0 and priRegionTopLeftY[ i ] % SubHeightC[ pri\_region\_layer\_id[ i ] ] shall be equal to 0, where SubWidthC[ pri\_region\_layer\_id[ i ] ] and SubHeightC[ pri\_region\_layer\_id[ i ] ] are set equal to SubWidthC and SubHeightC, respectively, when ChromaFormatIdc is equal to ChromaFormatIdc[ pri\_region\_layer\_id[ i ] ]. (JVET-AL0098 item 4)
     3. priRegionTopLeftX[ i ] % SubWidthC[ lId ] shall be equal to 0 and priRegionTopLeftY[ i ] % SubHeightC[ lId ] shall be equal to 0. (JVET-AL0129 item 11)

All 3 items are essentially the same, but editorially different.

Adopt item 31 a option i.

1. Add one of the following two constraints:
   * 1. pri\_target\_region\_top\_left\_x[ i ] % SubWidthC shall be equal to 0 and pri\_target\_region\_top\_left\_x[ i ] % SubHeightC shall be equal to 0. (JVET-AL0070 item 9 solution 1 part 2)
     2. priTargetRegionTopLeftX[ i ] % TargetSubWidthC shall be equal to 0 and priTargetRegionTopLeft[ i ] % TargetSubHeightC shall be equal to 0, where TargetSubWidthC and TargetSubHeightC are set equal to SubWidthC and SubHeightC, respectively, when ChromaFormatIdc is equal to pri\_target\_pic\_chroma\_format\_idc, priTargetRegionTopLeftX[ i ] is equal to ( pri\_target\_region\_top\_left\_x[ i ] + 1 ) \* priUnitSize, and priTargetRegionTopLeftY[ i ] is equal to ( pri\_target\_region\_top\_left\_y[ i ] + 1) \* priUnitSize. (JVET-AL0098 item 4)
     3. ( pri\_target\_region\_top\_left\_x[ i ] \* priUnitSize % SubWidthC ) and ( pri\_target\_region\_top\_left\_y[ i ] \* priUnitSize % SubHeightC ) shall be eqaul to 0. (JVET-AL0122 item 7)

All 3 items are essentially the same, but editorially different.

Adopt item 31 b option iii.

1. If no to a and b above, do either of the following:
   * 1. Related variables for region parameters are translated by using SubWidthC and SubHeightC. (JVET-AL0070 item 9 solution 2)
     2. Use the mechanism as the annotated regions SEI message and the object mask information SEI message for signalling of region parameters. (JVET-AL0070 item 9 solution 3)
2. Update the following constraints as highlighted: It is a requirement of bitstream conformance that priRegionWidth[ i ] % SubWidthC[ pri\_region\_layer\_id[ i ] ] shall be equal to 0 and priRegionHeight[ i ] % SubHeightC[ pri\_region\_layer\_id[ i ] ] shall be equal to 0. (JVET-AL0098 item 4)

No action on c and d.

1. Specify the derivation of priTargetRegionWidth and priTargetRegionHeight when pri\_use\_max\_dimensions\_flag is true: (Adopt JVET-AL0303 item 6)
2. Fix the bug related to target picture (re)construction. (JVET-AL0070 item 7, JVET-AL0122 item 11, JVET-AL0129 item 3)
3. Change the following (JVET-AL0070 item 7)
4. Make the following changes (JVET-AL0122 item 11):
5. Make the following changes: (JVET-AL0129 item 3)

Adopt item 33 option b.

1. Add signalling of human viewing and machine analysis suitability, as follows: (JVET-AL0131 item 6)

No action was taken on this.

1. Editorial changes that could be delegated to the editors:
2. (Agreed in JVET-AL\_notes\_d3) JVET-AL0070 item 2
3. (Agreed in JVET-AL\_notes\_d3) JVET-AL0070 item 3 (JVET-AL0132 item 2 also proposes).
4. Typo fixes in JVET-AL0070 item 9: MaxWidth ->MaxPicWidth, MaxHeight -> MaxPicHeight
5. JVET-AL0120 item 9, JVET-AL0303 item 1
6. JVET-AL0132 item 3

Delegate item 35 to the editors.

Decision: Adopt as noted as agreed above.

### Image format metadata SEI message (3+1)

Contributions in this area were discussed during 1300–1410 on Tuesday 1 April 2025 (chaired by S. Deshpande).

[JVET-AL0068](https://jvet-experts.org/doc_end_user/current_document.php?id=15374) AHG9: On image format metadata (IFM) SEI [J. Boyce, M. M. Hannuksela (Nokia), A. T. Hinds (Tencent)]

Chaired by S. Deshpande on 1 April at 13:00.

A number of modifications to the IFM SEI are proposed.

* Item 1: Change ifm\_num\_metadata\_payloads to ifm\_num\_metadata\_payloads\_minus1 and impose a range constraint

JVET-AL0128 item 1 also has the same proposal with the value range being 0 to 63, versus 0 to 7 here. Typically there may be 5 entries for 5 image format types and for JFIF there may be multiple additional ones.

Agreed to code with minus1 and with range of 0 to 63.

* Item 2: Modify ifm\_payload\_len\_minus1[ i ] from ue(v) to u(v) and impose range constraint
* Length of 1 marker segment in JPEG is 64 Kbyte. There could be multiple marker segments. The length of payload is expected to be few bytes for most (but not all) cases. The proposed change is beneficial if typical value is large. It was suggested to only specify a signalling range and keep current ue(v) coding with only one syntax element. JVET-AL0094 recommends range up to 128 Kbytes. It was commented that these sizes are too large and ue(v) could be 40 bits (in worst case). JVET-AL0128 item 3 is also related. Item 3: Modify the calculation of IccMajorVer

This is an asserted bug-fix. It was asked if the value 8 in ifm\_data\_payload\_byte[ i ][ 8 ] is considering the first value of 0 or 1. It was answered that it starts from 0.

Agreed.

* Item 4: Combine Tables YY and ZZ containing interpretation of IccMajorVer and IccMinorVer

Currently the two tables are listed separately and somewhat independently of each other. Also only some combinations of major and minor version are currently used. In future if some other combination is used, an additional entry could be added to the single proposed table.

Agreed.

* Item 5: Modify semantics for unspecified values of IccMajorVer and IccMinorVer

Some language should still be added for “reserved for future use”. The main aspect is not to say “Decoders shall ignore image format metadata SEI messages in which such values are present.” After discussion, the agreed language is along the lines of: “Values of ICCmajorVer and ICCminorVer that are not listed in Table yy are reserved for future use by ITU-T | ISO/IEC. Such values shall not be present in bitstreams conforming to this version of this Specification. Decoders are expected to ignore payload values which are not listed Table yy.” Exact wording delegated to the editors.

* Item 6: Modify semantics for ifm\_uri\_present\_flag[ i ] and ifm\_data\_uri[ i ].

JVET-AL0128 item 4 is related. See the additional notes about the discussion of these two items in that document. This is the current design intent. Mainly editorial. Agreed to take the suggested action.

[JVET-AL0094](https://jvet-experts.org/doc_end_user/current_document.php?id=15419) AHG9: On payload length of image format metadata (IFM) SEI [A. T. Hinds, Gilles Teniou, S. Wenger (Tencent), C. Bai, P. Green (on behalf of ICC)]

Chaired by S. Deshpande on 1 April at 13:45.

In the meeting report for the 37th JVET meeting (JVET-AK1000), it is reported that a restriction of 64KB should be imposed on the payload length for each metadata payload carried by the IFM SEI message. However, in discussions with experts from the International Color Consortium (ICC) following the 37th meeting, it was learned that a length restriction of 64KB could be insufficient (i.e., too small) to accommodate ICC profiles, in particular, for those that utilize LUT-based transformations. Rather, a 128KB length restriction is suggested by ICC experts so that ICC profiles may be carried in the payload of an IFM SEI message. This proposal accordingly modifies the length restriction of the IFM SEI to 128KB.

Related to the discussion of item 2 of JVET-AL0068 and item 3 in JVET-AL0128. As per discussion of those items, it is agreed to add a range value for the existing ue(v) syntax with the upper bound of the range of 128 Kbytes to the range. Also agreed to add informative note as proposed.

[JVET-AL0128](https://jvet-experts.org/doc_end_user/current_document.php?id=15453) AHG9: On image format metadata SEI message [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

Chaired by S. Deshpande on 1 April at 13:55.

This contribution proposes modifications that are asserted to provide improvement to some aspects of image format metadata (IFM) SEI message. The proposed modifications are as follows:

1 Change ifm\_num\_metadata\_payloads to ifm\_num\_metadata\_payloads\_minus1, and specify the allowed value range of it.

See the notes under JVET-AL0068 item 1.

1. Specify the allowed value range of ifm\_type\_id[ i ].

This is typically how we specify handling of reserved values. Agreed

1. Specify the allowed value range of ifm\_payload\_len\_minus1[ i ].

See the notes under JVET-AL0068 item 2.

1. Remove the signalling of ifm\_uri\_present\_flag[ i ] and move up ifm\_payload\_len\_minus1[ i ] and change it to ifm\_payload\_len[ i ].

Proposed modification overloads the ifm\_payload\_len[ i ] syntax element for asserted simplification of syntax table. For data uri case the bits on the wire are same as in current specification. For the other case, 1 bit is saved. There was a comment that current design is less confusing and this change may be confusing. No action was taken on this.

[JVET-AL0132](https://jvet-experts.org/doc_end_user/current_document.php?id=15457) AHG9: Editorial updates for VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*Aspects on IFM – JVET-AL0132 also relates to the digitally signed content and packed regions SEI messages*

Chaired by S. Deshpande on 1 April at 14:05.

1. Differentiate two ifm\_bit\_equal\_to\_zero. By calling them ifm\_bit\_equal\_to\_zero\_a and ifm\_bit\_eqaul\_to\_zero\_b.

Agreed to implement this editorial change.

### Other (5+1)

Contributions in this area were discussed during 1410–1600 on Tuesday 1 April 2025 (chaired by S. Deshpande and J. Boyce).

[JVET-AL0058](https://jvet-experts.org/doc_end_user/current_document.php?id=15364) AHG9: On the AI usage restrictions SEI message [M. M. Hannuksela, L. Kondrad, K. Kammachi-Sreedhar, E. B. Aksu, J. Boyce (Nokia)]

Chaired by S. Deshpande on 1 April at 14:10.

The contribution proposes the following changes relating to the AI usage restrictions (AUR) SEI message:

1. It is proposed to use "unusable" instead of the phrase "do not use" and avoid the word "restriction" in the normative semantics of the AUR SEI message outside the title of the SEI message.

The goal is to avoid imperative phrasing (e.g. “Do not use”) in the semantics. Proposed change includes changing “Do not use” to “unusable” in the Table and similar changes in principle to semantics. These are asserted to be editorial. Delegated to the editors.

1. It is proposed to clarify editorially that "optional context information" means that the context information for usage by AI applications is optionally present in the AUR SEI message.

Delegated to the editors.

1. To specify the value range of aur\_context[ i ], it is proposed either a) to specify aur\_context[ i ] as u(16) or b) to specify that the values of aur\_context[ i ] in the range of 16 to 65 535, inclusive, are reserved for future use by ITU-T | ISO/IEC.

Currently aur\_context[ i ] is coded as ue(v). JVET-AL0131 also proposes changing the syntax aur\_context[ i ] coding to u(16). Agreed to code the syntax element aur\_context[ i ] as u(16).

[JVET-AL0131](https://jvet-experts.org/doc_end_user/current_document.php?id=15456) AHG9: Proposed changes for miscellaneous aspects of SEIs in VSEI v4 [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

*Aspects on AI usage restrictions – JVET-AL0131 also relates to the digitally signed content and packed regions SEI messages*

Chaired by S. Deshpande on 1 April at 14:20.

(Related to AUR SEI message)

2. Define the reserved value for aur\_restriction[ i ] and modify the sentence specifying the allowed value range.

The value range 4-255 is proposed to be added as “Reserved”. aur\_restriction[ i ] is currently ue(v) coded and the value range is not specified. The values greater than 3 are currently reserved in the specification. Currently the value greater than 3 are ignored, the proposed change is to make them not be present in this version. Agreed that 255 is the upper bound for this ue(v) syntax element and the semantics change.

3. Change the descriptor of aur\_context[ i ] from ue(v) to u(16). See the notes under item 3 of JVET-AL0058. Additional aspect is to change “be ignored” to “not be present”. Agreed on that aspect.

[JVET-AL0077](https://jvet-experts.org/doc_end_user/current_document.php?id=15383) AHG9: On the text description information SEI message [M. M. Hannuksela, J. Boyce (Nokia)]

Chaired by S. Deshpande on 1 April at 14:30.

The following items related to the text description information (TDI) SEI message are proposed in this contribution:

1. It is proposed to resolve an asserted inconsistency of text description purposes applying to coded pictures and the TDI SEI message persistence specified in terms of decoded pictures in output order as follows:
   1. Categorize text description purposes into two categories distinguished by whether they apply to coded or decoded pictures.
   2. For the text description purposes applying to coded pictures, define the persistence of the TDI SEI message in terms of coded pictures in decoding order.
   3. For the text description purposes applying to decoded pictures, define the persistence of the TDI SEI message in terms of decoded pictures in output order.
   4. Constrain the text description SEI messages with a text description purpose indicating a tag URI for identifying the bitstream or an encoder description to remain the same until the end of a CLVS.

It was commented that there may not be issue for closed GOP. It was commented that this proposal may be a bit of over engineering. The main aspect relates to purpose values 5 and 6 and the current specification may not be broken for those values. No action for 1 a-c.

The proposed change in 1-d is still ok for cases such as ad-insertion, as it is specifies behavior for a CLVS. Agreed with the constraint in 1-d.

1. It is proposed to allow a null string for tdi\_descr\_string\_lang[ i ] to indicate that no natural language applies.

Some of the text strings may not be spoken language text string. The referred RFC does not allow defining the case with undefined language. So null string is proposed to be used for tdi\_descr\_string\_lang[ i ] to specify undefined. Agreed to instead specify an undefined language by adding a note specifying use of following as per RFC: zxx (no linguistic content; not applicable), und (Undetermined) so that one option is used for such purposes.

1. It is proposed to clarify the NOTE related to the AI marking purpose to indicate that the text description string contains information about machine-learning-based processing applied for creating the picture(s) within the persistence scope of this SEI message.

Agreed to change the note.

1. It is proposed to refer explicitly to the rating\_value\_text() of CTA-766-D in the semantics of tdi\_descr\_purpose equal to 4.

The intent is to clarify which text to include. The abbreviation and/or the value. It was asked if the intent is that the signalled string is displayed. It was agreed to clarify what exactly is included – whether it is abbreviated or full string or both there was no clear benefit for one or the other. Unless some reasons is found later, agreed as proposed.

1. For tdi\_descr\_purpose equal to 5, it is proposed to clarify that tdi\_descr\_string[ i ] identifies the bitstream to which the coded picture(s) within the persistence scope of this SEI message belong or have belonged and add a NOTE discussing how to set tag URI values for a spliced bitstream.

The inconsistency between specifying “bitstream” in the table and “CLVS” in semantics is proposed to be resolved. As per above decision on item 1, one CLVS has only one Tag URI for same tdi\_descr\_id value.

Agreed

[JVET-AL0130](https://jvet-experts.org/doc_end_user/current_document.php?id=15455) AHG9: Source picture timing for interlaced video with SPTI SEI message [J. Lee, H. Tan, J. Nam, C. Kim, J. Lim, S. Kim (LGE)]

Chaired by J. Boyce at 1548 on 1 April 2025.

This contribution proposes modifications that are asserted to provide improvement in handling source picture timing of an interlaced video with SPTI SEI message. The proposed modifications are as follows:

1. Apply SPTI SEI message only to non-duplicated pictures in an interlaced video.
2. Apply SPTI SEI message to top field and bottom field separately when a picture corresponds to a field.

It was remarked that SPTI SEI will be included in AVC and HEVC.

It was suggested that the most relevant use case for interlace content where the proposal would have an impact is for telecine. It was further suggested that use of the SPTI SEI is unnecessary for that use case because the source picture timing would already be known.

Slow motion content broadcast in interlace was also suggested as a use case that would be addressed by the contribution.

It was suggested the UK and France are still broadcasting in interlace for HD content.

It was questioned if there is any impact of top field first vs bottom field first.

Decision: Adopt to VSEI v4 and coding spec interfaces.

[JVET-AL0249](https://jvet-experts.org/doc_end_user/current_document.php?id=15576) AHG9: Proposed modifications to VSEI to address national body comments [J. Boyce (editor)]

This contribution provides proposed modifications to address the following national body comments: FR2-001 and JP-041.

FR2-001: Chaired by S. Deshpande on 1 April at 15:30.

Comment: In the list of strings for a specific txt\_descr\_id, it is our understanding that each is a translation of the same information. This is suggested by the fact that txt\_descr\_string\_lang[i] shall be different.

Proposed disposition: The following note to be added:

NOTE – The contents of txt\_descr\_string[ i ] for different values of i represent the same information in different languages.

It was suggested to change “same information” to “similar information”

Agreed to add the note as modified.

JP-041: Chaired by J. Chen on 1 April at 15:40.

Comment: The syntax element omi\_mask\_confidence[ i ][ j ] is defined as the unsigned (omi\_mask\_confidence\_length\_minus1 + 1) bits integer and units of two to power of -( omi\_mask\_confidence\_length\_minus1 + 1 ). This specification is unclear.

Proposed disposition: omi\_mask\_confidence[ i ][ j ] specifies the factor for confidence associated with the j-th object mask of the object mask picture in the i-th auxiliary layer associated with the current primary layer and a real number value MaskConfidence[ i ][ j ] specifying the degree of confidence, which shall range a value greater than 0 and less than or equal to 1, is defined as follows.

MaskConfidence[ i  ][ j ] = ( omi\_mask\_confidence[ i ][ j ] + 1 ) ÷ ( 1 << ( omi\_mask\_confidence\_length\_minus1 + 1 ) ).

The equation in proposed disposition is slightly different than the one in comment.

Agreed to make the change.

Delegated to the editors to decide whether to describe if the higher value of variable or higher value of the syntax element indicates higher confidence.

[JVET-AL0301](https://jvet-experts.org/doc_end_user/current_document.php?id=15628) AHG9: VSEI specification changes to reference the 3rd edition of video CICP [J. Xu, Y.-K. Wang (Bytedance)]

This contribution provides proposed modifications to address the following national body comments: FR2-001 and JP-041.

FR2-001: Chaired by J. Boyce and S. Deshpande on 1 April 2025 1530.

Notes by JB: This contribution provides VSEI text to add a constraint for two new code points introduced in the 3rd edition of video CICP. It is noted that the constraint was agreed at the 34th JVET meeting as noted for JVET-AH0175 item 2; and the same constraint has already been integrated into the latest HEVC and AVC specifications.

Decision: Adopt

Notes by SD:

Comment: In the list of strings for a specific txt\_descr\_id, it is our understanding that each is a translation of the same information. This is suggested by the fact that txt\_descr\_string\_lang[i] shall be different.

Proposed disposition: The following note to be added:

NOTE – The contents of txt\_descr\_string[ i ] for different values of i represent the same information in different languages.suggested to change “same information” to “similar information”

Agreed to add the note as modified.

JP-041: Chaired by J. Chen on 1 April at 15:40.

Comment: The syntax element omi\_mask\_confidence[ i ][ j ] is defined as the unsigned (omi\_mask\_confidence\_length\_minus1 + 1) bits integer and units of two to power of -( omi\_mask\_confidence\_length\_minus1 + 1 ). This specification is unclear.

Proposed disposition: omi\_mask\_confidence[ i ][ j ] specifies the factor for confidence associated with the j-th object mask of the object mask picture in the i-th auxiliary layer associated with the current primary layer and a real number value MaskConfidence[ i ][ j ] specifying the degree of confidence, which shall range a value greater than 0 and less than or equal to 1, is defined as follows.

MaskConfidence[ i  ][ j ] = ( omi\_mask\_confidence[ i ][ j ] + 1 ) ÷ ( 1 << ( omi\_mask\_confidence\_length\_minus1 + 1 ) ).

The equation in proposed disposition is slightly different than the one in comment.

Agreed to make the change.

Delegated to the editors to decide whether to describe if the higher value of variable or higher value of the syntax element indicates higher confidence.

## AHG9: Aspects on SEI messages in TuC for VSEI (16)

### NNPF SEI messages *(*4)

Contributions in this area were discussed during 0735–0750 and 1300–1345 on Wednesday 2 April 2025 (chaired by J. Boyce).

[JVET-AL0175](https://jvet-experts.org/doc_end_user/current_document.php?id=15500) AHG9: On Target Mastering Colour Volume Information in the NNPFC SEI message for Tone Mapping [C-H. Demarty, E. François, F. Aumont, O. Le Meur (InterDigital)]

This contribution proposes to add additional signalling of a Target Mastering Display Colour Volume in the neural-network post-filter characteristics (NNPFC) SEI message with Tone Mapping purpose.

Additionally, editorial changes in the adopted syntax for the Target Colour Volume information are proposed.

It was suggested to use the term target display rather than target mastering display. Another participant suggested that target display is to broad of a term, and perhaps target display colour volume could be used.

Decision: Add to TuC.

A -v2 version to be uploaded with modified editorial changes as discussed above.

[JVET-AL0177](https://jvet-experts.org/doc_end_user/current_document.php?id=15502) AHG9: On Signalling Tone Mapping Related Information in NNPFA [C-H. Demarty, E. François, F. Aumont, O. Le Meur (InterDigital)]

This contribution proposes to add signalling of Tone Mapping related information, namely Target Colour Volume and Luminance Adaptation metadata, in the neural-network post-filter activation (NNPFA) SEI message.

It is also proposed to add signalling of Target Mastering Display Colour Volume metadata in the NNPFA for tone mapping purpose depending on the acceptance of proposal JVET-AL0175 (AHG9: On Target Mastering Colour Volume Information in NNPFC SEI for Tone Mapping).

Finally, similar editorial changes as in proposal JVET-AL0175 (AHG9: On Target Mastering Colour Volume Information in NNPFC SEI for Tone Mapping) are proposed.

Version v2 includes additional text for specifying the interpretation.

Repeating parameters in the NNPFA SEI allows updating parameters without having to resend the NNPFC SEI.

It was questioned how often the proposed signalled parameters are expected to change. Several categories of parameters are included, that may change at different times, e.g. due to changing content or due to splicing.

Two syntax options are proposed.

It was questioned if the metadata is sufficient to describe an end-to-end tone mapping. That question is also applicable to the current TuC approach using NNPFC SEI.

It is noted that the parameters proposed to be duplicated in the NNPFA SEI are optional in the NNPFC SEI.

Some of the those parameters in the current TuC NNPFC are describing content, which seems out of the scope expected for NNPFC SEI, which is to describe network characteristics. Further study on the best location for content based parameters, and consideration on if any of the proposed parameters should be signalled in both the NNPA and NNPFC.

It was suggested that we consider if the overall complexity related to NNPF tone mapping would be justified in a new version of VSEI.

[JVET-AL0209](https://jvet-experts.org/doc_end_user/current_document.php?id=15534) AHG9: On providing robustness against layer dropping in multi-layer NNPF [T. M. Borges, Y. Sanchez, R. Skupin, C. Hellge, T. Schierl (Fraunhofer HHI)]

This contribution proposes the introduction of a layer essentiality flag to enhance the multi-layer NNPF proposal from JVET-AK0167, currently in TuC. This flag indicates which auxiliary pictures are required for multi-layer NNPF application and which can be omitted, thereby improving robustness against layer dropping.

Decision: add to TuC.

[JVET-AL0341](https://jvet-experts.org/doc_end_user/current_document.php?id=15668) AHG9: NNPFA SEI message extension for multi-purpose NNPFs [M. M. Hannuksela, F. Cricri (Nokia), C.-H. Demarty, E. François, F. Aumont (InterDigital)] [late]

Very late contribution (uploaded Wednesday 2 April). Review was deferred to the next meeting, as no time was left by the end of the current meeting after performing all business of higher urgency.

### Constituent rectangles SEI (3)

Contributions in this area were discussed during 1345–1540 on Wednesday 2 April 2025 (chaired by J. Boyce).

[JVET-AL0095](https://jvet-experts.org/doc_end_user/current_document.php?id=15420) AHG 9: On constituent rectangles SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

This contribution proposes two changes to the specification of constituent rectangles (CR) SEI message.

* To skip unnecessary syntax elements when a layer contains a single constituent rectangle.
* To improve the presence condition for the size of the guard band

It was suggested that the first proposal would inherently require that all sample locations in the coded picture are in the CR, which is not currently a requirement.

No action on the first proposal.

The current design doesn’t allow signalling a zero size guardband in one direction but not in the other. The contribution doesn’t address this issue. It might make sense to remove the \_minus1 from guard band size signalling. suggested to condition the presence of the cr\_guardbands\_present\_flag[ ] on having more than one CR in a row and/or column.

It was suggested that signalling of the guardband might still be useful for the subbitstream extraction use case. However, guardbands are not included on the edges of the picture but just between CRs.

Semantics changes for cr\_guardbands\_present\_flag[ ] are also proposed.

Decision: remove the \_minus1 in the cr\_guardband\_hor\_size\_minus1 and cr\_guardband\_verr\_size\_minus1. Also add semantics change for cr\_guardbands\_present\_flag[ ], with precise language determined by editors.

[JVET-AL0139](https://jvet-experts.org/doc_end_user/current_document.php?id=15464) AHG9: On multilayer support for CR SEI [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

Discussed on 2 April 2025 at 14:20 chaired by S. Deshpande.

Display-rectangles support for CR SEI has been adopted to the VSEI TuC in 38th JVET Kemer meeting (see document [JVET-AJ0245](https://jvet-experts.org/doc_end_user/current_document.php?id=14852)). In its current design, CR SEI assumes that all layers share the same number of regions and picture characteristics (VUI), which is not necessarily the case (problem 1). Furthermore, in some applications where CR layout is redundant from a layer to another, a redundant information is signalled for every layer (problem 2). This contribution proposes two changes fixing the above mentioned issues.

Regarding proposal related to asserted problem 1: An example was shown which is asserted to not be supported with the current signalling. It was asked if the different information (if such is the case) for layers should be provided by the interface rather than from the signalling. It was commented that some of the existing syntax elements related to colour space were added for a use case of enhanced chroma support at the previous meeting. It was suggested to study whether the example can be supported by using separate CRs for separate layers, instead of making the syntax elements layer specific, which may be complicated. The proponent commented that using multiple CRs is indeed a possible solution. It was asked if multiple CRs are used whether numbering space is common across CRs. It is suggested to compare the proposed approach with multiple CR approach.

It was also commented if we should limit only some syntax elements to be layer specific. Was not further considered (as no such a design became available at this meeting).

Regarding proposal related to asserted problem 2: There are existing layer specific syntax elements such that the aspect related to cr\_reuse\_layout\_flag of the proposal can be considered independently.

It was asked how common is the use case where layers have same layout. Some examples were described.

The proposal is essentially a bitrate saving proposal and the savings depends on how many layers are there and have the same values.

It was commented that there are 3 modes (subpictures, same size row & columns, and explicit) to signal CRs and this applies to 2 (the first two modes) of the 3 modes. Thus it will not work for the third mode.

Decision: Agreed on cr\_reuse\_layer\_flag aspect

[JVET-AL0308](https://jvet-experts.org/doc_end_user/current_document.php?id=15635) AHG9: On layer ID syntax elements in VSEI TuC [J. Xu, Y.-K. Wang (Bytedance)] [late]

This contribution proposes to change the coding method and specify the range for various syntax elements representing layer ID in the VSEI TuC document, including cr\_layer\_id and cr\_vui\_layer\_id in the constituent rectangles SEI message, doi\_nuh\_layer\_id and doi\_alpha\_nuh\_layer\_id in the display overlays information SEI message, bri\_nuh\_layer\_id in the bitdepth range information SEI message and ecfi\_vui\_layer\_id and ecfi\_layer\_id in the enhanced colour format information SEI message.

It was suggested to add a note VSEI TuC that the layer ID values may be further restricted by the referring video coding spec.

It was also suggested that the ue(v) limit be specified in the interface.

Other syntax elements such as bit depth, quantization parameter, etc., may have similar issues, and we may wish to have a consistent approach.

Decision: Adopt to TuC, with addition of a note as described above.

Further study if we want to specify a large range in VSEI or state that the range is specified by the referring spec, and if the approach can be applied to SEI messages in VSEI v4 and for additional parameters.

### Display rectangles SEI (4)

Contributions in this area were discussed during 1540–1650 on Wednesday 2 April 2025 (chaired by J. Boyce).

[JVET-AL0097](https://jvet-experts.org/doc_end_user/current_document.php?id=15422) AHG 9: Gaussian blur filling method in display rectangles SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

It is asserted that the current display rectangles (DR) SEI message has two problems:

1. Lacks the signalling of kernel size which is needed for Gaussian blurring operation. The lack of such signalling may lead to inconsistencies in blur effects and computational complexity.
2. The blur sigma value is defined as an integer, whereas floating-point representation allows for finer control over blur intensity.

This contribution proposes to introduce kernel size signalling and support floating-point sigma values, improving consistency, flexibility, and accuracy in blur effect.

Item 1 agreed.

It was suggested that an alternative to signalling the numerator and denominator of a floating point number may be using u(v) coding, but that requires normalization in the range of 0 to 1.

A bit shift is also possible, and would avoid the need for a division, such as expressing in units of 1/16ths.

It was noted that the provided semantics are using a / operator for the division, which will clip to the nearest integer, which may not be the intent, which may be to use ÷.

It was noted that sigma equal to 0 doesn’t make sense.

Side activity for the supported range and number of bits for the numerator and denominator and signalling alternatives.

Further discussion on 3 April.

Agreed to keep the blur sigma signalling as u(8) with a minus1 and to modify the semantics to indicate that it is in units of 1/16ths.

[JVET-AL0099](https://jvet-experts.org/doc_end_user/current_document.php?id=15424) AHG9: On design of display rectangles SEI message [J. Nam, H. Tan, J. Lee, C. Kim, J. Lim, S. Kim (LGE)]

This contribution proposes modifications that are asserted to provide improvement to some aspects of display rectangles (DR) SEI message in JVET-AK2032. The proposed modifications can be summarized as follows:

1. Match the number of display rectangles for position updates

Option 1: add a constraint that when dr\_pos\_updates\_flag is equal to 1, the value of dr\_num\_rect\_minus1 shall be equal to the value of the corresponding syntax element in the previous DR SEI message.

Option 2: signal two syntax elements (i.e., dr\_assigned\_rect\_id[ i ] and dr\_rect\_id[ i ]) to specify rectangle identifier for each display rectangle.

Agreed on option 2 of item 1, with an additional condition for presence of dr\_rect\_id[ i ] only when dr\_pos\_updates\_flag equal to 1.

2. Simplify loop for signalling syntax elements.

Option 1: Signal one loop over the number of display rectangles.

Option 2: Signal one loop over the number of display rectangles for syntax elements to be signalled when dr\_pos\_updates\_flag is equal to 0.

Agreed to use option 2 of item 2 for the combining the second and third loops, while keeping the first loop containing the aspect ratio separate.

3. Signal a syntax element (i.e., dr\_rect\_pos\_update\_flag[ i ]) to specify that the display rectangle position of the i-th rectangle is updated or not when dr\_pos\_updates\_flag is equal to 1.

Agreed on item 3.

4. Signal sign values of top-left position for display rectangle only when the corresponding values are greater than 0.

Agreed on item 4.

5. Derive the variables DrRectTopLeftX[ i ] and DrRectTopLeftX[ i ] by scaling with DrUnitSize.

It was suggested that the unit size of the width and height requires less fine granularity than the position.

There is an issue with the semantics of dr\_rect\_top\_left\_x[ ] and dr\_rect\_top\_left\_y[ ].

Decision: Remove the reference to DrUnitSize units.

6. Remove the current constraint on DrUnitSize value related to SubWidthC and SubHeightC, while add the constraints on the DrRectWidth[ i ], DrRectHeight[ i ], DrFillWidth[ i ], DrFillHeight[ i ], DrRectTopLeftX[ i ] and DrRectTopLeftY[ i ] values related to SubWidthC and SubHeightC.

Agreed on item 6.

7. Signal the syntax elements (i.e., dr\_fill\_content\_width[ i ], dr\_fill\_content\_region\_top\_left\_x[ i ], dr\_fill\_content\_region\_top\_left\_y[ i ]) for filling parameters when spatial extrapolation filling method is used.

It was suggested that it is not necessary to signal these syntax elements.

Editorial issue: Semantics for the Extrapolate fill method (method 1) should be checked for if there is a bug, because the cropped decoded picture size can be used to determine the regions that need filling.

8. Derive the variables DrFillTopLeftX[ i ] and DrFillTopLeftX[ i ] by scaling with DrUnitSize.

Decision: Adopt as noted above.

[JVET-AL0138](https://jvet-experts.org/doc_end_user/current_document.php?id=15463) AHG9: VVC interface for Display Rectangles SEI [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

Discussed on 2 April 2025 at 16:40 chaired by S. Deshpande.

Display Rectangles (DR) SEI has been adopted to the VSEI TuC in 38th JVET Geneva meeting (see document [JVET-AK0142](https://jvet-experts.org/doc_end_user/current_document.php?id=15113)). This contribution proposes to add an interface text for usage of DR SEI with VVC.

Agreed

[JVET-AL0141](https://jvet-experts.org/doc_end_user/current_document.php?id=15466) AHG9: Showcase on the implementation of display rectangles SEI [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)] [late]

Discussed on 2 April 2025 at 16:45 chaired by S. Deshpande.

Display Rectangles (DR) SEI has been adopted to the VSEI TuC in 38th JVET Geneva meeting (see document JVET-AK0142). This contribution showcases how display rectangles SEI message can be utilized in a real-world scenario. The contribution comes with an implementation and associated configuration files. Furthermore, a semantics bug was found during implementation, for which a fix is proposed.

Note: version 2 of this contribution adds the slide deck.

A showcase demo was shown.

Regarding the identified semantics bug: this part of the code relates to checking if display samples are within the cropped picture.

It was agreed to fix the semantics bug.

### Other (7)

Contributions in this area were discussed during 1650–1720 Wednesday 2 April and 1300–1510 on Thursday 3 April 2025 (chaired by J. Boyce).

[JVET-AL0091](https://jvet-experts.org/doc_end_user/current_document.php?id=15416) AHG9: On the multiplane image information (MPII) SEI message [S. McCarthy, S. Oh, W. Husak (Dolby)]

The multiplane image information (MPII) SEI message is included in the Technologies under consideration for future extensions of VSEI (TuC for VSEI). MPI technology is also included in the second edition of ISO/IEC 23090-12 MPEG immersive video, which has reached FDIS stage. It is proposed to remove the MPII SEI message from the TuC for VSEI to facilitate communicating to the outside community for adoption of MPI technology.

Agreed.

[JVET-AL0093](https://jvet-experts.org/doc_end_user/current_document.php?id=15418) AHG 9: On value range for syntax elements coded as u(v) [H. Tan, C. Kim, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

It is asserted that when a syntax element that is coded as u(v) and the number of bits is not explicitly specified but need to be calculated based on the value of other syntax element, there may be a need to explicitly specify the value range for the syntax element. This is particularly needed when the calculation to get the number of bits involves rounding operation such as Ceil( ), Round( ), and Floor( ).

This contribution proposes the following:

1. Explicitly specify the value range for syntax element coded as u(v) in which the number of bits is not given explicitly but needs to be calculated. Consequently, we need to specify the value range for the following syntax elements:
   * cr\_rect\_group\_id[ i ]
2. doi\_layer\_idx[ i ]the coding of doi\_nuh\_layer\_id[ i ] from u(v) to u(6).

Agreed for item 1.

No action on item 2 because of action on JVET-AL0308.

[JVET-AL0140](https://jvet-experts.org/doc_end_user/current_document.php?id=15465) AHG9: Region-specific quality metrics for QM SEI [T. Biatek, J. Boyce, M. M. Hannuksela (Nokia)]

Discussed on 2 April 2025 at 17:00 chaired by S. Deshpande.

Quality Metrics (QM) SEI enables transmission of diverse quality metrics to the receiver, with a granularity from picture to CLVS. In its current design, the QM SEI does not enable identification of localized artifacts. This contribution proposes to enable region-specific signalling of quality metrics, addressing the above mentioned problem.

The proposed modifications to syntax and semantics include:

* Addition of a flag indicating whether region-based metrics are transmitted or not, supporting subpicture, tile, CR or custom rectangle representation of regions.
* Addition of a quality metric signalling for every region, and for the remaining picture area.

Some concerns were expressed:

The need for signalling region-wise quality metric was questioned by multiple participants. The proponent answered that in streaming use case there may be some use, e.g. for doing region wise post processing. However the signalling is not providing information about type of artifacts in different regions. It was commented that for streaming use case overall quality may be more important rather than region-wise quality.

It was also commented that it is necessary to define what the quality metrics are (e.g. to provide the equations which can be normatively referenced from well-defined and stable standards). It was commented that we cannot approve a specification in ITU which does not normatively reference something which cannot be referenced from approved list of bodies.

No action was taken on this.

[JVET-AL0216](https://jvet-experts.org/doc_end_user/current_document.php?id=15543) [AHG9] Lens Optical Correction SEI – floating point parameters representation [G. Teniou, S. Wenger, A. Hinds (Tencent)]

This contribution provides justification on the choice of 25 bits representation to signal distortion parameters and suggests alternate approaches to signal the focal parameters.

The contribution includes the following:

1. How to signal the focal center (proposed syntax and semantics in clause 2.2.1)
2. How to signal the focal length (proposed syntax and semantics in clause 2.2.2.1 for option 1 or 2.2.2.2 for option 2.
3. Validate the signalling of radial distortion parameters (using i(25))
4. Agree the typo on the default value of one parameter in clause 2.4
5. Validate the signalling of chromatic aberration parameters (using u(25) and i(25))
6. Validate the signalling of vignetting parameters (using i(25))

No action was taken on the focal center proposal in section 2.2.1.

Two options proposed regarding focal length in section 2.2.2.

Curent design in TuC in JVET-AK2032:

**loc\_focal\_length** defines the focal length of the lens, i.e., the distance from the lens in which rays of light that fall parallel to the optical axis into the lens are converged. It is expressed in units of 0.1 millimeters. A value of 0 indicates that the focal length is undefined. When not present, the value of loc\_focal\_length is inferred to be equal to 0.

Option 1 of current contribution:

**loc\_focal\_length** defines the focal length of the lens, i.e., the distance from the lens in which rays of light that fall parallel to the optical axis into the lens are converged. It is expressed in units of millimeters. A value of 0 indicates that the focal length is undefined. When not present, the value of loc\_focal\_length is inferred to be equal to 0.

The current contribution removes the 0.1 millimeters to express in units of millimeters. The contribution states the following:

* 11 bits are needed to signal the integer part.
* 10 bits are necessary to signal 3 digits of the decimal part (10xln(2)/ln(10) = 3,01029)

However, there is no description in the semantics of how to convert the local\_focal\_length syntax element into a floating point number.

No action on focal length.

Section 2.3 provides a rationale for the current design of radial distortion and does not ask for a change to the design.

Section 2.4 asserts that there a bug in the inference value of loc\_rd\_poly4\_k1 and proposes changing it 224, which corresponds to a value of 1, as opposed to the current value of 0.

Decision: agreed to chance the inference value of loc\_rd\_poly4\_k1.

Section 2.5 provides a rationale for the current design of Transversal chromatic aberration and does not ask for a change to the design.

Section 2.6 provides a rationale for the current design of vignetting and does not ask for a change to the design.

[JVET-AL0226](https://jvet-experts.org/doc_end_user/current_document.php?id=15553) AHG9: Proposed segmentation plane test sequences (AUX\_SEGMENT) [E. Thomas, E. Potetsianakis, E. Alexiou, M.-L. Champel (Xiaomi)]

At JVET 37th, the Technologies under consideration for future extensions of VSEI (version 7) was issued with the support for segmentation plane sequence carried as auxiliary layer.

It is proposed to add the proposed test sequences to the common set of test sequences to support the development of the conformance and reference software related to this new auxiliary layer type.

A restrictive license was proposed.

The plane segmentation image (PSI) SEI message is in TuC but doesn’t currently have SW available. This content could be used to test such software.

Will need consider where such a sequence could be made available.

It was suggested that other types of auxiliary content might benefit from having test content available.

It was suggested that it would be useful to make the tool available that was used to create the video from the Google AI image segmenter selfie model, and a description of the tool.

[JVET-AL0286](https://jvet-experts.org/doc_end_user/current_document.php?id=15613) AHG9: On dual-lens optical correction SEI message [A. Karabutov, E. Alshina (Huawei)] [late]

The contribution proposes add support of the case of projection of images from dual-lens fish-eye systems on the same frame. Specifically, the following changes relating to the optical correction SEI message are proposed:

1. Signalling the number of projection of images on the same frame by the syntax element “loc\_number\_minus1”.

2. Signalling the optical parameters for each lens separately.

3. Signalling whether the second lens has the same direction as the first lens by the flag “loc\_inverse\_direction”.

The contribution notes that there are various camera configurations available on the market that employ dual-lens systems or feature two sensors, where images captured by both lenses or sensors are combined and stored within the same frame.

The proposed loc\_number\_minus1 syntax element is u(1), so only allows 1 or 2 lenses. It should maybe be renamed as a flag. It was suggested to consider more than 2 lenses.

As compared to the Multiview acquisition info SEI message, this contribution is aimed at content where a single picture contains the results of capture by two fisheye lenses. No information is provided about where in the coded picture each lens capture is represented.

Semantics of the loc\_inverse\_direction[ i ] need some improvement to clarify what opposite direction means.

It was noted that there is a fisheye video info SEI message in the omnidirectional SEI message category in HEVC that describes content captured by a device with two fisheye lenses aimed in opposite directions. The fisheye video info SEI message is not in VSEI.

Some support expressed for the proposed functionality.

It was suggested that it would be useful to see a showcase and software for the proposal.

Further study encouraged to improve semantics and distinguish capability vs. existing the fisheye video info SEI message in HEVC, and consider if more than 2 lenses should be supported.

[JVET-AL0302](https://jvet-experts.org/doc_end_user/current_document.php?id=15629) Updates of the enhanced colour format information SEI message [D. Podborski, A.M. Tourapis (Apple)] [late]

This contribution proposes several updates to the semantics of the enhanced colour format information SEI message that is currently in the TuC document. The changes are intended to better clarify this SEI message’s usage and application.

It is also noted that the existing SEI messages for describing Alpha and Depth pictures do not properly handle either the use of the constituent rectangle and the enhanced colour format information SEI messages when such indicate the presence of alpha and/or depth information in a coded video sequence. A possible bug affecting the alpha channel information SEI message is also identified and proposed to be corrected.

Summary of updates:

* Improved text for the enhanced colour format information SEI message.
* Extensions to the alpha channel information SEI message to support alpha indicated through constituent rectangle and enhanced colour format information SEI messages.
* Updated the constraint for the alpha\_channel\_bit\_depth\_minus8 syntax element in the alpha channel information SEI message to relate to the bitdepth of the coded alpha information instead of the associated primary picture.
* Extensions to the depth representation information SEI message to support depth indicated through constituent rectangle and enhanced colour format information SEI messages.

Agreed to add improved text for ECFI SEI to TuC.

It is proposed to relax the constraint that the bit depth of the alpha auxiliary picture be the same as the bit depth of the associated primary picture.

The proponent also suggested that there is a bug in the order specified when both alpha\_channel\_incr\_flag and alpha\_channel\_clip\_flag, but doesn’t address this in the contribution.

It was noted that JVET-AI0178 proposed changes to the alpha channel info and depth representation info SEI messages to support use with constituent rectangles, and was marked for further study.

It was noted that JVET-AH0154 proposed changes to the alpha channel info and depth representation info SEI messages to enable standalone alpha channel and depth maps without an associated primary picture.

Follow-up discussion in plenary Friday 4 April:

The aspects related to alpha channel info and depth representation info SEI messages (which currently only can be used in context of auxiliary pictures due to semantics constraint) need further study, also in the wider context of potentially adding elements to CICP.

It is agreed that relaxing the constraint that the bit depth of the alpha auxiliary picture be the same as the bit depth of the associated primary picture is useful e.g. in context of the new HEVC multi-view profiles, but there might be conflict with existing implementation that expect such a constraint. Furher study is necessary on that.

## Additional SEI message aspects (9)

Contributions in this area were discussed during 1600–1830 on Thursday 3 April 2025 (chaired by J. Boyce and S. Deshpande).

[JVET-AL0069](https://jvet-experts.org/doc_end_user/current_document.php?id=15375) AHG9/AHG18: Error recovery SEI message [J. Boyce, M. M. Hannuksela (Nokia)]

See the notes in section 4.17.

[JVET-AL0073](https://jvet-experts.org/doc_end_user/current_document.php?id=15379) AHG9/AHG18: Loss recovery information SEI message [C. Kim, H. Tan, J. Nam, J. Lee, J. Lim, S. Kim (LGE)]

See notes in section 4.17.

[JVET-AL0092](https://jvet-experts.org/doc_end_user/current_document.php?id=15417) AHG9: Confidence information SEI message [J. Boyce, T. Biatek, M. M. Hannuksela (Nokia)]

Discussed on 3 April 2025 at 15:35 chaired by S. Deshpande.

Confidence map images are commonly provided by APIs that produce depth maps and object tracking masks. A new confidence information SEI message is proposed to provide information describing how to interpret samples in an auxiliary picture containing a confidence map, identified by a proposed new AUX\_CONFIDENCE auxiliary picture type in the SDI SEI message.

The proposed SEI message signals the layer ID of the described layer, e.g. the layer containing a depth map or object mask, etc., and optionally signals sample values that represent the min and max values, which represent confidence levels of 0 and 1, respectively.

It was asked what does confidence mean. It was answered that confidence here relates to e.g. how confident is the depth estimator regarding the provided values. It was asked if confidence is always associated with depth or can it be associated with something else. It was answered that the semantics are not restricted to depth.

Proposed ci\_described\_layer\_id syntax element should be changed to ue(v) as per previous discussions.

It was asked if depth picture should be considered a primary picture for the confidence picture although depth picture by itself is an auxiliary picture.

It was asked if the confidence map should be coded losslessly. It was answered that the confidence map does not need to be compressed losslessly. It was asked if any compression results were available for the confidence map layer. Not at this time.

The proposal includes adding aux type and additionally SEI message to describe which is the layer described. SDI SEI only has a primary picture association for the aux pictures.

It was asked how confidence value from API/ sensor data is translated to a range.

It was commented that ARCore also gives a “clean” depth image and that in most cases that is what will be used instead of “raw” depth and confidence values.

It was asked if persistence has an issue related to cancellation of all information. A constraint may need to be added to handle not changing described layer id.

It was asked if confidence picture can be scaled down in resolution. It was suggested that the system may not provide a per sample confidence value reliably anyway and sending this at original resolution may not be very useful.

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.

Decision: agreed to add AUX\_CONFIDENCE value to SDI SEI in TuC.

[JVET-AL0127](https://jvet-experts.org/doc_end_user/current_document.php?id=15452) AHG9: Danmu information SEI message [J. Xu, Y.-K. Wang, L. Zhang (Bytedance)]

Chaired by J. Boyce.

This contribution proposes a new SEI message to convey danmu information, to support interoperability for videos with danmus. A comparison with the MPEG timed text standard is provided.

The contribution asserts that following aspects make TTML unsuitable to represent danmus:

1. Attributes are described in plain text, which is not bit rate efficient. It can be a serious issue especially when the number of danmus is large.
2. When an attribute is described, it describes the exact information, which does not allow any flexibility for the video displayer.
3. To support even simple animation needs much overhead.

A question was raised about persistence and CLVS duration and what the impact of IDRs would be. Can a danmu signalled in one CVLS be displayed in the next CLVS after an IDR is present? No, the persistence would cancel it for the new CLVS. It would be possible to repeat signalling of the Danmu in a new SEI message in the next CLVS.

The archival use case was suggested as being more useful for the proposed SEI than the real time streaming case.

Decision: add to TuC.

[JVET-AL0133](https://jvet-experts.org/doc_end_user/current_document.php?id=15458) AHG9: Signalling of thumbnail information [J. Lee, H. Tan, C. Kim, J. Nam, J. Lim, S. Kim (LGE)]

This contribution proposes new SEI messages to provide the use of thumbnails associated with one or more pictures in the bitstream. Thumbnails help with video preview and navigation by extracting and editing portions of the original content. The proposed SEI messages provide information that can be used to indicate the source and extraction details of thumbnails. The proposed SEI messages provide common signalling across difference systems and devices that is helpful to improve storage efficiency and simplify the management of thumbnails with the associated original video content.

Two SEI messages are proposed: thumbnail source info SEI and thumbnail extraction info SEI.

There is a parsing dependency across the two SEI messages.

It was questioned if the display rectangles SEI message could accomplish a similar functionality to the thumbnail extraction info SEI. It was noted that thumbnails would only be used for individual pictures, and not the entire sequence.

It was suggested that an aux type could be defined for thumbnails, which would already have an associated primary picture layer.

It was noted that thumbnails are already widely used in applications, and there is not a clear need for additional standardization. It was suggested that DASH-IF has a thumbnail related solution.

It was suggested that a picture to be used to generate a thumbnail could be indicated.

No action was taken on this.

[JVET-AL0212](https://jvet-experts.org/doc_end_user/current_document.php?id=15539) AHG9/AHG15: Depth-adaptive picture scaling information SEI [V. Zakharchenko, T. Biatek, J. Boyce (Nokia)]

Discussed on 3 April 2025 at 17:20 chaired by S. Deshpande.

An SEI message is proposed to enable adaptive resampling of decoded picture based on corresponding samples of depth auxiliary pictures.

The Depth-adaptive picture scaling SEI message is asserted to be useful for use cases where the decoded picture must be resampled to a resolution of the display device to reduce a number of bitstreams stored for a variety of platforms, such use cases are broadcasting, teleconferencing, image/video analysis, reprojection, and creation of derivative content.

It was asked why the client cannot do the rescaling based on the original picture and depth map. The answer was that the SEI provides hint for rescaling with a prescribed algorithm.

It was asked- for the example rescaled images shown what was the scale factor and how the downscaled images look instead of the re-upscaled images. The answer was the images were down sampled by a factor of 8 in both dimension. The downscaled images were not easily available at this time.

It was asked if there are any results compared to naïve interpolation and how much is the benefit of the proposed approach. Not at this time, but they can be provided in future. It was asked what would be a good approach to compare these – PSNR or subjective metric. It was suggested to think about an appropriate metric to use for evaluation of results using the proposed approach.

It was asked if same algorithm is applied to chroma. It was answered that in the simulation the algorithm was applied separately to R, G, B. It was suggested to see how the results are for luma vs chroma and how the complexity differs in that case.

It was suggested to use depth map to have a weighted PSNR and calculate distortion. It was commented that possible problem of this approach is that bit allocation is done by importance and the importance assignment is standardized by SEI. The proponents rather think this as conveying artistic intent.

It was asked if block level scaling as proposed results in discontinuities. The answer was yes and smoothing filter on edges can be done. It was suggested to use overlap to handle this.

Further study recommended.

[JVET-AL0219](https://jvet-experts.org/doc_end_user/current_document.php?id=15546) AHG9: Colour mapping information SEI [J. Boyce, T. Biatek, M. M. Hannuksela (Nokia)]

Discussed on 3 April 2025 at 17:50 chaired by S. Deshpande.

A colour mapping information SEI message is proposed to enable description of the use of colour maps that transform monochrome samples into RGB samples that have been selected for improved human visualization. Related contribution JVET-AL0218 proposes adding a colour map codepoint to CICP. The SEI message proposed in this contribution signals a colour map ID that is interpreted by the CICP colour map codepoint.

This contribution also supports use of colour map IDs that are “Unspecified” by CICP and allows their colour map function to be determined by external means or to be described in the SEI message via a piecewise linear look up table.

The proposed syntax currently assumes something is added to CICP, but it can be modified to only provide lookup if CICP addition was not done.

It was asked why SEI needs to specify which colour map to apply and can the client not choose which colour map it wants to apply. It was answered that the content creator intent can be signalled via the SEI.

It was suggested to use EOI type for this purpose. It was answered that the mapping information does not exist in EOI, but it could be presumably added.

It was commented that there are two modes and one of those may apply only to monochrome/ luma.

It was commented that the luma min-max might be different based on if it is full range or not. It was asked why min value needs to be signalled as it is available in video range. It was done for easy mapping purpose.

It was commented that if we decide to do this two separate SEIs should be considered.

It was agreed to treat the decision about SEI separately than CICP decision.

The proponent suggested to add this SEI to TuC and to further study CICP aspect.

It was suggested to remove cmi\_map\_for\_display\_flag. It was ok to keep that flag for now and in next meeting we should consider if that flag is needed or should be removed.

It was agreed to remove the CICP dependency, the semantics of cmi\_colour\_map\_id will be changed and conditioning on value > 192 will be removed

A revision of the text will be uploaded to reflect this.

Decision: Agreed to include in TuC with changes described above to be uploaded in a revision.

[JVET-AL0224](https://jvet-experts.org/doc_end_user/current_document.php?id=15551) AHG9: Auxiliary sampling alignment information SEI [V. Zakharchenko, J. Boyce, D. Rusanovskyy, M. M. Hannuksela (Nokia)]

Discussed on 3 April 2025 at 18:20 chaired by S. Deshpande.

An SEI message is proposed to 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 proposed SEI message 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.

It was commented that it is also important to know that there is alignment and asked if this is clear from the signalling. Another possible use case was described: a stereo capture on smartphone using 2 separate lenses. It was commented that this use case may need some additional solution.

It was commented that this may also be related to phase indication SEI message and it was asked if that SEI message can be used. The proponent thought that may be possible, but we need to ensure that if resolution is different, then it must be a power of two, otherwise it can be directly used. It was commented that phase indication SEI message support resolution change.

It was commented previously that some of the semantics currently (not in this proposal) seems to assume that auxiliary picture resolution is same as primary picture. It was commented that in real-world examples that may not be the case. Some of the SEI messages may need to be checked about this aspect.

The decision from this point in discussion was chaired by Y.-K. Wang. Further study encouraged possibly to broaden the use case basd on above discussion.

[JVET-AL0326](https://jvet-experts.org/doc_end_user/current_document.php?id=15653) AHG9/AHG18: Modification to error recovery SEI message [H. Tan (LGE), M. M. Hannuksela, J. Boyce (Nokia)] [late]

See the notes in section 4.17.

## Non-SEI HLS aspects (0)

Kept as template for future use.

# Plenary meetings, joint meetings, BoG reports, and liaison communications

## General

The following topics were discussed in JVET plenary Monday 31 March at 0820:

* Status of last meeting’s output documents
* Liaison communication –
  + Response to m72555 should be handled at SC29 level
  + to JPEG, regarding information on investigations of AI based I picture coding, mention relevance of bit-exact reconstruction investigations. E. Alshina will prepare a draft, review on Thursday morning
* Scheduling for the remaining week (further detail on scheduling is recorded in section 2.12).
* Review status from tracks and discussion on potential open issues
  + It was agreed to review documents with highest priority first.
* Review of documents at plenary level

Specific discussion on some general issues related to HLS was as follows:

…

## MPEG information sharing meetings

Information sharing sessions with other WGs and AGs of the MPEG community were held on Monday 31 March 0500–0800, Wednesday 2 April 0500–0600, and Friday 4 April 2100–2300.

The status and plans for the work in the MPEG WGs and AGs was reviewed at these information sharing sessions.

## Joint meetings

### Joint sessions 1530-1730 Monday 31 March and 0500-0700 Thursday 3 April on next generation video standardization: JVET with ISO/IEC JTC 1/SC 29/WG 2 MPEG Technical Requirements, VCEG (ITU-T Q6/21), and ISO/IEC JTC 1/SC 29/AG 5 MPEG Visual Quality Assessment

Joint meeting sessions were held at 1530-1730 on Monday 31 March and 0500-0700 on Thursday 3 April on planning for potential next generation video coding standardization with capability beyond that of the VVC standard, and particularly to consider jointly issuing a Call for Evidence (CfE) toward developing such a standard.

These were joint sessions of JVET with ISO/IEC JTC 1/SC 29/WG 2 MPEG Technical Requirements, ITU-T Q6/21 (a.k.a. VCEG), and ISO/IEC JTC 1/SC 29/AG 5 MPEG Visual Quality Assessment.

This section is based on notes recorded by Gary Sullivan (Rapporteur of ITU-T Q6/21 and Chair of ISO/IEC JTC 1/SC 29). About 320 people attended these sessions.

Organization leaders present in one or both of these sessions included Jens-Rainer Ohm for JVET, Igor Curcio and Mary-Luc Champel of MPEG WG 2, Gary J. Sullivan, Justin Ridge, Yan Ye and Thomas Wiegand of VCEG, Mathias Wien of ISO/IEC JTC 1/SC 29/AG 5, and Jörn Ostermann of ISO/IEC JTC 1/SC 29/AG 2.

At the previous meeting, an updated document had been produced on “Preliminary draft of use cases and requirements for potential next-generation video coding standard beyond VVC capability”. It was issued as an annex to the Q6/21 meeting report and as WG 2 output document [N 429](https://dms.mpeg.expert/doc_end_user/documents/149_Geneva/wg11/MDS24904_WG02_N00429.zip).

Documents presented and discussed are listed below.

[VCEG-BX08](https://www.itu.int/wftp3/av-arch/video-site/2503_Tel/VCEG-BX08-v1-RequirementsNGVC.docx) / MPEG [m72255](https://dms.mpeg.expert/doc_end_user/current_document.php?id=98583&id_meeting=202) [J. Samuelsson-Allendes, S. Deshpande, T. Ikai (Sharp)] Gap analysis and suggested updates to next-generation video coding requirements draft

(This contribution was not registered for JVET.)

This contribution presents a summary of a gap analysis carried out with respect to existing MPEG/VCEG video coding standards. The contribution also provides suggestions for updates of “Preliminary draft of use cases and requirements for potential next-generation video coding standard beyond VVC capability” based on the gap analysis. This contribution is an update of the previous contribution JVET-AK0338.

There was an accompanying [slide deck](https://www.itu.int/wftp3/av-arch/video-site/2503_Tel/VCEG-BX08-v1_presentation.pptx), which was requested to be uploaded to be available for study.

Discussed aspects included film grain and “digital noise”.

Discussion of the contribution resulted in edits to the prior “Preliminary draft of use cases and requirements for potential next-generation video coding standard beyond VVC capability” output document, and the result was agreed to be produced as an output of VCEG and MPEG WG 2.

[JVET-AL0052](https://jvet-experts.org/doc_end_user/current_document.php?id=15358) / [VCEG-BX19](https://www.itu.int/wftp3/av-arch/video-site/2503_Tel/VCEG-BX19-v1-RequirementsNGVC.docx) / MPEG [m71802](https://dms.mpeg.expert/doc_end_user/current_document.php?id=98130&id_meeting=202) [T. Solovyev, S. Ikonin, E. Alshina (Huawei)] Huawei comments on use case and requirements for next-generation video coding

This document analyses next generation video codec use case and requirements, suggests updates of the prior output on the subject which the proponent characterized as minor, and provides comments on the potential Call for Evidence.

Discussed aspects included:

* Loss/error concealment issue (addressed previously in review of VCEG-BX08 / MPEG m72255).
* Complexity / power consumption – on wearable devices, no action was taken at this time; this is for further study, although it is a valid concern. It was noted that power consumption can be difficult to estimate.
* Challenging content – it was commented that bit rate saving is useful regardless of the content type; a wide range of bit rates and wide range of content characteristics should be addressed, including challenging content
* Ultra-low end-to-end transmission latency, including 20 ms and lower
* Bit-exact reconstruction
* Measuring complexity

Results of the discussion were recorded in an edited copy of BX19, then integrated into the “Preliminary draft of use cases and requirements for potential next-generation video coding standard beyond VVC capability” output document, which was agreed to be produced as an output of VCEG and MPEG WG 2.

[JVET-AL0235](https://jvet-experts.org/doc_end_user/current_document.php?id=15562) / [VCEG-BX20](https://www.itu.int/wftp3/av-arch/video-site/2503_Tel/VCEG-BX20-v1-RequiremenstNGVC.docx) / MPEG [m72057](https://dms.mpeg.expert/doc_end_user/current_document.php?id=98385&id_meeting=202) [B. Kroon, C. Varekamp (Philips] On the immersive requirements for the next generation video codec

This contribution aims to improve the requirements that relate to immersive use cases.

The draft “Preliminary draft of use cases and requirements for potential next-generation video coding standard beyond VVC capability” had two immersive use cases that were of interest to this contributor, who suggested that they require novel view synthesis:

* Immersive applications, such as virtual, augmented and mixed reality for communication, interaction and entertainment.
* Representation of content to allow the rendering of a viewpoint from a limited specified perspective

There are also some adjacent use cases that were said to be of interest:

* Single- and multiview representations for medical applications
* Low-delay 3D representation for remote communication

With these use cases in mind, the following content types were suggested to be relevant:

* Stereoscopic and multi-view content.
* Content with associated sample-based maps (e.g. for depth or alpha).
* Coding of alpha and/or depth components together with tristimulus colour components.

The proponent suggested that it is useful to be able to consider multiple partial views or planes with optional depth information and camera parameters.

After discussion, related changes were integrated into the “Preliminary draft of use cases and requirements for potential next-generation video coding standard beyond VVC capability” output document, which was agreed to be produced as an output of VCEG and MPEG WG 2.

Other aspects of discussion

AHG17 testing outside of the CTC was discussed, with a JVET BoG scheduled for Tuesday 1 April.

There was discussion of how to solicit and test constrained-complexity encoding. It was suggested to potentially have multiple tested complexity levels of a proposal.

There was also discussion of how to obtain evidence on other aspects such as loss resilience.

A possible dry run using the ECM was suggested for subjective study at the next meeting.

It was agreed for a preliminary Call for Evidence to be issued at this meeting. The target date for responses was discussed and suggested to be October, since the January 2026 meeting is planned to be online, and remarked that the Santa Eularia facilities of April–May 2026 may not have a lot of meeting space.

Soliciting information on parallelization was suggested.

JVET was asked to produce a draft Call for review in a second joint session to be held on Thursday. It should reference the draft requirements document.

The goal was agreed to be to produce an output draft requirements document as a public output of this meeting, and to further discuss this in the Thursday joint session.

Joint session Thursday 0500-0700

JVET-AL0047, produced by AHG17 and refined by a BoG, was reviewed. Additional notes about that document are found elsewhere in this report. Aspects discussed in the joint session included the following:

* Improved compression
  + Test cases were reviewed
* Fast Improved compression with runtime-constrained encoding
  + Similar test cases (a BoG output from F. Bossen was presented by E. Alshina and reviewed)
    - Comment re training set of NNs as well as other aspects
    - Why the full resolution requirement? It was commented that this could affect NN-based schemes. There was similar language in the other section. It was agreed to modify this to say that methods involving reduced resolution coding need to be described.
    - What about the suggested encoder runtime target – how will this be used? Remarks about multi-threading – multi-threading should be described.
    - It is not necessary to cover the full range of runtime variants. Submitting only a lower runtime variant, for example, should be fine.
    - It is not intended to be very restrictive about what evidence is to be submitted.
    - Are executables and cross-checking really needed? Some said encouragement should suffice. This is partly a matter of simplifying the logistics. It was suggested that this should be generally expected but not absolutely required.
    - Some aspects can remain under study – the intent is to issue a preliminary call.
    - Which version(s) are to be evaluated subjectively? It is not our intention to compare the submissions to each other, but rather to solicit evidence of potential, and testing capability is limited. There is not necessarily an intent to test everything that is submitted.
    - Perceptually optimized submissions are allowed; this should be discussed if not in the document yet. This could be interpreted as conflicting with having a constant-QP recommendation, but the request to have a description of such methods also means this is not prohibited. Optimizations that could apply to the anchor would be valuable to know about. It was agreed to just say that such schemes should be described.
    - “VTM default” means “VTM anchor”
* Other functionality (scalability, error robustness)

There may need to be an AHG preparatory pre-meeting in October.

A “dry run” for the planned evaluation testing is anticipated in July; it was agreed to mention this in the Draft CfE.

The CfE response deadline could be delayed if difficulties are encountered.

The timeline was agreed to be to expect responses for October.

Multipass aspects may need refinement.

Rate point tables are to be added.

The following main action plans were agreed:

* For JVET to issue a public draft joint CfE, referencing a public draft requirements document
* For WG 2 and VCEG to approve the public draft requirements document

## BoGs (1)

[JVET-AL0337](https://jvet-experts.org/doc_end_user/current_document.php?id=15664) BoG report on CfE test conditions for constrained encoder complexity category [F. Bossen, E. Alshina]

The BoG conducted a first session online on April 1st 0515-0705 UTC. A total of 216 participants joined the session.

The BoG conducted a second session online on April 2nd 0727-0820 UTC. A total of 100+ participants joined the session.

The BoG was established after the review of JVET-AL0052 with the following mandates:

* identify the test cases to be prepared for the next meeting in the testing for fast encoding based on VTM, ECM and NNVC
* discuss the open questions (see details below)
* review contributions related to testing conditions targeting reduction of run time
* after meeting with parent bodies, and if the plan to execute such a test is agreed, to discuss a first draft of section 4 in JVET-AL0047

**Review of relevant contributions**

This section was discussed during the first session April 1 0515-0705 UTC chaired by F. Bossen and E. Alshina.

Some contributions listed in the sections 4.10 and 4.16 from the JVET-AL meeting notes can be relevant.

[**JVET-AL0055**](https://jvet-experts.org/doc_end_user/current_document.php?id=15361) **AhG10: On constrained encoder complexity configuration of VTM [T. Solovyev, J. Sauer, J. E. F. Pardo, E. Alshina (Huawei)]**

The document describes alternative configurations of VTM, focusing on lower encoder complexity. Simulation results for the preferred variant (“medium”) show 37%/46%/44%/43% of the encoder runtime with the bd‑rate 4.47%/1.49%/4.17%/4.34% relatively to the default VTM 23.5 RA, AI, LDB and LDP configurations respectively.

Changes partitioning settings for all three proposed configurations (“slow”, “medium”, “fast”). Doesn’t disable tools (except for explicit MTS, implicit MTS is used instead). Note that MTT depth is 0 for inter pictures in “fast” configuration.

The change in MTT depth has the biggest impact.

It was suggested to consider adding configurations as examples to VTM with potentially better names.

[**JVET-AL0263**](https://jvet-experts.org/doc_end_user/current_document.php?id=15590) **Crosscheck of JVET-AL0055 (AhG10: On constrained encoder configuration of VTM) [H. Le Lais, P. de Lagrange (InterDigital)] [late]**

Summary of the random-access “fast” configuration test

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Random Access Main 10** | | | | |
|  | **VTM 23.5 'fast' over VTM 23.4** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | 12.90% | 15.92% | 19.01% | 14.2% | 92.9% |
| Class A2 | 16.26% | 20.21% | 19.98% | 14.9% | 94.3% |
| Class B | 12.65% | 18.83% | 20.01% | 15.9% | 95.9% |
| Class C | 12.22% | 16.73% | 18.45% | 17.7% | 97.3% |
| Class E |  |  |  |  |  |
| **Overall** | **13.31%** | **17.96%** | **19.39%** | **15.8%** | **95.4%** |
| Class D | 11.03% | 16.06% | 16.86% | 27.1% | 95.6% |
| Class F | 12.46% | 16.18% | 17.07% | 25.1% | 102.5% |

Summary of the random-access “medium” configuration test

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Random Access Main 10** | | | | |
|  | **VTM 23.5 'medium' over VTM 23.4** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | 3.65% | 4.56% | 5.52% | 36.9% | 97.2% |
| Class A2 | 5.04% | 6.05% | 5.78% | 38.2% | 100.3% |
| Class B | 4.24% | 5.95% | 5.99% | 37.7% | 100.4% |
| Class C | 4.96% | 6.08% | 6.37% | 34.0% | 100.3% |
| Class E |  |  |  |  |  |
| **Overall** | **4.47%** | **5.73%** | **5.95%** | **36.6%** | **99.7%** |
| Class D | 4.21% | 5.86% | 5.56% | 40.1% | 100.7% |
| Class F | 5.66% | 6.13% | 6.24% | 46.3% | 102.5% |

Summary of the random-access “slow” configuration test

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Random Access Main 10** | | | | |
|  | **VTM 23.5 'slow' over VTM 23.4** | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | 1.24% | 1.55% | 1.83% | 56.7% | 97.4% |
| Class A2 | 1.58% | 2.03% | 1.93% | 59.0% | 96.4% |
| Class B | 1.35% | 1.89% | 1.80% | 59.0% | 98.9% |
| Class C | 1.71% | 2.31% | 2.49% | 56.7% | 97.7% |
| Class E |  |  |  |  |  |
| **Overall** | **1.47%** | **1.96%** | **2.02%** | **57.9%** | **97.8%** |
| Class D | 1.45% | 2.19% | 2.01% | 62.3% | 99.0% |
| Class F | 1.35% | 1.67% | 1.58% | 71.0% | 99.7% |

[**JVET-AL0242**](https://jvet-experts.org/doc_end_user/current_document.php?id=15569) **[AHG7][AHG17] ECM performance under different MTT configurations [S. Puri, K. Naser, F. Le Léannec, E. François (InterDigital)] [late]**

This contribution provides an analysis of ECM coding performance under different configurations by changing the MTT depth. It is asserted that the coding gain vs encoder/decoder time compared to the VTM anchor appears to be highly similar and independent from the MTT depth setting. Furthermore, this contribution evaluates group tools on/off under different MTT depth configurations, where similar behavior is observed. It is shown that by changing the operating point of ECM to use MTT-depth1 or MTT-depth2, a better runtime is achieved making it practical test configuration.

This contribution suggests considering some intermediate operating points with reduced complexity as additional anchors for JVET CFE or CFP.

Tested groups 1-5 off in combination with reduced MTT depth. BD-rate results for group off tests are similar regardless of MTT depth.

The fastest configuration is likely still slower than the VTM (CTC).

[**JVET-AL0245**](https://jvet-experts.org/doc_end_user/current_document.php?id=15572) **[AHG7][AHG17] Further consideration of common test condition [T. Ikai, K.-W. Liang (Sharp)] [late]**

At the last meeting, JVET-AK0232 proposed the development of constraint test conditions and suggested that a better balance between coding efficiency and encoding time should be considered for CTC as well. This document further explores this notion by analyzing experiment results on ECM-16.1 under various MTT depth settings. It is recommended to configure the encoder setting at the next standard to approximately 2x to 4.5x encoding time compared to VTM.

It is proposed to use MTT depth below for ECM CTC.

--MaxMTTHierarchyDepth=2 --MaxMTTHierarchyDepthISliceL=2

--MaxMTTHierarchyDepthISliceC=2 --MaxMTTHierarchyDepthByTid=221111

Request is to have encoder run time constraint for CfE to be <= 4-5x VTM (CTC) for the RA case.

Discussion: this could be a “high” complexity target. Could be 4x to make it a “round” number. Generally agreeable (4-5x). Multiple voices of support.

It was noted that at similar MTT depth, ECM is about 12x the runtime of the VTM.

[**JVET-AL0304**](https://jvet-experts.org/doc_end_user/current_document.php?id=15631) **Crosscheck of JVET-AL0245 ([AHG7][AHG17] Further consideration of common test condition) [J. Pardo (Huawei)] [late]**

**Summary of discussion**

This section was discussed during the first session April 1 0727-0820 UTC chaired by F. Bossen and E. Alshina, unless otherwise noted.

The BoG is aiming to design tests and comparison methodology for constrained encoder complexity category in planned Call for Evidence (CfE).

Open questions are:

* **Should decoder run time be constrained**?
  + Establish constrain DecT\_test < K \* DecT\_anchor ( K- TBD)
    - Pros: more realistic, such constrain is expected to be applicable to final version of standard
    - Cons: too restrictive, in particular if CPU run time is measured then NN-based method will be excluded
  + No decoder run time constrain but K = DecT\_test / DecT\_anchor must be reported and cross-checked
    - Pros: wide range of technologies can participate in CfE, based on K for received responses rule can be refined for CfP
    - Cons: comparison between designs with very different decoder complexity is not very clean
  + Agreed: Decoder run time will not be constrained. However, decoder run time is to be reported and will be considered to determine outcome of CfE.
* **How many complexity points shall be included into the package**?
  + Suggestion from Frank Bossen: 3 constraints for submission
    - a) <= ~5x times VTM (CTC),
    - b) <= ~1x times VTM (CTC),
    - c) <= ~0.2x VTM (CTC) (roughly same HM).

Constraints are “soft” (the main goal is to be able to draw a run time / BD-rate curve, not to hit precise run time targets). Submission for all constraints is strongly encouraged but not mandatory.

A response could include denser sampling of run time / BD-rate curve, e.g., 2.5x and 0.4x.

This was agreed.

Example of run-time / BD-rate curve:

***BD-rate***

***EncT\_test/EncT\_anchor***

0.0%

1 K 11

*preset*=0

*preset*=*N*

*preset*=1

~ECM

* Best in unrestricted encoder category
* Best trade-off

The following items were discussed during the second session April 2 0515-0705 UTC chaired by F. Bossen and E. Alshina.

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* **What should be an anchor**?
  + VTM default configuration
    - Pros: anchor is the same as in other category, ready earlier, less viewing efforts
    - Cons: unrealistically far from real-time encoder configuration
  + VTM constrained (A) encoder speed ~ HM full version or (B) same set of tools as in VVenC ‘faster’ present
    - Pros: analog of SW real-time (1080p@30) encoder
    - Cons: anchor results must be regenerated

Discussion:

VTM (CTC, e.g., default configuration) will be sole anchor against which to compute BD-rate values.

Multiple configurations of VTM will be used to generated a reference curve (default, 3 faster, 1 slower). All VTM configurations will need to be rate matched.

Agreed.

Note: which data points to evaluate subjectively is TBD. Testing all points may not be practical.

* **Which configuration of VTM, ECM, NNVC can become meaningful comparison points**
  + VTM 16.25 vs HM ([JVET-Z0003](https://jvet-experts.org/doc_end_user/documents/26_Teleconference/wg11/JVET-Z0003-v1.zip))
    - RA cfg: 38%, Enc: ×8, Dec: ×2 (1.7), LDB cfg: 28%, Enc: ×7, Dec: ×2 (1.6).
  + NNVC 12 (VLOP) vs VTM 11 ([JVET-AJ0014](https://jvet-experts.org/doc_end_user/documents/36_Kemer/wg11/JVET-AJ0014-v3.zip))
    - RA cfg: 6%, Enc: ×1, Dec: ×15, LDB cfg: 4%, Enc: ×1, Dec: ×16.
  + NNVC 12 (LOP) vs VTM 11 (JVET-AL0014)
    - RA cfg: 8%, Enc: ×1, Dec: ×35, LDB cfg: 6%, Enc: ×1, Dec: ×31.
  + NNVC 12 (HOP) vs VTM 11 ([JVET-AJ0014](https://jvet-experts.org/doc_end_user/documents/36_Kemer/wg11/JVET-AJ0014-v3.zip))
    - RA cfg: 14%, Enc: ×3, Dec: ×1150, LDB cfg: 12%, Enc: ×4, Dec: ×1050.
  + ECM w/o groups 1..5 vs VTM 11 ([JVET-AL0007](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0007-v1.zip))
    - RA cfg: 16%, Enc: ×6, Dec: ×6, LDB cfg: 12%, Enc: ×4, Dec: ×4.
  + ECM w/o group 4 vs VTM 11 ([JVET-AL0007](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0007-v1.zip))
    - RA cfg: 26%, Enc: ×8, Dec: ×9, LDB cfg: 22%, Enc: ×9, Dec: ×8.
  + ECM 13 vs VTM 11 ([JVET-AL0006](https://jvet-experts.org/doc_end_user/documents/38_Teleconference/wg11/JVET-AL0006-v1.zip))

RA cfg: 27%, Enc: ×11, Dec: ×12, LDB cfg: 23%, Enc: ×11, Dec: ×9.

Test results reported in reviewed contributions, as well as results reported by Ahg6, 7 and 14 are visualised on a plot below.

Discussion: use the following data points:

* VTM (5 configurations, see above)
* ECM with about 5x VTM (CTC) time. See JVET-AL0245.
* NNVC LOP (~1x VTM)

Agreed

* **Which complexity measure should be used?**
  + CPU run time? Single thread?
  + If a response is multithreaded, equivalent single-threaded time should be reported. Additional metrics should be included, as for the unconstrained case.
  + Same quality metrics to be used as for the unconstrained case.
* **Which configurations to test?**
  + Random access? Low-delay?
  + Both should be tested (see below)
* **Which content classes to test in constrained encoder category?** 
  + **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 in portrait format at 1080×1920 resolution using a random-access configuration.

Option a) all content classes, but not obligation to respond with all content classes

Option b) exclude some content classes for constrained encoder

Agreed to include all content classes. Submitting for all classes is strongly encouraged. If not all classes are included in a response, included classes should have all sequences in the class.

***BD-rate***

***EncT\_test/EncT\_anchor***

0.0%

1 K 11

*preset*=0

*preset*=*N*

*peset*=1

~ECM

* Best in unrestricted encoder category
* Best trade-off

During the presentation of v1 of the BoG report on Wednesday 2 April morning, it was agreed in JVET plenary to include JVET-AL0055 as a new alternative configuration for reduced encoding time in JVET-AL2010.

From follow-up review in JVET plenary after second BoG meeting:

* Decoder constraints will not be imposed, but runtime to be reported (could in principle also be measured from the bitstreams and binary decoders)
* Range of encoder run time 0.2x…5x appears reasonable, but no rigid constraint that it is a MUST to cover the entire range. Any information on this would be welcome. Submitting 3 points is recommended, but any submission starting from 1 point would be considered

Contributions bringing additional information already to the next meeting (outside of the collective preparation with VTM/ECM) would be welcome and could be included in the dry-run testing.

For VTM, 3 faster configurations, and the “slow” configurations could be tested additionally to CTC.

## Liaison communications (1)

The following liaison statements were received at this meeting.

[MPEG m71590](https://dms.mpeg.expert/doc_end_user/current_document.php?id=97659&id_meeting=201) / SC 29 N 22551 / WG 1 N 101111 Liaison letter from SC 29/WG 1 to WG 4 and WG 5 on JPEG AI

This liaison letter had arrived late during the previous JVET meeting, so no response was prepared from JVET at that meeting. JPEG had not held a meeting since it sent this letter in January.

WG1 described the following developments regarding JPEG AI, from its 106th JPEG meeting, 6–10 January 2025.

* JPEG AI Part 1 had become an International Standard to be published very soon.
* Further focus on Part 1 will be devoted to a version 2 as planned.

The discussions focused on JPEG AI Part 2: Profiling, Part 3: Reference Software, Part 4: Conformance and Part 5: File format. JPEG AI Parts 2, 3 and 5 had moved to the Draft International Standard (DIS) stage.

* Part 2: Profiling: The discussions centered on defining levels, with an analysis of decoder memory requirements for different values of key syntax elements, such as synthesis tile/overlap size, and residual and hypedecoder tile/overlap size. Additionally, memory requirements for models (parameters) across different profiles were examined, along with the characteristics of popular devices. The conclusion reached was that there is no need to specify limits for tile sizes and overlaps. Therefore, the level specification, which defines the lower bound on the throughput of a conforming decoder, was based solely on reconstructed image sizes (number of samples) and the number of models. Furthermore, one Main stream profile and three decoder tool subsets as three decoder profiles are specified. A stream must uniquely define one stream and one or more decoder profiles in a combined way.
* Part 3: Reference Software: The reference decoder software is capable of decoding codestreams that conform to ISO/IEC 6048-1. The reference software includes the following components for informational reasons: 1) encoder, 2) training scripts, 3) evaluation procedure for evaluation of the codec on a dataset, 4) natural test dataset and 5) pretrained models in PyTorch format.
* Part 5: File Format: Existing file format specifications have been extended to accommodate the embedding of JPEG AI codestreams. Specifically, Part 5 outlines the use of JPEG AI coding for timed image sequences within files based on the ISO base media file format (ISO/IEC 14496-12), referred to as Motion JPEG AI. This file format is designed to store one or more motion sequences of JPEG AI compressed images along with their associated timing. Additionally, it specifies the encapsulation of JPEG AI images, image collections, and image sequences within the HEIF image file format (ISO/IEC 23008-12).

Regarding Part 4 (conformance), the plan was to issue the DIS at the next JPEG meeting. The work has been focused on addressing DoCR comments and to improve and refine the text of the specification.

In addition, the experimental results of two Core Experiments were discussed and analysed, along with two input contributions about Gain Map for HDR image transmission and compressed domain image classification.

The following core experiments were established in the 106th JPEG meeting:

* CE11.1 - JPEG AI Subjective Assessment Study
* CE11.2 - Gain map compression using JPEG AI
* CE11.3 - Smartphone implementation of JPEG AI decoder

WG1 looked forward to continued coordination, cooperation and collaboration with WG4 and WG5.

WG 5 N 356 Liaison statement to ISO/IEC JTC 1/SC 29/WG 1 (JPEG) on JPEG AI and explorations on video coding

A liaison reply document WG 5 N 356 was prepared in response to the incoming letter MPEG m71590 / SC 29 N 22551 / WG 1 N 101111 and was reviewed in JVET on Thursday 3 April at 1300-1320. The draft reply was also presented in the MPEG AG 3 Communication meeting Thursday 3 April during 1300-1500. The content of that reply is described below.

The Joint Video Experts Team (JVET) of ITU-T WP3/21 and ISO/IEC JTC 1/SC 29 (as WG 5 in SC 29) thanked ISO/IEC JTC 1/SC 29/WG 1 (JPEG) for its liaison reply and its update on the status of the JPEG AI project (ISO/IEC JTC 1/SC 29 N 22551 a.k.a. JTC 1/SC 29/WG 1 N 101111).

The letter said to JPEG that on our side, in the exploration of neural network-based video coding (NNVC), we have updated our common software codebase to version 12 (NNVC-12). The new version of NNVC supports four tools: NN-based intra coding mode, NN-based super-resolution, NN-based post-filter, and an NN-based in-loop filter which has three operation points: high (HOP), low (LOP) and very low complexity (VLOP), and additionally a content-adaptive version of the low operation point NN-based in-loop filter is supported. Test results for some possible tool combinations with NNVC-12 can be found in [JVET-AL0014](https://jvet-experts.org/doc_end_user/current_document.php?id=15349) – the AhG report on NNVC software development.

JVET said the primary focus in the NNVC development is its use for video coding with inter-picture prediction for random access and low-delay configurations. However, of particular interest for JPEG would be results in the all-intra test configuration. Relative to VTM-11, the measured improvement of NNVC-12 is as follows:

* LOP (Low Operation Point) BD-rate: 9.2%, Enc. Time ×1.6, Dec.Time ×26;
* HOP (High Operation Point) BD-rate: 13.7%, Enc. Time ×2.5, Dec.Time ×769;
* VLOP (Very Low Operation Point) BD-rate: 7.3%, Enc. Time ×1.5, Dec.Time ×11;

The major focus of JVET is video coding. In the random access configuration, relative to VTM-11, the measured improvement of NNVC-12 is as follows:

* LOP (Low Operation Point) BD-rate: 8.2%, Enc. Time ×1.2, Dec.Time ×35;
* HOP (High Operation Point) BD-rate: 14.2%, Enc. Time ×2.5, Dec.Time ×1135;
* VLOP (Very Low Operation Point) BD-rate: 5.8%, Enc. Time ×1.1, Dec.Time ×15;

In all of these tests, only the NN-based intra coding and NN-based in-loop filter are enabled. Depending on the in-loop filter configuration, the computational complexity measured in kMAC/pixel is 22 for LOP, 471 for HOP and 10 for VLOP.

PSNR-Y is used as the quality metric for these results, and encoding and decoding run time are measured on a CPU single thread. Compared to earlier versions of NNVC, the compression performance keeps improving while complexity (measured in CPU run time and kMAC/pixel) reduces.

A document describing algorithms and software modules contained in the NNVC common software codebase has been issued as [JVET-AL2019](https://jvet-experts.org/doc_end_user/current_document.php?id=15681) (with an editing period).

[JVET-AL0023](https://jvet-experts.org/doc_end_user/current_document.php?id=15401) is a summary report of our Exploration Experiment 1 evaluating performance and complexity aspects of NNVC technologies. One of the recent developments was 0.6% compression performance improvement of the LOP configuration by addition of the attention block into the filter design.

JVET has received several proposals demonstrating combinations of end-to-end AI based and traditional coding, in particular, end-to-end AI coded pictures are inserted as external reference pictures for a traditional codec. A compression performance improvement achievable by this approach is reported at the level 4% BD-rate in the all-intra configuration, and 1% for random access. In order to further explore this possibility, it is intended to add support for this functionality to an exploration branch of the NNVC software. In order for a JPEG AI coded external reference picture to be considered in this exploration, it should meet requirements of bit-exact reproducibility.

The study of NN-based algorithms for video coding will be continued in Exploration Experiment 1. The description for tests included into the next round of EE 1 has been issued as [JVET-AL2023](https://jvet-experts.org/doc_end_user/current_document.php?id=15671) (with an editing period). Exploration Experiment 1 will include the following categories of explorations: very low and low operation point in-loop filters, NN-based inter and NN-based super resolution.

Another major focus of JVET is the exploration of potential tool extensions using more conventional video coding technologies for coding efficiency improvements. This work also primarily focuses on inter-picture predictive video coding with random access and low-delay configurations. Candidate technologies have been adopted into the Enhanced Compression Model (ECM), with an algorithm description documented in [JVET-AL2025](https://jvet-experts.org/doc_end_user/current_document.php?id=15683) (with an editing period) and coordinated software implementation for testing. The performance of ECM-16.0 is summarized in [JVET-AL0006](https://jvet-experts.org/doc_end_user/current_document.php?id=15389). Of particular interest to JPEG is the all-intra configuration. Relative to a corresponding VVC anchor, ECM-16.0 demonstrates 16.5% BD-rate gain (based on PSNR-Y) in the all-intra configuration with ×11 encoding and ×6 decoding run time ratios (based on CPU run time). This version of the ECM includes the neural network based intra prediction mode, and an interface for testing different variants of NN-based in-loop filters has been added in this meeting. It was reported that on top of the ECM in all-intra configuration tests, BD-rate gain of 0.7%, 1.3% and 3.4% BD-rate gain can be achieved by the VLOP, LOP and HOP variants of NN-based in-loop filters, respectively. In random access configuration BD-rate gain is 0.9%, 1.7% and 5.4% for the VLOP, LOP and HOP variants of NN-based in-loop filters, respectively.

Based on consultation with parent bodies, JVET said it has issued a draft Joint Call for Evidence on video compression with capability beyond existing standards with a current plan to perform an evaluation in October 2025. CfE responses might also include solutions based on neural network technologies.

JVET said that it looks forward to further communicating with JPEG on items of mutual interest.

# Project planning

## Software timeline

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-AL2023.

An EE on enhanced compression technology beyond VVC capability using techniques other than neural-network technology was also established, as recorded in output document JVET-AL2024.

Initial versions of these documents were presented and approved.

## Drafting of specification text, encoder algorithm descriptions, and software

The following agreement has been established: the editorial team has the discretion to not integrate recorded adoptions for which the available text is grossly inadequate (and cannot be fixed with a reasonable degree of effort), if such a situation hypothetically arises. In such an event, the text would record the intent expressed by the committee without including a full integration of the available inadequate text.

## Plans for improved efficiency and contribution consideration

The group considered it important to have the full design of proposals documented to enable proper study.

Adoptions need to be based on properly drafted working draft text (on normative elements) and HM/VTM encoder algorithm descriptions – relative to the existing drafts. Proposal contributions should also provide a software implementation (or at least such software should be made available for study and testing by other participants at the meeting, and software must be made available to cross-checkers in EEs).

Suggestions for future meetings included the following generally-supported principles:

* Normative contributions (relating to changes in bitstream/decoder) shall include draft specification text
* Proposals shall contain all details relevant for understanding and be self-contained. In cases where the document is a follow-up of a previous contribution, the overall concept and the novelties should be highlighted at minimum
* Coding tool and encoder optimization proposals shall contain Excel sheets that allow assessment on a per-sequence basis
* Algorithm description text is strongly encouraged for non-normative contributions that are intended to be included in model description documents (VTM, ECM, etc.), and that is required for inclusion in TR drafts.
* Early upload deadline to enable substantial study prior to the meeting
* Using a clock timer to ensure efficient proposal presentations (5 min) and discussions (not exercised currently)

As general guidance, it was suggested to avoid usage of company names in document titles, software modules etc., and not to describe a technology by using a company name.

## General issues for experiments

It was emphasized that those rules which had been set up or refined during the 12th JVET meeting should be observed. In particular, for some CEs of some previous meetings, results were available late, and some changes in the experimental setup had not been sufficiently discussed on the JVET reflector.

Group coordinated experiments have been planned as follows:

* “Core experiments” (CEs) are the coordinated experiments on coding tools which are deemed to be interesting but require more investigation and could potentially become part of a draft standard by the next meeting or in the near future.
* “Exploration experiments” (EEs) are also coordinated experiments. These are conducted on technology which is not foreseen to become part of a draft standard in the near future. The investigating methodology for assessment of such technology can also be an important part of an EE. (Further general rules for EEs, as far as deviating from the CE rules below, should be discussed in a future meeting. For the current meeting, procedures as described in the EE description document are deemed to be sufficient.)
* A CE is a test of a specific fully described technology in a specific agreed way. It is not a forum for thinking of new ideas (like an AHG). The CE coordinators are responsible for making sure that the CE description is complete and correct and has adequate detail. Reflector discussions about CE description clarity and other aspects of CE plans are encouraged.
* A description of each experiment is to be approved at the meeting at which the experiment plan is established. This should include the issues that were raised by other experts when the tool was presented, e.g., interference with other tools, contribution of different elements that are part of a package, etc. The experiment description document should provide the names of individual people, not just company names.
* Software for tools investigated in a CE will be provided in one or more separate branches of the software repository. Each CE will have a “fork” of the software, and within the CE there may be multiple branches established by the CE coordinator. The software coordinator will help coordinate the creation of these forks and branches and their naming. All JVET members will have read access to the CE software branches (using shared read-only credentials as described below).
* During the experiment, revisions of the experiment plans can be made, but not substantial changes to the proposed technology. Withdrawing parts of experiments that were intended to show the individual benefits of a tool or parts of a tool is strongly discouraged. Combination tests may not be considered in such cases. Any changes made to individual tools in a combination shall be documented.
* The CE description must match the CE testing that is done. The CE description needs to be revised if there has been some change of plans.
* The CE summary report must describe any changes that were made in the process of finalizing the CE.
* By the next meeting it is expected that at least one independent cross-checker will report a detailed analysis of each proposed feature that has been tested and confirm that the implementation is correct. Commentary on the potential benefits and disadvantages of the proposed technology in cross-checking reports is highly encouraged. Having multiple cross-checking reports is also highly encouraged (especially if the cross-checking involves more than confirmation of correct test results). The reports of cross-checking activities may (and generally should) be integrated into the CE report rather than submitted as separate documents.
* It is mandatory to report encoder optimizations made for the benefit of a tool, and if an equivalent optimization could be applied on the anchor, a comparison against the improved anchor shall be provided.
* A new proposal can be included in a CE based on group decision, regardless if an independent party has already performed a cross-check in the meeting when it was first proposed.

It is possible to define sub-experiments within particular CEs, for example designated as CEX.a, CEX.b, etc., where X is the basic CE number.

As a general rule, it was agreed that each CE should be run under the same testing conditions using one software codebase, which should be based on the group test model software codebase. An experiment is not to be established as a CE unless there is access given to the participants in (any part of) the CE to the software used to perform the experiments.

The general agreed common conditions for single-layer coding efficiency experiments for SDR video are described in the prior output document JVET-T2010.

Experiment descriptions should be written in a way such that it is understood as a JVET output document (written from an objective “third party perspective”, not a proponent perspective – e.g., not referring to methods as “improved”, “optimized”, “enhanced”, etc.). The experiment descriptions should generally not express opinions or suggest conclusions – rather, they should just describe what technology will be tested, how it will be tested, who will participate, etc. Responsibilities for contributions to CE work should identify individuals in addition to company names.

CE descriptions contain a basic description of the technology under test, but should not contain excessively verbose descriptions of a technology (at least not unless the technology is not adequately documented elsewhere). Instead, the CE descriptions should refer to the relevant proposal contributions for any necessary further detail. However, the complete detail of what technology will be tested must be available – either in the CE description itself or in documents that are referenced in the CE description that are also available in the JVET document archive.

Any technology must have at least one cross-check partner to establish a CE – a single proponent is not enough. It is highly desirable have more than just one proponent and one cross-checker.

The CE development workflow 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 1200 on 4 Apr., preferably copy from the table below and sending with changemarks or yellow highlight of changes.

Review of AHG plans was conducted during the plenary on Friday 4 Apr. 2025 at 1515–1615.

|  |  |  |
| --- | --- | --- |
| **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 357) in order to make it easy to reference.

# Output documents

The following documents were agreed to be produced or endorsed as outputs of the meeting. Names recorded below indicate the editors responsible for the document production. Where applicable, dates of planned finalization and corresponding parent-body document numbers are also noted.

It was reminded that in cases where the JVET document is also made available as 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 357, as noted in section 9.

[JVET-AL1000](https://jvet-experts.org/doc_end_user/current_document.php?id=15673) Meeting Report of the 38th JVET Meeting [J.-R. Ohm] [WG 5 N 344] (2025-05-02)

Initial versions of the meeting notes (d0 … d9) were made available on a daily basis during the meeting.

Remains valid – not updated: [JVET-AC1001](https://jvet-experts.org/doc_end_user/current_document.php?id=12566) Guidelines for HM-based software development [K. Sühring, F. Bossen, X. Li (software coordinators)]

Remains valid – not updated: [JVET-Y1002](https://jvet-experts.org/doc_end_user/current_document.php?id=11463) High Efficiency Video Coding (HEVC) Test Model 16 (HM 16) Encoder Description Update 16 [C. Rosewarne (primary editor), K. Sharman, R. Sjöberg, G. J. Sullivan (co-editors)] [WG 5 [N 103](https://dms.mpeg.expert/doc_end_user/current_document.php?id=82085&id_meeting=189)]

Remains valid – not updated: [JVET-AH1003](https://jvet-experts.org/doc_end_user/current_document.php?id=14259) Coding-independent code points for video signal type identification (Draft 3) [G. J. Sullivan, A. Tourapis]

Primary editor: G. J. Sullivan.

[JVET-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.

Remains valid – not updated: [JVET-AH1005](https://jvet-experts.org/doc_end_user/current_document.php?id=14261) Technology under consideration for future editions of CICP [E. Thomas, A. Tourapis] [WG 5 N 289)]

From new activities and contributions kept for further study, updates expected in future meetings.

[JVET-AL1006](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] [WG 5 DAM N 349)] (2025-04-18)

Primary editor: Y.-K. Wang.

A DoC WG 5 N 348 on the CDAM was reviewed and approved on Friday 4 April at 0550-0600.

Changes agreed at this meeting:

* JVET-AL0059 AHG9: Inclusion of the packed regions information SEI message in HEVC
* JVET-AL0061 AHG 9: Encoder optimization information for AVC and HEVC
* JVET-AL0062 AHG 9: AI usage restrictions SEI message for AVC and HEVC
* JVET-AL0148 AHG9: Generative face video and generative face video enhancement SEI messages for HEVC and AVC
* JVET-AL0210 AHG9: On SEI processing order SEI message for HEVC and AVC
* JVET-AL0223 Corrections and clarifications for profile-related aspects of the draft text of HEVC
* JVET-AL0339 Merged text of JVET-AL0086 and JVET-AL0204 for the FGC 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.

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-AL1017](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 CDAM N 345] (2025-04-18)

Primary editor: B. Bross

Changes agreed at this meeting:

* JVET-AL0061 AHG 9: Encoder optimization information for AVC and HEVC
* JVET-AL0062 AHG 9: AI usage restrictions SEI message for AVC and HEVC
* JVET-AL0148 AHG9: Generative face video and generative face video enhancement SEI messages for HEVC and AVC
* JVET-AL0210 AHG9: On SEI processing order SEI message for HEVC and AVC

Resolved bug fixes carried over from JVET-AK1004 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-AL1018](https://jvet-experts.org/doc_end_user/current_document.php?id=15677) HEVC with extensions and corrections (Draft 1) [G. J. Sullivan, Y.-K. Wang] (2025-06-15)

Primary editor: Y.-K. Wang.

To prepare the next edition of H.265 – developed from JVET-AL0223, in particular regarding the editorial updates on profiles. Other changes made in the differential text JVET-AL1006 (e.g., new SEI messages) not yet 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-AL2005](https://jvet-experts.org/doc_end_user/current_document.php?id=15678) Additions and corrections for VVC version 4 (Draft 12) [G. J. Sullivan, B. Bross, M. M. Hannuksela, Y.-K. Wang] [WG 5 DAM N 351)] (2025-04-18)

A DoC WG 5 N 350 on the CDAM was reviewed and approved on Friday 4 April at 0505-0520.

Changes agreed at this meeting:

* JVET-AL0056 AHG9: On the encoder optimization information SEI message
* JVET-AL0123 AHG9: On the encoder optimization information (EOI) SEI message
* JVET-AL0117 AHG9: On association of NAL units to DSC verification substreams
* JVET-AL0324 (incl. aspects of JVET-AL0072, JVET-AL0098, JVET-AL0120, JVET-AL0122, JVET-AL0129, JVET-AL0303) AHG9: A summary of proposals on the PRI SEI message
* JVET-AL0130 AHG9: Source picture timing for interlaced video with SPTI SEI message
* JVET-AL0339 Merged text of JVET-AL0086 and JVET-AL0204 for the FGC 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: G. J. Sullivan.

[JVET-AL2006](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] [WG 5 DAM N 347)] (2025-04-18)

A DoC WG 5 N 346 on the CDAM was reviewed and approved on Friday 4 April at 0520-0550.

Changes agreed at this meeting:

* SPO
  + JVET-AL0063 AHG9: On SPO SEI message
  + JVET-AL0064 AHG9: On the SPO SEI message complexity signalling
  + JVET-AL0208 AHG9: On SPO root-process signalling constraint
* NNPF
  + JVET-AL0075 AHG9: On nnpfa\_num\_input\_pic\_shift
  + JVET-AL0096 AHG9: On signalling of extension syntax elements in NNPFA SEI message
* EOI
  + JVET-AL0056 AHG0: On the encoder optimization information SEI message
  + JVET-AL0123 AHG9: On the encoder optimization information (EOI) SEI message
  + JVET-AL0310 On signalling of resampling type for EOI SEI message
* OMI
  + JVET-AL0066 AHG9: Lossy compression with Object mask info SEI
  + JVET-AL0067 AHG9: On the OMI SEI
  + JVET-AL0071 AHG9: On OMI SEI message
* GFV
  + JVET-AL0155 AHG9: Further fixes and cleanup on GFV and GFVE SEI messages
* DSC
  + JVET-AL0078 AHG9: On Digital Signing
  + JVET-AL0103 AHG9: Editorial changes for the three DSC SEI messages
  + JVET-AL0117 AHG9: On association of NAL units to DSC verification substreams
  + JVET-AL0118 AHG9: Miscellaneous changes for the three DSC SEI messages
  + JVET-AL0222 AHG9: On Digitally Signed Content SEI messages
  + JVET-AL0327 AHG9: Handling of multiple DSC systems
* PRI
  + JVET-AL0070 AHG9: On packed regions information SEI message
  + JVET-AL0324 (incl. aspects of JVET-AL0072, JVET-AL0098, JVET-AL0120, JVET-AL0122, JVET-AL0129, JVET-AL0303) AHG9: A summary of proposals on the PRI SEI message
* IFM
  + JVET-AL0068 AHG9: On image format metadata (IFM) SEI
  + JVET-AL0094 AHG9: On payload length of image format metadata (IFM) SEI
  + JVET-AL0128 AHG9: On image format metadata SEI message
* AUR
  + JVET-AL0058 AHG9: On the AI usage restrictions SEI message
* TDI
  + JVET-AL0077 AHG9: On the text description information SEI message
* SPTI
  + JVET-AL0130 AHG9: Source picture timing for interlaced video with SPTI SEI message
* FGC
  + JVET-AL0339 AHG9: Merged text of JVET-AL0086 and JVET-AL0204 for the FGC SEI message
* Multiple
  + JVET-AL0132 AHG9: Editorial updates for VSEI v4
  + JVET-AL0131 AHG9: Proposed changes for miscellaneous aspects of SEIs in VSEI v4
  + JVET-AL0249 AHG9: Proposed modifications to VSEI to address national body comments
  + JVET-AL0301 AHG9: VSEI specification changes to reference the 3rd edition of video CICP

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

Primary editor: J. Boyce.

Remains valid – not updated: [JVET-AJ2007](https://jvet-experts.org/doc_end_user/current_document.php?id=14996) Guidelines for NNVC software development [F. Galpin, S. Eadie, L. Wang, Z. Xie, Y. Li]

Remains valid – not updated: [JVET-X2008](https://jvet-experts.org/doc_end_user/current_document.php?id=11228) Conformance testing for versatile video coding (Draft 7) [J. Boyce, F. Bossen, K. Kawamura, I. Moccagatta, W. Wan]

The document number was planned to be re-used for a 3rd edition in ITU , once that is submitted to ITU-T (could be in October 2025).

Remains valid – not updated: [JVET-AJ2009](https://jvet-experts.org/doc_end_user/current_document.php?id=14997) Reference software for versatile video coding 2nd edition (Draft 2) [F. Bossen, K. Sühring, X. Li] [WG 5 DIS N 322)]

Software relating to H.266.2 and ISO/IEC 23090-16 can be found at <https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/-/tree/2nd-edition>.

Primary editor: F. Bossen.

[JVET-AL2010](https://jvet-experts.org/doc_end_user/current_document.php?id=15680) VTM and HM common test conditions and software reference configurations for SDR 4:2:0 10 bit video [F. Bossen, X. Li, V. Seregin, K. Sharman, K. Sühring] (2025-04-18)

Add alternative configuration from JVET-AL0055 and clarification about intra picture period (see discussion under JVET-AL0114). Also links to test sequences are updated due to the change of the content server.

Remains valid – not updated: [JVET-AC2011](https://jvet-experts.org/doc_end_user/current_document.php?id=12575) VTM and HM common test conditions and evaluation procedures for HDR/WCG video [A. Segall, E. François, W. Husak, S. Iwamura, D. Rusanovskyy]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-U2012](https://jvet-experts.org/doc_end_user/current_document.php?id=10681) JVET common test conditions and evaluation procedures for 360° video [Y. He, J. Boyce, K. Choi, J.-L. Lin]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-T2013](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=10546) VTM common test conditions and software reference configurations for non-4:2:0 colour formats [Y.-H. Chao, Y.-C. Sun, J. Xu, X. Xu]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-Q2014](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9683) JVET common test conditions and software reference configurations for lossless, near lossless, and mixed lossy/lossless coding [T.-C. Ma, A. Nalci, T. Nguyen]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-Q2015](http://phenix.it-sudparis.eu/jvet/doc_end_user/current_document.php?id=9684) JVET functionality confirmation test conditions for reference picture resampling [J. Luo, V. Seregin]

Links to test sequences need to be updated due to the change of the content server.

Remains valid – not updated: [JVET-AJ2016](https://jvet-experts.org/doc_end_user/current_document.php?id=14998) Common test conditions and evaluation procedures for neural network-based video coding technology [E. Alshina, F. Galpin, R.-L. Liao, S. Liu, A. Segall]

Remains valid – not updated: [JVET-AI2017](https://jvet-experts.org/doc_end_user/current_document.php?id=14615) Common test conditions and evaluation procedures for enhanced compression tool testing [M. Karczewicz, Y. Ye]

Links to test sequences need to be updated due to the change of the content server.

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-AL2019](https://jvet-experts.org/doc_end_user/current_document.php?id=15681) Description of algorithms version 11 and software version 13 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:

* Decision: Adopt the architecture from JVET-AL0084, using the model parameters from cross-check JVET-AL0246. It was also requested to double-check the correctness of the LOP diagram to be used in JVET-AL2019.
* Decision: Adopt JVET-AL0169. Training script also should be submitted with the merge request.

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-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)

Draft 1 (the output of the last meeting) was submitted for ITU approval, only containing necessary bug fixes and clarifications on top of the TR already approved in ISO/IEC. This means that currently the ITU and ISO versions are slightly diverging. JVET-AK2020 contains some paragraphs only relevant for v2 of ISO (as those are already included in v1 of ITU), and other paragraphs adding additional aspects that would be relevant for v2 of both ISO and ITU. It is expected that by the time of finalization of v2, alignment of the twin text can be reached.

New elements from JVET-AL0282.

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-AL2023](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)] (2025-04-18)

An initial draft of this document was reviewed and approved at 0855-0910 on Friday 4 April.

This round of EE1 tests includes:

* *EE1-1: LOP in-loop filter* 
  + EE1-1.1 – Sample-based adaptive blending weight selection for LOP
  + EE1-1.2 – Over-Parameterized LOP In-Loop Filter
  + EE1-1.3 – Backbone Block Enhancement of LOP In-Loop Filter with Over-Parameterized Training and Variable Channels
  + EE1-1.4 – Conditional loop-filter
* *EE1-2: VLOP in-loop filter* 
  + EE1-2.1 – Improved VLOP with Attention
  + EE1-2.2 – Conditional loop-filter
* *EE1-3: NN-inter prediction*
  + EE1-3.1 – RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding
  + EE1-3.2 – Deep Reference Frame Generation for Inter Prediction Enhancement
* *EE1-4: NN-based super-resolution*
  + EE1-4.1 – Cross-component enhanced NNSR

[JVET-AL2024](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)] (2025-05-02)

An initial draft of this document was reviewed and approved at 1300-1310 on Friday 4 April.

This round of EE2 tests will include:

|  |  |
| --- | --- |
| **1 Intra prediction** | |
| 1.1 | TIMD fusion with neural network based intra prediction |
| 1.2a | TIMD fusion with block vector based prediction |
| 1.2b | BV merge list improvement |
| 1.2c | Test 1.2a + Test 1.2b |
| 1.3 | IntraTMP template type adaptation |
| 1.4 | Test 1.2c + Test 1.3 |
| 1.5 | Test 1.1 + Test 1.4 |
| 1.6a | Intra merge mode |
| 1.6b | Intra merge mode using another adjacency map. |
| 1.7a | Block prediction with cubic interpolation filter in TIMD |
| 1.7b | Template prediction with 6-tap interpolation filter in TIMD |
| 1.7c | Test 1.7a + Test 1.7b |
| 1.8 | Harmonization of SGPM-BV and LIC |
| 1.9 | Block vector-based intra mode derivation |
| 1.10a | Matrix-based position dependent intra prediction for GPM |
| 1.10b | Matrix-based position dependent intra prediction for CIIP |
| 1.10c | Matrix-based position dependent intra prediction for GPM/CIIP |
| 1.10d | Extension to regression GPM |
| **2 Inter prediction** | |
| 2.1a | Chained candidates in AMVP list |
| 2.1b | Chained candidates in AMVP and merge lists |
| 2.2a | Regression-based GPM intra-inter blending weights derivation in original domain |
| 2.2b | Regression-based GPM intra-inter blending weights derivation in LMCS domain |
| 2.3 | Affine bilateral matching merge mode |
| **3 Transform and coefficients coding** | |
| 3.1a | Predictive transform coefficient coding |
| 3.1b | Test 3.1a on very high bitrate (QP 2, 7, 12, 17) |
| 3.2 | Directional sign prediction |
| 3.3 | Third transform set selection for IntraNN |
| 3.4a | Reduced zero-out for NSPT kernels |
| 3.4b | Decreased number of NSPT kernels |
| 3.4c | Test 3.4a + Test 3.4b |
| 3.5 | Test 3.3 + Test 3.4 |
| 3.6a | Modified binarization of bypass-coded TSRC |
| 3.6b | Modified priority of sig\_coeff\_flag context coding in TSRC |
| 3.6c | Test 3.6b with relaxed budget constraint |
| 3.6d | ECM anchor with no budget restraint |
| **4 In-loop filtering** | |
| 4.1 | TALF with reconstructed samples |
| 4.2 | Reuse of ALF control information |
| 4.3 | On ALF-CCCM |
| 4.4 | NN-ILF integration with ALF |
| 4.5 | Improvement of the NN ILF in ALF |

[JVET-AL2025](https://jvet-experts.org/doc_end_user/current_document.php?id=15683) Algorithm description of Enhanced Compression Model 17 (ECM 17) [M. Coban, R.-L. Liao, K. Naser, J. Ström, L. Zhang] (2025-06-15)

New elements from notes elsewhere in this report:

*Partitioning*

* Decision: Adopt JVET-AL0143 test 1.1.c

*Intra prediction*

* Decision: Adopt JVET-AL0206 test 2.9
* Decision: Adopt JVET-AL0191 test 2.2d
* Decision: Adopt JVET-AL0126 test 2.3
* Decision: Adopt JVET-AL0188 test 2.5
* Decision: Adopt JVET-AL0125 Test 2.6c
* Decision: Adopt JVET-AL0108 Test 2.7

*Inter prediction*

* Decision: Adopt JVET-AL0160 test 3.1
* Decision: Adopt JVET-AL0157 test 3.3e
* Decision: Adopt JVET-AL0134 test 3.4a
* Decision: Adopt JVET-AL0079 test 3.5
* Decision: Adopt JVET-AL0214 test 3.6
* Decision: Adopt JVET-AL0161 test 3.7b
* Decision: Adopt JVET-AL0162 test 3.8a
* Decision: Adopt JVET-AL0081 test 3.9

*Transform and coefficient coding*

* Decision: Adopt JVET-AL0181 test 4.1
* Decision: Adopt JVET-AL0215 test 4.4c

*In-loop filtering*

* Decision: Adopt JVET-AL0153 test 5.1
* Decision: Adopt JVET-AL0142 test 5.2
* Decision: Adopt JVET-AL0135 test 5.3b
* Decision: Adopt JVET-AL0182 (TALF reference picture extensions)
* Decision(SW): Adopt JVET-AL0228 (NNLF interface) to ECM. Shall be disabled by default (via macro, or establishing a separate branch). Also include description of interface in JVET-AL2025.

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-AL2026**](https://jvet-experts.org/doc_end_user/current_document.php?id=15684)**Draft Joint Call for Evidence on video compression with capability beyond VVC [J.-R. Ohm, M. Wien] [WG 5 N 355] (2025-04-15)**

Developed from JVET-AL0047v5 and JVET-AL0338, to be finalized in AHG17 telco (April 15).

Remains valid – not updated: [JVET-AJ2027](https://jvet-experts.org/doc_end_user/current_document.php?id=15005) Common test conditions for gaming applications [J. Sauer, R. Chernyak, S. Puri, S. Thiebaud]

[JVET-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 CD, WG 5 N 352 to be issued integrating these new bitstreams in ISO style, and deliver the corrected and bitstreams together with the valid old bitstreams as an attachment (preferentially mid to end of June to have CD ballot results in October). The ISO secretariat needs to be informed to create a URL for the conformance bitstreams. This is formally not necessary for the CD ballot which could point to the ftp site that is used for conformance development, but might be useful to be requested as early as possible to later speed up the delivery of the DIS.

Remains valid – not updated: [JVET-AH2029](https://jvet-experts.org/doc_end_user/current_document.php?id=14274) Visual quality comparison of ECM/VTM encoding [V. Baroncini, J.-R. Ohm, M. Wien] [AG 5 N 118]

[JVET-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 4 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-AL2032](https://jvet-experts.org/doc_end_user/current_document.php?id=15687) Technologies under consideration for future extensions of VSEI (version 8) [S. McCarthy, J. Boyce, J. Chen, S. Deshpande, M. M. Hannuksela, H. Tan, Y.-K. Wang] (2025-05-16)

New elements from notes elsewhere in this report:

* FGC
  + JVET-AL0211 AHG9: Resolution nesting for FGC SEI message
* SPO
  + JVET-AL0064 AHG9: On the SPO SEI message complexity signalling
* EOI
  + JVET-AL0221 AHG9: EOI SEI message with luma range adaptation for machine analysis
* DSC
  + JVET-AL0186 AHG9: Subpicture support for digitally signed content SEI messages
* Multiple
  + JVET-AL0308 AHG9: On layer ID syntax elements in VSEI TuC
  + JVET-AL0093 AHG 9: On value range for syntax elements coded as u(v)
* NNPF
  + JVET-AL0175 AHG9: On Target Mastering Colour Volume Information in the NNPFC SEI message for Tone Mapping
  + JVET-AL0209 AHG9: On providing robustness against layer dropping in multi-layer NNPF
* CR
  + JVET-AL0095 AHG 9: On constituent rectangles SEI message
  + JVET-AL0139 AHG9: On multilayer support for CR SEI
* DR
  + JVET-AL0097 AHG 9: Gaussian blur filling method in display rectangles SEI message
  + JVET-AL0099 AHG9: On design of display rectangles SEI message
  + JVET-AL0138 VVC interface for Display Rectangles SEI
  + JVET-AL0141 AHG9: Showcase on the implementation of display rectangles SEI
* MPI
  + JVET-AL0091 AHG9: On the multiplane image information (MPII) SEI message
* LOC
  + JVET-AL0216 [AHG9] Lens Optical Correction SEI – floating point parameters representation
* ECFI
  + JVET-AL0302 Updates of the enhanced colour format information SEI message
* New
  + JVET-AL0127 AHG9: Danmu information SEI message
  + JVET-AL0219 AHG9: Colour mapping information SEI

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

It was agreed that MPI is not further changed, and will be removed upon completion of a corresponding MIV profile.

Remains valid – not updated: [JVET-AF2033](https://jvet-experts.org/doc_end_user/current_document.php?id=13593) Report of verification test on VVC multi-layer coding: Content layering [S. Iwamura, P. de Lagrange, M. Wien] [AG 5 N 105)]

Remains valid – not updated: [JVET-AI2034](https://jvet-experts.org/doc_end_user/current_document.php?id=14624) Call for new HDR materials for future video coding development [E. François, W. Husak, S. Iwamura, D. Rusanovskyy, A. Segall, M. Wien] [WG 5 N 312)]

Remains valid – not updated: [JVET-AJ2035](https://jvet-experts.org/doc_end_user/current_document.php?id=15008) Test conditions and evaluation procedures for generative face video coding [S. McCarthy, B. Chen]

Remains valid – not updated: [JVET-AG2036](https://jvet-experts.org/doc_end_user/current_document.php?id=13921) Call for training materials for neural network-based video coding tool development [E. Alshina, F. Galpin, S. Liu, M. Wien] [WG 5 N 266)]

Remains valid – not updated: [JVET-AJ2037](https://jvet-experts.org/doc_end_user/current_document.php?id=15009) Report on subjective quality testing of the FGC SEI message (AG 5 N 140) [P. de Lagrange, W. Husak, M. Wien] [AG 5 N 140)] (2024-12-31)

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] (2025-03-21)

Planned to be 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 1615-1645 on Friday 4 Apr .

Future meeting plans were established with the following general guidelines (assuming face-to-face meetings):

* Meeting under ITU-T SG21 auspices when it meets (ordinarily starting meetings on the Tuesday or Wednesday of the first week and closing it on the Wednesday of the second week of the SG21 meeting – a total of 8-9 meeting days), and
* Otherwise meeting under ISO/IEC JTC 1/‌SC 29 auspices when its MPEG WGs meet (ordinarily starting meetings on the Thursday or Friday prior to the main week of such meetings and closing it on the same day as other MPEG WGs – a total of 8–9 meeting days).

In cases where an exceptionally high workload is expected for a meeting, an earlier starting date may be defined, 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 Thu. 26 June – Fri. 4 July 2025, 39th meeting under ISO/IEC JTC 1/‌SC 29 auspices in Daejeon, – KR, to be conducted as hybrid meeting,
* During 3 – 12 October 2025, 40th meeting under ITU-T SG21 auspices in Geneva, CH, to be conducted as hybrid meeting (starting Friday 3 Oct. afternoon for opening and AHG reports only; an AHG meeting might start 1-2 days earlier to prepare CfE viewing),
* During 14 – 23 January 2026, 41st meeting under ISO/IEC JTC 1/‌SC 29 auspices, to be conducted as teleconference meeting,
* During 24 April – 1 May 2026, 42nd meeting under ISO/IEC JTC 1/‌SC 29 auspices in Santa Eulària, ES, to be conducted as hybrid meeting,
* During 7 – 15 July 2026, 43rd meeting under ITU-T SG21 auspices in Geneva, CH, to be conducted as hybrid meeting,
* During 14 – 23 October 2026, 44th meeting under ISO/IEC JTC 1/‌SC 29 auspices in Hangzhou, CN, to be conducted as hybrid meeting,
* During January 2027, 45th meeting under ISO/IEC JTC 1/‌SC 29 auspices, date and location t.b.d.
* During April 2027, 46th meeting under ITU-T SG21 auspices, date and location t.b.d.

The agreed document deadline for the 39th JVET meeting was planned to be Thursday 19 June 2025.

Huawei, NERC-DTV, TCL, vivo, and Xiaomi were thanked for offering test material that could be used in the development of video coding standards.

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.

It was remarked by the chair that the meeting time of this teleconference meeting was not sufficient to review all contributions in sufficient detail (e.g., in sections 4.17, 4.18, and 5.2.4, some categories could not be reviewed and discussed in the detail they might have deserved). Also, priorities needed to be set, and 4 contributions (JVET-AL0333, JVET-AL0334, JVET-AL0335, and JVET-AL0341) which were submitted very late as new proposals could not be reviewed. These were deferred to the next meeting.

The 38th JVET meeting was closed at approximately 0014 hours UTC on Saturday 05 April 2025.

# Annex A to JVET report: List of documents

Dates and times in the table below are in Paris/Geneva time (1 hr. ahead of UTC before 30 March, 2 hrs. afterwards). It is noted that, if title or authorship of a document deviates from the title or author list in the body of the report, the list of documents in this annex contains the correct title and authors.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| JVET number | MPEG number | Created | First upload | Last upload | Title | Source |
| [JVET-AL0001](https://jvet-experts.org/doc_end_user/current_document.php?id=15384) | m71854 | 2025-03-18 15:31:52 | 2025-03-25 11:52:54 | 2025-03-26 22:09:51 | JVET AHG report: Project Management (AHG1) | J.-R. Ohm (chair)  G. J. Sullivan (vice chair) |
| [JVET-AL0002](https://jvet-experts.org/doc_end_user/current_document.php?id=15385) | m71855 | 2025-03-18 15:32:14 | 2025-03-26 05:52:05 | 2025-03-26 05:52:05 | 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) |
| [JVET-AL0003](https://jvet-experts.org/doc_end_user/current_document.php?id=15386) | m71856 | 2025-03-18 15:32:33 | 2025-03-26 08:05:55 | 2025-03-26 08:05:55 | 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) |
| [JVET-AL0004](https://jvet-experts.org/doc_end_user/current_document.php?id=15387) | m71857 | 2025-03-18 15:32:49 | 2025-03-26 07:10:30 | 2025-03-26 08:39:11 | 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-AL0005](https://jvet-experts.org/doc_end_user/current_document.php?id=15388) | m71858 | 2025-03-18 15:33:06 | 2025-03-26 05:33:32 | 2025-03-26 10:36:16 | 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) |
| [JVET-AL0006](https://jvet-experts.org/doc_end_user/current_document.php?id=15389) | m71859 | 2025-03-18 15:33:28 | 2025-03-25 22:08:01 | 2025-03-25 22:08:01 | JVET AHG report: ECM software development (AHG6) | V. Seregin (chair)  J. Chen  R. Chernyak  F. Le Léannec  K. Zhang (vice-chairs) |
| [JVET-AL0007](https://jvet-experts.org/doc_end_user/current_document.php?id=15390) | m71860 | 2025-03-18 15:33:56 | 2025-03-25 23:49:58 | 2025-03-25 23:49:58 | 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) |
| [JVET-AL0008](https://jvet-experts.org/doc_end_user/current_document.php?id=15391) | m71861 | 2025-03-18 15:34:15 | 2025-03-25 06:56:22 | 2025-03-26 03:57:24 | 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) |
| [JVET-AL0009](https://jvet-experts.org/doc_end_user/current_document.php?id=15392) | m71862 | 2025-03-18 15:34:39 | 2025-03-25 01:59:49 | 2025-03-25 01:59:49 | JVET AHG report: SEI message studies (AHG9) | S. McCarthy  Y.-K. Wang (co-chairs)  J. Boyce  T. Chujoh  S. Deshpande  C. Fogg  M. M. Hannuksela  P. de Lagrange  G. J. Sullivan  H. Tan  A. Tourapis  S. Wenger  P. Wu (vice-chairs) |
| [JVET-AL0010](https://jvet-experts.org/doc_end_user/current_document.php?id=15393) | m71863 | 2025-03-18 15:34:56 | 2025-03-25 15:03:50 | 2025-03-26 01:12:21 | JVET AHG report: Encoding algorithm optimization (AHG10) | K. Andersson  P. de Lagrange  A. Duenas (co-chairs)  T. Ikai  T. Solovyev  A. Tourapis (vice chairs) |
| [JVET-AL0011](https://jvet-experts.org/doc_end_user/current_document.php?id=15394) | m71864 | 2025-03-18 15:35:11 | 2025-03-25 22:09:34 | 2025-03-27 09:43:49 | 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) |
| [JVET-AL0012](https://jvet-experts.org/doc_end_user/current_document.php?id=15395) | m71865 | 2025-03-18 15:35:27 | 2025-03-25 00:42:13 | 2025-03-26 02:34:02 | 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) |
| [JVET-AL0013](https://jvet-experts.org/doc_end_user/current_document.php?id=15396) | m71866 | 2025-03-18 15:35:40 | 2025-03-26 09:50:20 | 2025-03-26 09:50:20 | JVET AHG report: Film grain technologies (AHG13) | W. Husak  P. de Lagrange (co-chairs)  A. Duenas  X. Meng  A. Segall  G. Teniou  A. Tourapis (vice-chairs) |
| [JVET-AL0014](https://jvet-experts.org/doc_end_user/current_document.php?id=15349) | m71761 | 2025-02-11 15:33:21 | 2025-02-12 09:11:32 | 2025-03-25 17:14:21 | JVET AHG report: NNVC software development (AHG14) | F. Galpin (chair)  R. Chang  Yue Li  Yun Li  M. Santamaria  J. N. Shingala  Z. Xie (vice-chairs) |
| [JVET-AL0015](https://jvet-experts.org/doc_end_user/current_document.php?id=15397) | m71867 | 2025-03-18 15:35:54 | 2025-03-25 11:41:49 | 2025-03-26 14:41:18 | JVET AHG report: Gaming content compression (AHG15) | S. Puri  J. Sauer (co-chairs)  R. Chernyak  A. Duenas  L. Wang  V. Zakharchenko (vice chairs) |
| [JVET-AL0016](https://jvet-experts.org/doc_end_user/current_document.php?id=15398) | m71868 | 2025-03-18 15:36:11 | 2025-03-25 16:39:25 | 2025-03-25 16:39:25 | JVET AHG report: Generative face video compression (AHG16) | Y. Ye (chair)  H.-B. Teo  Z. Lyu  S. McCarthy  S. Wang (vice chairs) |
| [JVET-AL0017](https://jvet-experts.org/doc_end_user/current_document.php?id=15399) | m71869 | 2025-03-18 15:36:30 | 2025-03-26 07:11:49 | 2025-03-26 07:11:49 | JVET AHG report: Testing of video coding technology beyond CTC (AHG17) | M. Wien (chair)  E. Alshina  V. Baroncini  P. de Lagrange  Y. Ye (vice chairs) |
| [JVET-AL0018](https://jvet-experts.org/doc_end_user/current_document.php?id=15400) | m71870 | 2025-03-18 15:37:24 | 2025-03-25 21:22:00 | 2025-03-25 21:22:00 | 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-AL0020](https://jvet-experts.org/doc_end_user/current_document.php?id=15537) | m72025 | 2025-03-19 21:11:57 | 2025-03-24 21:56:20 | 2025-04-04 18:14:06 | Deployment status of the HEVC standard | G. J. Sullivan |
| [JVET-AL0021](https://jvet-experts.org/doc_end_user/current_document.php?id=15538) | m72026 | 2025-03-19 21:35:29 | 2025-03-24 21:56:48 | 2025-03-24 21:56:50 | Deployment status of the VVC standard | G. J. Sullivan |
| [JVET-AL0023](https://jvet-experts.org/doc_end_user/current_document.php?id=15401) | m71871 | 2025-03-18 15:39:19 | 2025-03-25 22:10:31 | 2025-03-26 19:42:56 | EE1: Summary report of exploration experiment on neural network-based video coding | E. Alshina  R. Chang  F. Galpin  Yue Li  Yun Li  M. Santamaria  J. Ström  Z. Xie (EE coordinators) |
| [JVET-AL0024](https://jvet-experts.org/doc_end_user/current_document.php?id=15402) | m71872 | 2025-03-18 15:39:59 | 2025-03-27 06:06:36 | 2025-03-27 06:06:36 | EE2: Summary report of exploration experiment on enhanced compression beyond VVC capability | V. Seregin  J. Chen  R. Chernyak  K. Naser  J. Ström  F. Wang  M. Winken  X. Xiu  K. Zhang (EE coordinators) |
| [JVET-AL0041](https://jvet-experts.org/doc_end_user/current_document.php?id=15346) | m71756 | 2025-02-06 15:48:02 | 2025-02-07 17:05:18 | 2025-03-12 16:33:08 | AHG17: AhG meeting notes | M. Wien |
| [JVET-AL0042](https://jvet-experts.org/doc_end_user/current_document.php?id=15347) | m71757 | 2025-02-06 15:56:17 | 2025-03-07 13:02:41 | 2025-03-07 13:02:41 | AHG4/AHG17: Additional cropped HDR sequences for non-CTC testing | A. Filippov  J. Konieczny  Z. Zhi  V. Rufitskiy  H. Qin  T. Dong  X. Tang (TCL)  S. Shen  Y. Qin  Y. Wang  X. Wang  Y. Guan (NERC-DTV) |
| [JVET-AL0043](https://jvet-experts.org/doc_end_user/current_document.php?id=15348) | m71759 | 2025-02-07 14:46:02 | 2025-02-07 21:42:05 | 2025-02-07 21:42:05 | [AHG11] [AHG14] Teleconference on NNVC | E. Alshina  F. Galpin |
| [JVET-AL0044](https://jvet-experts.org/doc_end_user/current_document.php?id=15350) | m71765 | 2025-02-22 00:14:45 | 2025-02-22 00:35:46 | 2025-03-18 22:22:18 | AHG18: Teleconference on ultra-low latency and packet loss resilience | S. Ikonin  S. Wenger  V. Zakharchenko (co-chairs)  S. Deshpande  J. Ström  X. Ma  C. Kim  S. Puri  S. Fößel (vice-chairs) |
| [JVET-AL0045](https://jvet-experts.org/doc_end_user/current_document.php?id=15351) | m71785 | 2025-03-03 10:45:32 | 2025-03-03 11:10:50 | 2025-03-10 09:40:33 | [AHG17] Proposal of 6 candidates SDR HD clips | E. François  P. de Lagrange  C. Salmon-Legagneur (InterDigital) |
| [JVET-AL0046](https://jvet-experts.org/doc_end_user/current_document.php?id=15352) | m71788 | 2025-03-04 09:09:22 | 2025-03-05 13:39:31 | 2025-03-05 13:39:31 | [AHG17] UGC test sequences from vivo | Z. Lyu  Y. Li  C. Zhou  G. Wang (vivo) |
| [JVET-AL0047](https://jvet-experts.org/doc_end_user/current_document.php?id=15353) | m71789 | 2025-03-04 11:35:55 | 2025-03-04 17:23:02 | 2025-04-15 18:28:57 | Proposed draft text: Call for Evidence on video compression with capability beyond existing standards | J.-R. Ohm  M. Wien |
| [JVET-AL0048](https://jvet-experts.org/doc_end_user/current_document.php?id=15354) | m71790 | 2025-03-04 12:32:18 | 2025-03-05 09:16:08 | 2025-03-24 10:28:20 | [AHG17] Proposal of new sequences in UHD-SDR-RA category | M. Abdoli  A. Tissier  R. G. Youvalari  F. Plowman  M.-L. Champel (Xiaomi) |
| [JVET-AL0049](https://jvet-experts.org/doc_end_user/current_document.php?id=15355) | m71798 | 2025-03-07 06:38:31 | 2025-03-07 06:42:19 | 2025-03-07 06:42:19 | [AHG17] Proposal of 4 sequence candidates for the SDR-LD-HD category | R.-L. Liao  Y. Ye (Alibaba) |
| [JVET-AL0050](https://jvet-experts.org/doc_end_user/current_document.php?id=15356) | m71799 | 2025-03-07 12:34:12 | 2025-03-07 12:39:08 | 2025-03-07 12:39:08 | AHG17: UGC test sequences from Huawei | J. Pardo  Y. Zhao  Y. Sun  P. Liu  Y. Lu  C. Wang (Huawei) |
| [JVET-AL0051](https://jvet-experts.org/doc_end_user/current_document.php?id=15357) | m71801 | 2025-03-07 18:23:09 | 2025-03-07 18:25:28 | 2025-03-07 18:25:28 | [AHG17] Proposed CfE language regarding ultra low delay and error resilience | S. Wenger (Tencent) |
| [JVET-AL0052](https://jvet-experts.org/doc_end_user/current_document.php?id=15358) | m71802 | 2025-03-07 19:06:20 | 2025-03-07 19:07:53 | 2025-03-28 13:40:08 | AhG17: Comments on proposed draft text: Call for Evidence on video compression with capability beyond existing standards | E. Alshina  T. Solovyev (Huawei) |
| [JVET-AL0053](https://jvet-experts.org/doc_end_user/current_document.php?id=15359) | m71805 | 2025-03-11 05:39:35 | 2025-03-11 09:00:44 | 2025-03-26 17:37:40 | AHG17: Results of expert viewing of non-CTC sequences | M. Wien  A. Wieckowski  K. Andersson |
| [JVET-AL0054](https://jvet-experts.org/doc_end_user/current_document.php?id=15360) | m71806 | 2025-03-12 11:18:49 | 2025-03-12 13:06:48 | 2025-03-26 16:17:37 | AHG17: adjusted QPs for non-CTC sequences | E. François (InterDigital)  E. Alshina (Huawei)  P. Nikitin (Qualcomm) |
| [JVET-AL0055](https://jvet-experts.org/doc_end_user/current_document.php?id=15361) | m71810 | 2025-03-13 04:15:44 | 2025-03-13 04:18:34 | 2025-04-01 07:01:37 | AhG10: On constrained encoder complexity configuration of VTM | T. Solovyev  J. Sauer  J. E. F. Pardo  E. Alshina (Huawei) |
| [JVET-AL0056](https://jvet-experts.org/doc_end_user/current_document.php?id=15362) | m71814 | 2025-03-14 15:13:04 | 2025-03-14 15:34:22 | 2025-03-14 15:34:22 | AHG9: On the encoder optimization information SEI message | M. M. Hannuksela (Nokia) |
| [JVET-AL0057](https://jvet-experts.org/doc_end_user/current_document.php?id=15363) | m71815 | 2025-03-14 15:14:33 | 2025-03-14 15:34:56 | 2025-03-14 15:34:56 | AHG9: Inclusion of the encoder optimization information SEI message in HEVC | M. M. Hannuksela  J. Boyce (Nokia) |
| [JVET-AL0058](https://jvet-experts.org/doc_end_user/current_document.php?id=15364) | m71816 | 2025-03-14 15:15:53 | 2025-03-14 15:35:32 | 2025-03-14 15:35:32 | AHG9: On the AI usage restrictions SEI message | M. M. Hannuksela  L. Kondrad  K. Kammachi-Sreedhar  E. B. Aksu  J. Boyce (Nokia) |
| [JVET-AL0059](https://jvet-experts.org/doc_end_user/current_document.php?id=15365) | m71817 | 2025-03-14 22:00:13 | 2025-03-14 22:28:48 | 2025-03-14 22:28:48 | AHG9: Inclusion of the packed regions information SEI message in HEVC | J. Boyce  M. M. Hannuksela (Nokia) |
| [JVET-AL0060](https://jvet-experts.org/doc_end_user/current_document.php?id=15366) | m71818 | 2025-03-14 23:12:08 | 2025-03-19 20:08:23 | 2025-03-28 00:36:05 | Sandwiched Compression: Repurposing Standard Codecs with Neural Network Wrappers | O. Guleryuz (Google) |
| [JVET-AL0061](https://jvet-experts.org/doc_end_user/current_document.php?id=15367) | m71819 | 2025-03-17 02:05:14 | 2025-03-19 09:59:35 | 2025-04-01 18:01:49 | AHG9: Encoder optimization information for AVC and HEVC | C. Kim  H. Tan  J. Nam  J. Lee  J. Lim  S. Kim (LGE) |
| [JVET-AL0062](https://jvet-experts.org/doc_end_user/current_document.php?id=15368) | m71820 | 2025-03-17 02:06:31 | 2025-03-19 10:00:32 | 2025-04-01 10:37:17 | AHG9: AI usage restrictions SEI message for AVC and HEVC | C. Kim  H. Tan  J. Nam  J. Lee  J. Lim  S. Kim (LGE) |
| [JVET-AL0063](https://jvet-experts.org/doc_end_user/current_document.php?id=15369) | m71829 | 2025-03-17 17:57:32 | 2025-03-19 14:14:27 | 2025-03-31 20:23:00 | AHG9: On the SPO SEI message | Y. He  M. Karczewicz (Qualcomm)  Y.-K. Wang (Bytedance)  M. M. Hannuksela (Nokia) |
| [JVET-AL0064](https://jvet-experts.org/doc_end_user/current_document.php?id=15370) | m71830 | 2025-03-17 17:58:11 | 2025-03-19 14:16:38 | 2025-04-01 19:55:37 | AHG9: On the SPO SEI message complexity signalling | Y. He  M. Karczewicz (Qualcomm) |
| [JVET-AL0065](https://jvet-experts.org/doc_end_user/current_document.php?id=15371) | m71831 | 2025-03-17 18:02:05 | 2025-03-19 14:17:40 | 2025-03-19 14:17:40 | AHG9: On the PON SEI message | Y. He, M. Karczewicz (Qualcomm) |
| [JVET-AL0066](https://jvet-experts.org/doc_end_user/current_document.php?id=15372) | m71832 | 2025-03-18 01:01:59 | 2025-03-19 16:55:16 | 2025-03-31 09:21:25 | AHG9: Lossy compression with Object mask info SEI | J. Boyce  M. M. Hannuksela (Nokia) |
| [JVET-AL0067](https://jvet-experts.org/doc_end_user/current_document.php?id=15373) | m71833 | 2025-03-18 01:02:04 | 2025-03-19 16:55:38 | 2025-03-31 15:43:00 | AHG9: On the OMI SEI | J. Boyce  M. M. Hannuksela (Nokia) |
| [JVET-AL0068](https://jvet-experts.org/doc_end_user/current_document.php?id=15374) | m71834 | 2025-03-18 01:02:07 | 2025-03-19 16:55:58 | 2025-03-19 16:55:58 | AHG9: On image format metadata (IFM) SEI | J. Boyce  M. M. Hannuksela (Nokia)  A. T. Hinds (Tencent) |
| [JVET-AL0069](https://jvet-experts.org/doc_end_user/current_document.php?id=15375) | m71835 | 2025-03-18 01:02:11 | 2025-03-19 16:56:34 | 2025-03-19 16:56:34 | AHG9/AHG18: Error recovery SEI message | J. Boyce  M. M. Hannuksela (Nokia) |
| [JVET-AL0070](https://jvet-experts.org/doc_end_user/current_document.php?id=15376) | m71836 | 2025-03-18 01:54:08 | 2025-03-19 12:54:35 | 2025-03-27 16:59:01 | AHG9: On packed regions information SEI message | T. Chujoh  Z. Fan  R. Ishimoto  T. Ikai (Sharp) |
| [JVET-AL0071](https://jvet-experts.org/doc_end_user/current_document.php?id=15377) | m71838 | 2025-03-18 05:47:12 | 2025-03-19 14:18:29 | 2025-03-28 05:40:25 | AHG9: On the OMI SEI message | Y. He  M. Karczewicz (Qualcomm) |
| [JVET-AL0072](https://jvet-experts.org/doc_end_user/current_document.php?id=15378) | m71839 | 2025-03-18 05:47:29 | 2025-03-19 14:19:35 | 2025-03-19 14:19:35 | AHG9: On the PRI SEI message | Y. He  M. Karczewicz (Qualcomm) |
| [JVET-AL0073](https://jvet-experts.org/doc_end_user/current_document.php?id=15379) | m71840 | 2025-03-18 05:54:34 | 2025-03-19 23:47:20 | 2025-03-19 23:47:20 | AHG9/AHG18: Loss recovery information SEI message | C. Kim  H. Tan  J. Nam  J. Lee  J. Lim  S. Kim (LGE) |
| [JVET-AL0074](https://jvet-experts.org/doc_end_user/current_document.php?id=15380) | m71846 | 2025-03-18 11:33:37 | 2025-03-20 02:07:39 | 2025-03-20 02:07:39 | AHG10: Teleconference on encoder optimization | P. de Lagrange |
| [JVET-AL0075](https://jvet-experts.org/doc_end_user/current_document.php?id=15381) | m71847 | 2025-03-18 13:43:12 | 2025-03-20 06:43:52 | 2025-03-31 19:21:25 | AHG9: On nnpfa\_num\_input\_pic\_shift | M. M. Hannuksela (Nokia) |
| [JVET-AL0076](https://jvet-experts.org/doc_end_user/current_document.php?id=15382) | m71848 | 2025-03-18 13:44:44 | 2025-03-19 19:50:12 | 2025-03-31 16:26:17 | AHG9: On multi-purpose NNPFs | M. M. Hannuksela  F. Cricri (Nokia) |
| [JVET-AL0077](https://jvet-experts.org/doc_end_user/current_document.php?id=15383) | m71849 | 2025-03-18 13:45:57 | 2025-03-19 19:49:36 | 2025-03-19 19:49:36 | AHG9: On the text description information SEI message | M. M. Hannuksela  J. Boyce (Nokia) |
| [JVET-AL0078](https://jvet-experts.org/doc_end_user/current_document.php?id=15403) | m71873 | 2025-03-18 16:31:49 | 2025-03-19 22:59:49 | 2025-03-19 22:59:49 | AHG9: On Digital Signing | S. Deshpande (Sharp) |
| [JVET-AL0079](https://jvet-experts.org/doc_end_user/current_document.php?id=15404) | m71874 | 2025-03-18 16:59:47 | 2025-03-19 21:23:05 | 2025-03-19 21:23:05 | EE2-3.5: On affine motion compensation | H. Huang  R. Yu  Z. Zhang  Y. Zhang  V. Seregin  M. Karczewicz (Qualcomm) |
| [JVET-AL0080](https://jvet-experts.org/doc_end_user/current_document.php?id=15405) | m71875 | 2025-03-18 17:20:28 | 2025-03-19 16:56:23 | 2025-03-19 16:56:23 | AHG11: Bit-exact reconstruction for NN video tools | L. Kerofsky  Y. Li  M. Karczewicz (Qualcomm) |
| [JVET-AL0081](https://jvet-experts.org/doc_end_user/current_document.php?id=15406) | m71876 | 2025-03-18 17:49:00 | 2025-03-19 22:08:16 | 2025-03-26 08:43:08 | EE2-3.9: Extended BDOF usage for MV refinement | R. Yu  H. Huang  V. Seregin  M. Karczewicz (Qualcomm) |
| [JVET-AL0082](https://jvet-experts.org/doc_end_user/current_document.php?id=15407) | m71877 | 2025-03-18 17:52:15 | 2025-03-19 22:08:36 | 2025-03-31 09:29:16 | AHG12: Modifications to regression-based GPM with intra and inter prediction | R. Yu  V. Seregin  M. Karczewicz (Qualcomm) |
| [JVET-AL0083](https://jvet-experts.org/doc_end_user/current_document.php?id=15408) | m71879 | 2025-03-18 18:30:00 | 2025-03-19 17:13:13 | 2025-03-19 17:13:13 | AHG7: On Luma-Chroma Gain Rebalancing | X. Li (Google)  Y. Wang  K. Zhang  L. Zhang (Bytedance) |
| [JVET-AL0084](https://jvet-experts.org/doc_end_user/current_document.php?id=15409) | m71880 | 2025-03-18 19:50:25 | 2025-03-19 10:19:33 | 2025-03-24 16:56:25 | EE1-1.2: LOP5 improvement with parallel 1x3/3x1 Backbone | T. Shao  P. Yin  S. McCarthy (Dolby)  J. N. Shingala  A. Shyam  A. Suneja  S. P. Badya (Ittiam) |
| [JVET-AL0085](https://jvet-experts.org/doc_end_user/current_document.php?id=15410) | m71881 | 2025-03-18 19:51:11 | 2025-03-19 10:20:33 | 2025-03-25 21:53:58 | EE1-3.1: NNVC-LOP5 retraining with additional BVI-AOM dataset | A. Suneja  J. N. Shingala  A. Shyam  S. P. Badya (Ittiam)  T. Shao  P. Yin  S. McCarthy (Dolby) |
| [JVET-AL0086](https://jvet-experts.org/doc_end_user/current_document.php?id=15411) | m71882 | 2025-03-18 20:49:41 | 2025-03-19 21:59:57 | 2025-04-01 08:50:21 | AHG9/AHG13: On Spatial Resolution for the Film Grain Characteristics (FGC) SEI message | J. Samuelsson-Allendes  S. Deshpande (Sharp) |
| [JVET-AL0087](https://jvet-experts.org/doc_end_user/current_document.php?id=15412) | m71883 | 2025-03-18 22:31:30 | 2025-03-19 20:30:23 | 2025-04-01 15:56:43 | AHG12: Predictive transform coefficient coding | T. N. Canh  F. Pu  P. Yin  S. McCarthy (Dolby) |
| JVET-AL0088 |  |  |  |  | Withdrawn |  |
| JVET-AL0089 |  |  |  |  | Withdrawn |  |
| JVET-AL0090 |  |  |  |  | Withdrawn |  |
| [JVET-AL0091](https://jvet-experts.org/doc_end_user/current_document.php?id=15416) | m71887 | 2025-03-18 22:58:48 | 2025-03-18 23:01:02 | 2025-03-18 23:01:02 | AHG9: On the multiplane image information (MPII) SEI message | S. McCarthy  S. Oh  W. Husak (Dolby) |
| [JVET-AL0092](https://jvet-experts.org/doc_end_user/current_document.php?id=15417) | m71888 | 2025-03-18 23:40:27 | 2025-03-19 16:57:10 | 2025-03-19 16:57:10 | AHG9: Confidence information SEI message | J. Boyce  T. Biatek  M. M. Hannuksela (Nokia) |
| [JVET-AL0093](https://jvet-experts.org/doc_end_user/current_document.php?id=15418) | m71890 | 2025-03-19 00:22:13 | 2025-03-19 00:25:16 | 2025-03-19 00:25:16 | AHG9: On value range for syntax elements coded as u(v) | H. Tan  C. Kim  J. Nam  J. Lee  J. Lim  S. Kim (LGE) |
| [JVET-AL0094](https://jvet-experts.org/doc_end_user/current_document.php?id=15419) | m71891 | 2025-03-19 00:24:29 | 2025-03-19 18:58:03 | 2025-03-21 20:57:35 | AHG9: On payload length of image format metadata (IFM) SEI | A. T. Hinds  Gilles Teniou  S. Wenger (Tencent)  C. Bai  P. Green (on behalf of ICC) |
| [JVET-AL0095](https://jvet-experts.org/doc_end_user/current_document.php?id=15420) | m71895 | 2025-03-19 02:45:51 | 2025-03-19 10:05:03 | 2025-03-19 10:05:03 | AHG9: On constituent rectangles SEI message | C. Kim  H. Tan  J. Nam  J. Lee  J. Lim  S. Kim (LGE) |
| [JVET-AL0096](https://jvet-experts.org/doc_end_user/current_document.php?id=15421) | m71896 | 2025-03-19 02:52:15 | 2025-03-19 10:03:08 | 2025-03-19 10:03:08 | AHG9: On signalling of extension syntax elements in NNPFA SEI message | C. Kim  H. Tan  J. Nam  J. Lee  J. Lim  S. Kim (LGE) |
| [JVET-AL0097](https://jvet-experts.org/doc_end_user/current_document.php?id=15422) | m71897 | 2025-03-19 02:59:18 | 2025-03-19 10:07:40 | 2025-03-19 10:07:40 | AHG9: Gaussian blur filling method in display rectangles SEI message | C. Kim  H. Tan  J. Nam  J. Lee  J. Lim  S. Kim (LGE) |
| [JVET-AL0098](https://jvet-experts.org/doc_end_user/current_document.php?id=15423) | m71898 | 2025-03-19 03:05:55 | 2025-03-19 10:24:34 | 2025-03-30 14:31:32 | AHG9: On target picture in packed regions information SEI message | J. Nam  H. Tan  J. Lee  C. Kim  J. Lim  S. Kim (LGE) |
| [JVET-AL0099](https://jvet-experts.org/doc_end_user/current_document.php?id=15424) | m71899 | 2025-03-19 03:06:15 | 2025-03-19 10:25:03 | 2025-03-19 10:25:03 | AHG9: On design of display rectangles SEI message | J. Nam  H. Tan  J. Lee  C. Kim  J. Lim  S. Kim (LGE) |
| [JVET-AL0100](https://jvet-experts.org/doc_end_user/current_document.php?id=15425) | m71900 | 2025-03-19 03:14:16 | 2025-03-19 03:20:29 | 2025-03-19 03:20:29 | AHG14: The extension of SADL library | W. Ma  N. Fu  W. Bao  Z. Chen (Wuhan Univ.) |
| [JVET-AL0101](https://jvet-experts.org/doc_end_user/current_document.php?id=15426) | m71902 | 2025-03-19 04:11:41 | 2025-03-19 04:28:52 | 2025-03-26 04:50:59 | AHG16: Further experiments on VVC GFVC | L. Liu  C. Jung (Xidian Univ.) |
| [JVET-AL0102](https://jvet-experts.org/doc_end_user/current_document.php?id=15427) | m71904 | 2025-03-19 04:14:15 | 2025-03-19 04:42:10 | 2025-04-01 04:06:37 | AHG9/AHG16: SEI message and further experiments on QP-adaptive GFVC | W. Kang  L. Liu  C. Jung (Xidian Univ.) |
| [JVET-AL0103](https://jvet-experts.org/doc_end_user/current_document.php?id=15428) | m71905 | 2025-03-19 05:05:45 | 2025-03-19 06:23:49 | 2025-03-30 22:13:35 | AHG9: Editorial changes for the three DSC SEI messages | Y.-K. Wang  J. Xu (Bytedance) |
| [JVET-AL0104](https://jvet-experts.org/doc_end_user/current_document.php?id=15429) | m71906 | 2025-03-19 05:10:33 | 2025-03-19 10:39:07 | 2025-03-31 06:10:10 | EE1-2.1: Lightweight Multiscale Reference Frame Generation for VVC Inter Coding | P. Li  C. Jung  Q. Qin (Xidian Univ.) |
| [JVET-AL0105](https://jvet-experts.org/doc_end_user/current_document.php?id=15430) | m71907 | 2025-03-19 05:12:11 | 2025-03-19 05:23:45 | 2025-03-24 13:47:41 | EE1-2.2: RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding | Q. Qin  C. Jung (Xidian Univ.) |
| [JVET-AL0106](https://jvet-experts.org/doc_end_user/current_document.php?id=15431) | m71908 | 2025-03-19 05:18:12 | 2025-03-19 18:26:34 | 2025-03-26 06:05:56 | EE2-2.4: block vector guided EIP | Z. Xie  Y. Yu  H. Yu  D. Wang (OPPO) |
| [JVET-AL0107](https://jvet-experts.org/doc_end_user/current_document.php?id=15432) | m71909 | 2025-03-19 05:19:03 | 2025-03-19 18:26:56 | 2025-03-27 14:03:21 | EE2-2.11: a combination of EE2-2.4 and EE2-2.10 | Z. Xie  Y. Yu  H. Yu  D. Wang (OPPO)  Z. Lv  C. Zhou  G. Wang (vivo) |
| [JVET-AL0108](https://jvet-experts.org/doc_end_user/current_document.php?id=15433) | m71910 | 2025-03-19 05:19:54 | 2025-03-19 18:21:38 | 2025-03-26 06:00:48 | EE2-2.7: Block vector guided DIMD | L. Zhang  Y. Yu  H. Yu  D. Wang (OPPO) |
| [JVET-AL0109](https://jvet-experts.org/doc_end_user/current_document.php?id=15434) | m71911 | 2025-03-19 05:22:03 | 2025-03-19 19:29:49 | 2025-03-27 06:16:21 | EE2-related: On binarization of a coefficient level in TSRC | Y. Yu  L. Xu  J. Gan  H. Yu  D. Wang (OPPO) |
| [JVET-AL0110](https://jvet-experts.org/doc_end_user/current_document.php?id=15435) | m71912 | 2025-03-19 05:23:38 | 2025-03-19 18:23:59 | 2025-03-28 07:26:40 | EE2-related: On ALF-CCCM | N. Song  L. Xu  Y. Yu  H. Yu  D. Wang (OPPO) |
| [JVET-AL0111](https://jvet-experts.org/doc_end_user/current_document.php?id=15436) | m71913 | 2025-03-19 05:24:15 | 2025-03-19 18:18:10 | 2025-04-01 14:58:27 | Non-EE2: Matrix-based position dependent intra prediction for GPM/CIIP | Z. Sun  Y. Yu  L. Xu  H. Yu  D. Wang (OPPO) |
| [JVET-AL0112](https://jvet-experts.org/doc_end_user/current_document.php?id=15437) | m71914 | 2025-03-19 05:24:57 | 2025-03-19 18:27:19 | 2025-04-02 17:26:37 | Non-EE2: Third transform set selection for intraNN | Z. Xie  F. Wang  Y. Yu  H. Yu  D. Wang (OPPO) |
| [JVET-AL0113](https://jvet-experts.org/doc_end_user/current_document.php?id=15438) | m71915 | 2025-03-19 05:25:27 | 2025-03-19 18:20:17 | 2025-04-01 07:33:07 | AHG12: Directional sign prediction | L. Xu  Y. Yu  Z. Sun  L. Zhang  H. Yu  D. Wang (OPPO) |
| [JVET-AL0114](https://jvet-experts.org/doc_end_user/current_document.php?id=15439) | m71916 | 2025-03-19 05:27:21 | 2025-03-19 19:01:33 | 2025-03-31 07:31:16 | AHG10: On intra mode selection | Y. Yu  L. Zhang  Z. Sun  J. Gan  F. Wang  H. Yu  D. Wang (OPPO) |
| [JVET-AL0115](https://jvet-experts.org/doc_end_user/current_document.php?id=15440) | m71917 | 2025-03-19 05:47:49 | 2025-03-19 21:55:13 | 2025-03-19 21:55:13 | AHG9: Substream dependency signalling in the DSCI SEI message | Y.-K. Wang (Bytedance)  Y. Li  K. Yang (SJTU)  J. Xu (Bytedance)  Y. Xu (SJTU) |
| [JVET-AL0116](https://jvet-experts.org/doc_end_user/current_document.php?id=15441) | m71918 | 2025-03-19 05:54:07 | 2025-03-19 22:00:07 | 2025-03-19 22:00:07 | AHG9: On DSCI content UUID | Y. Li (SJTU)  J. Xu  Y.-K. Wang (Bytedance)  K. Yang  Y. Xu (SJTU) |
| [JVET-AL0117](https://jvet-experts.org/doc_end_user/current_document.php?id=15442) | m71919 | 2025-03-19 05:58:23 | 2025-03-19 22:03:32 | 2025-04-01 06:25:56 | AHG9: On association of NAL units to DSC verification substreams | Y.-K. Wang  J. Xu (Bytedance)  Y. Li  K. Yang  Y. Xu (SJTU) |
| [JVET-AL0118](https://jvet-experts.org/doc_end_user/current_document.php?id=15443) | m71920 | 2025-03-19 06:01:24 | 2025-03-19 22:05:47 | 2025-04-01 06:22:09 | AHG9: Miscellaneous changes for the three DSC SEI messages | Y.-K. Wang  J. Xu (Bytedance)  Y. Li  K. Yang  Y. Xu (SJTU) |
| [JVET-AL0119](https://jvet-experts.org/doc_end_user/current_document.php?id=15444) | m71921 | 2025-03-19 06:04:14 | 2025-03-19 22:09:09 | 2025-03-25 22:12:08 | AHG9: Support of low-delay DSC verification process | Y.-K. Wang  J. Xu (Bytedance)  Y. Li, K. Yang  Y. Xu (SJTU) |
| [JVET-AL0120](https://jvet-experts.org/doc_end_user/current_document.php?id=15445) | m71922 | 2025-03-19 06:05:04 | 2025-03-19 22:12:02 | 2025-03-30 19:56:31 | AHG9: On the packed regions information SEI message - part 1 | Y.-K. Wang  J. Xu (Bytedance) |
| [JVET-AL0121](https://jvet-experts.org/doc_end_user/current_document.php?id=15446) | m71924 | 2025-03-19 06:12:23 | 2025-03-19 06:41:57 | 2025-03-26 01:17:52 | AHG11: Sample-based adaptive blending weight selection for LOP | H. Kwon  H. Ko (HYU) |
| [JVET-AL0122](https://jvet-experts.org/doc_end_user/current_document.php?id=15447) | m71925 | 2025-03-19 06:37:44 | 2025-03-19 22:04:26 | 2025-03-19 22:04:26 | AHG9: On the packed regions information (PRI) SEI message - part 2 | J. Xu  Y.-K. Wang (Bytedance) |
| [JVET-AL0123](https://jvet-experts.org/doc_end_user/current_document.php?id=15448) | m71926 | 2025-03-19 06:39:21 | 2025-03-19 22:06:52 | 2025-03-19 22:06:52 | AHG9: On the encoder optimization information (EOI) SEI message | J. Xu  Y.-K. Wang (Bytedance) |
| [JVET-AL0124](https://jvet-experts.org/doc_end_user/current_document.php?id=15449) | m71927 | 2025-03-19 07:04:10 | 2025-03-19 12:26:47 | 2025-03-26 02:42:13 | EE2-2.10: Multiple filter taps for EIP | Z. Lyu  C. Zhou  G. Wang (vivo) |
| [JVET-AL0125](https://jvet-experts.org/doc_end_user/current_document.php?id=15450) | m71928 | 2025-03-19 07:29:34 | 2025-03-19 11:01:34 | 2025-03-26 02:39:58 | EE2-2.6: Improvement on MPM | G. Wang  C. Zhou  Z. Lv (vivo) |
| [JVET-AL0126](https://jvet-experts.org/doc_end_user/current_document.php?id=15451) | m71929 | 2025-03-19 07:53:59 | 2025-03-20 02:20:45 | 2025-03-27 03:41:02 | EE2-2.3: CCP merge mode with adjustment | Y. Wang  K. Zhang  W. Yin  Z. Deng  N. Zhang  L. Zhao  M. Salehifar  L. Zhang (Bytedance) |
| [JVET-AL0127](https://jvet-experts.org/doc_end_user/current_document.php?id=15452) | m71933 | 2025-03-19 08:39:11 | 2025-03-19 22:13:42 | 2025-03-19 22:13:50 | AHG9: Danmu information SEI message | J. Xu  Y.-K. Wang  L. Zhang (Bytedance) |
| [JVET-AL0128](https://jvet-experts.org/doc_end_user/current_document.php?id=15453) | m71934 | 2025-03-19 08:52:54 | 2025-03-20 01:55:57 | 2025-03-20 01:55:57 | AHG9: On image format metadata SEI message | J. Lee  H. Tan  C. Kim  J. Nam  J. Lim  S. Kim (LGE) |
| [JVET-AL0129](https://jvet-experts.org/doc_end_user/current_document.php?id=15454) | m71935 | 2025-03-19 08:53:00 | 2025-03-19 13:19:13 | 2025-03-19 13:19:13 | AHG9: On signalling of regions in PRI SEI message | J. Lee  H. Tan  J. Nam  C. Kim  J. Lim  S. Kim (LGE) |
| [JVET-AL0130](https://jvet-experts.org/doc_end_user/current_document.php?id=15455) | m71936 | 2025-03-19 08:53:05 | 2025-03-19 13:19:47 | 2025-03-26 04:37:57 | AHG9: Source picture timing for interlaced video with SPTI SEI message | J. Lee  H. Tan  J. Nam  C. Kim  J. Lim  S. Kim (LGE) |
| [JVET-AL0131](https://jvet-experts.org/doc_end_user/current_document.php?id=15456) | m71937 | 2025-03-19 08:53:11 | 2025-03-19 13:20:25 | 2025-03-19 13:20:25 | AHG9: Proposed changes for miscellaneous aspects of SEIs in VSEI v4 | J. Lee  H. Tan  C. Kim  J. Nam  J. Lim  S. Kim (LGE) |
| [JVET-AL0132](https://jvet-experts.org/doc_end_user/current_document.php?id=15457) | m71938 | 2025-03-19 08:53:17 | 2025-03-19 13:20:52 | 2025-03-19 13:20:52 | AHG9: Editorial updates for VSEI v4 | J. Lee  H. Tan  C. Kim  J. Nam  J. Lim  S. Kim (LGE) |
| [JVET-AL0133](https://jvet-experts.org/doc_end_user/current_document.php?id=15458) | m71939 | 2025-03-19 08:53:22 | 2025-03-19 13:21:22 | 2025-03-19 13:21:25 | AHG9: Signalling of thumbnail information | J. Lee  H. Tan  C. Kim  J. Nam  J. Lim  S. Kim (LGE) |
| [JVET-AL0134](https://jvet-experts.org/doc_end_user/current_document.php?id=15459) | m71940 | 2025-03-19 09:14:08 | 2025-03-19 11:57:03 | 2025-03-26 04:09:52 | EE2-3.4: Joint reordering of GPM split modes and partition indices | C. Ma  X. Xiu  X. Wang (Kwai) |
| [JVET-AL0135](https://jvet-experts.org/doc_end_user/current_document.php?id=15460) | m71942 | 2025-03-19 09:29:32 | 2025-03-20 02:55:05 | 2025-03-27 06:21:25 | EE2-5.3: Cross-Chroma Input for Chroma-ALF and CC-ALF | W. Yin  K. Zhang  H. Liu  Y. Wang  Z. Deng  N. Zhang  L. Zhao  M. Salehifar  L. Zhang (Bytedance)  C. Ma  X. Xiu  C.-W. Kuo  X. Wang (Kwai) |
| [JVET-AL0136](https://jvet-experts.org/doc_end_user/current_document.php?id=15461) | m71943 | 2025-03-19 09:33:40 | 2025-03-19 09:52:12 | 2025-03-25 15:32:53 | AHG11: Over-Parameterized LOP In-Loop Filter | J. Han  C. Jung  Q. Qin (Xidian Univ.) |
| [JVET-AL0137](https://jvet-experts.org/doc_end_user/current_document.php?id=15462) | m71944 | 2025-03-19 09:35:20 | 2025-03-19 10:31:05 | 2025-03-25 14:01:56 | AHG11: Backbone Block Enhancement of LOP In-Loop Filter with Over-Parameterized Training and Variable Channels | J. Han  C. Jung  Q. Qin (Xidian Univ.) |
| [JVET-AL0138](https://jvet-experts.org/doc_end_user/current_document.php?id=15463) | m71945 | 2025-03-19 09:40:27 | 2025-03-19 09:53:52 | 2025-03-19 09:53:52 | AHG9: VVC interface for Display Rectangles SEI | T. Biatek  J. Boyce  M. M. Hannuksela (Nokia) |
| [JVET-AL0139](https://jvet-experts.org/doc_end_user/current_document.php?id=15464) | m71946 | 2025-03-19 09:42:14 | 2025-03-19 10:00:27 | 2025-03-19 10:00:27 | AHG9: On multilayer support for CR SEI | T. Biatek  J. Boyce  M. M. Hannuksela (Nokia) |
| [JVET-AL0140](https://jvet-experts.org/doc_end_user/current_document.php?id=15465) | m71947 | 2025-03-19 09:42:57 | 2025-03-19 10:03:16 | 2025-03-19 10:03:16 | AHG9: Region-specific quality metrics for QM SEI | T. Biatek  J. Boyce  M. M. Hannuksela (Nokia) |
| [JVET-AL0141](https://jvet-experts.org/doc_end_user/current_document.php?id=15466) | m71948 | 2025-03-19 09:43:37 | 2025-03-29 13:47:35 | 2025-04-02 10:49:59 | AHG9: Showcase on the implementation of display rectangles SEI | T. Biatek  J. Boyce  M. M. Hannuksela (Nokia) |
| [JVET-AL0142](https://jvet-experts.org/doc_end_user/current_document.php?id=15467) | m71949 | 2025-03-19 10:02:06 | 2025-03-19 10:23:21 | 2025-03-26 01:11:44 | EE2-5.2: CCSAO with reused CTU control | C.-W. Kuo  X. Xiu  X. Wang (Kwai) |
| [JVET-AL0143](https://jvet-experts.org/doc_end_user/current_document.php?id=15468) | m71952 | 2025-03-19 10:06:52 | 2025-03-19 18:45:48 | 2025-03-26 02:42:20 | EE2-1.1: Chroma partition prediction in separate tree condition | P.-H. Lin  J.-L. Lin  V. Seregin  M. Karczewicz (Qualcomm) |
| [JVET-AL0144](https://jvet-experts.org/doc_end_user/current_document.php?id=15469) | m71955 | 2025-03-19 10:13:44 | 2025-03-19 16:26:56 | 2025-03-19 16:26:56 | EE1-3.1: Retraining LOP4 and LOP5 using extended dataset from BVI-AOM | D. Liu  J. Ström  M. Damghanian  P. Wennersten (Ericsson) |
| [JVET-AL0145](https://jvet-experts.org/doc_end_user/current_document.php?id=15470) | m71956 | 2025-03-19 10:18:47 | 2025-03-19 16:51:50 | 2025-03-27 06:00:43 | EE1-1.4: Conditional loop-filter | M. Santamaria  F. Cricri  N. Le (Nokia) |
| JVET-AL0146 |  |  |  |  | Withdrawn |  |
| [JVET-AL0147](https://jvet-experts.org/doc_end_user/current_document.php?id=15472) | m71958 | 2025-03-19 10:31:01 | 2025-03-19 10:35:37 | 2025-03-19 10:35:37 | AHG16: Refined parameter translator of generative face video coding | S. Yin  S. Wang  Z. Zhang (CityUHK)  B. Chen  Y. Ye  R.-L. Liao  J. Chen (Alibaba) |
| [JVET-AL0148](https://jvet-experts.org/doc_end_user/current_document.php?id=15473) | m71959 | 2025-03-19 10:31:01 | 2025-03-19 10:55:53 | 2025-03-19 10:55:53 | AHG9: Generative face video and generative face video enhancement SEI messages for HEVC and AVC | J. Chen  B. Chen  Y. Ye (Alibaba)  S. Gehlot  G.-M. Su  P. Yin  S. McCarthy (Dolby)  A. Trioux  F. Yang (Xidian Univ.)  Y.-K. Wang (Bytedance)  H.-B. Teo  J.-Y. Thong  K. Abe (Panasonic)  Y. Xu, K. Yang, Y. Li (SJTU) |
| [JVET-AL0149](https://jvet-experts.org/doc_end_user/current_document.php?id=15474) | m71960 | 2025-03-19 10:32:52 | 2025-03-20 04:54:51 | 2025-03-20 04:54:51 | EE2-2.12: Non-adjacent DIMD for TMRL | V. Rufitskiy  A. Filippov  T. Dong  H. Qin  J. Konieczny  K. Ding (TCL) |
| [JVET-AL0150](https://jvet-experts.org/doc_end_user/current_document.php?id=15475) | m71961 | 2025-03-19 10:36:40 | 2025-03-19 10:46:00 | 2025-03-25 10:21:15 | Non-EE2: CABAC context switch of sig\_coeff\_flag and abs\_level\_gtx\_flag for LFNST/NSPT | T. Kusakabe  K. Abe  T. Sugio  T. Nishi (Panasonic) |
| [JVET-AL0151](https://jvet-experts.org/doc_end_user/current_document.php?id=15476) | m71962 | 2025-03-19 10:41:22 | 2025-03-19 14:51:25 | 2025-03-26 16:31:20 | EE2-3.2: Extension on spatial and temporal merge candidates | J.-L. Lin  P.-H. Lin  Z. Zhang  V. Seregin  M. Karczewicz (Qualcomm) |
| [JVET-AL0152](https://jvet-experts.org/doc_end_user/current_document.php?id=15477) | m71963 | 2025-03-19 10:42:52 | 2025-03-19 11:55:31 | 2025-04-06 10:47:45 | AHG8: Dense QP coding results of combining adaptive temporal resampling, pre-processing, ROI-based adaptive QP, QP offset adjustment for higher temporal layers and post-processing algorithms for machine vision | S. Wang  J. Chen  Y. Ye  B. Li (Alibaba)  S. Wang (CityUHK) |
| [JVET-AL0153](https://jvet-experts.org/doc_end_user/current_document.php?id=15478) | m71964 | 2025-03-19 10:53:28 | 2025-03-19 21:51:04 | 2025-03-19 21:51:04 | EE2-5.1: ALF-CCCM | P. Astola  I. Jumakulyyev  D. Bugdayci Sansli  J. Lainema (Nokia) |
| [JVET-AL0154](https://jvet-experts.org/doc_end_user/current_document.php?id=15479) | m71965 | 2025-03-19 10:54:08 | 2025-03-19 11:05:58 | 2025-03-27 14:54:06 | AHG17: Resampling test for large resolution sequences | G. Clare (bcom)  F. Henry (Orange)  M. Tarchouli,  M. Riviere (Ateme) |
| [JVET-AL0155](https://jvet-experts.org/doc_end_user/current_document.php?id=15480) | m71966 | 2025-03-19 11:00:59 | 2025-03-20 03:41:07 | 2025-03-27 12:45:09 | AHG9: Further fixes and cleanup on GFV and GFVE SEI messages | J. Chen  B. Chen  Y. Ye (Alibaba) |
| [JVET-AL0156](https://jvet-experts.org/doc_end_user/current_document.php?id=15481) | m71967 | 2025-03-19 11:06:16 | 2025-03-19 18:15:43 | 2025-04-01 06:08:21 | AHG9/AHG16: Colour calibration for generative face video coding | J. Chen  B. Chen  Y. Ye (Alibaba)  S. Yin  S. Wang (CityUHK) |
| [JVET-AL0157](https://jvet-experts.org/doc_end_user/current_document.php?id=15482) | m71968 | 2025-03-19 11:06:21 | 2025-03-19 12:05:55 | 2025-03-26 17:07:09 | EE2-3.3: Additional inter merge candidates | N. Zhang  K. Zhang  Z. Deng  L. Zhao  Y. Wang  W. Yin  M. Salehifar  L. Zhang (Bytedance)  J.-L. Lin  P.-H. Lin  Z. Zhang  V. Seregin  M. Karczewicz (Qualcomm) |
| [JVET-AL0158](https://jvet-experts.org/doc_end_user/current_document.php?id=15483) | m71969 | 2025-03-19 11:10:59 | 2025-03-19 16:43:46 | 2025-03-26 21:19:50 | EE2-4.3: On coefficient level binarization in Transform Skip | M. Abdoli  R. G. Youvalari  F. Plowman  A. Tissier (Xiaomi) |
| [JVET-AL0159](https://jvet-experts.org/doc_end_user/current_document.php?id=15484) | m71972 | 2025-03-19 11:58:29 | 2025-03-19 20:31:15 | 2025-03-28 10:50:13 | AHG9: On backbone and tail of NNPFs | F. Cricri  M. M. Hannuksela (Nokia) |
| [JVET-AL0160](https://jvet-experts.org/doc_end_user/current_document.php?id=15485) | m71973 | 2025-03-19 12:08:49 | 2025-03-20 02:28:54 | 2025-03-25 08:43:44 | EE2-3.1: Subblock-based spatial MVP | Z. Deng  K. Zhang  N. Zhang  L. Zhao  Y. Wang  W. Yin  M. Salehifar  L. Zhang (Bytedance) |
| [JVET-AL0161](https://jvet-experts.org/doc_end_user/current_document.php?id=15486) | m71974 | 2025-03-19 12:21:44 | 2025-03-19 14:37:58 | 2025-03-25 03:45:25 | EE2-3.7: On interpolation filter for template matching | Z. Dai  R.-L. Liao  J. Chen  X. Li  Y. Ye (Alibaba) |
| [JVET-AL0162](https://jvet-experts.org/doc_end_user/current_document.php?id=15487) | m71975 | 2025-03-19 12:23:07 | 2025-03-19 15:27:21 | 2025-03-25 09:13:14 | EE2-3.8: CMVP extension for constructed affine merge candidates | C. Li  R.-L. Liao  J. Chen  Y. Ye (Alibaba) |
| JVET-AL0163 |  |  |  |  | Withdrawn |  |
| [JVET-AL0164](https://jvet-experts.org/doc_end_user/current_document.php?id=15489) | m71977 | 2025-03-19 12:55:53 | 2025-03-19 20:15:14 | 2025-03-19 20:15:14 | EE1-1.1: Multiscale blocks in LOP5 and VLOP3 filters | R. Yang  M. Santamaria  F. Cricri  H. Zhang  J. Lainema  M.M. Hannuksela (Nokia) |
| [JVET-AL0165](https://jvet-experts.org/doc_end_user/current_document.php?id=15490) | m71978 | 2025-03-19 13:14:18 | 2025-03-19 17:47:15 | 2025-03-28 08:11:46 | AHG11: Training NNSR using Reparameterization and Progressive Activation | H. Cho  S. Bahk  H. Y. Kim (KHU)  D. Kim  S.-C. Lim (ETRI) |
| [JVET-AL0166](https://jvet-experts.org/doc_end_user/current_document.php?id=15491) | m71979 | 2025-03-19 13:14:49 | 2025-03-19 16:45:09 | 2025-03-19 16:45:09 | EE1 related: Improved VLOP with Attention | Y. Li  L. Kerofsky  M. Karczewicz (Qualcomm) |
| [JVET-AL0167](https://jvet-experts.org/doc_end_user/current_document.php?id=15492) | m71980 | 2025-03-19 13:14:54 | 2025-03-19 16:45:47 | 2025-03-19 16:45:47 | EE1 related: Further simplification of VLOP with Attention | Y. Li  L. Kerofsky  M. Karczewicz (Qualcomm) |
| [JVET-AL0168](https://jvet-experts.org/doc_end_user/current_document.php?id=15493) | m71981 | 2025-03-19 13:15:00 | 2025-03-19 16:46:15 | 2025-04-03 07:53:21 | EE2-5.4: On the performance improvement of NN-based ILF in ALF | Y. Li  M. Karczewicz  J. Wang  L. Kerofsky  H. Wang  N. Hu  R. Yu  M. Coban  V. Seregin (Qualcomm)  T. Poirier  F. Galpin  F. Le Léannec  E. François (InterDigital)  D. Rusanovskyy  K. Panusopone  S. Hong  L. Wang (Nokia) |
| [JVET-AL0169](https://jvet-experts.org/doc_end_user/current_document.php?id=15494) | m71982 | 2025-03-19 13:15:38 | 2025-03-19 15:54:03 | 2025-04-01 07:41:16 | EE1-1.3 Dimension-wise decomposed representation of multiplier for content-adaptive loop filtering | Z. Xu  J. Konieczny  A. Filippov  C. Hollmann  V. Rufitskiy  T. Dong (TCL) |
| JVET-AL0170 |  |  |  |  | Withdrawn |  |
| [JVET-AL0171](https://jvet-experts.org/doc_end_user/current_document.php?id=15496) | m71984 | 2025-03-19 13:31:57 | 2025-03-19 14:05:58 | 2025-03-28 18:29:30 | AHG7: Tools interaction analysis of ECM-16.0 | R. Ishimoto  Z. Fan  T. Chujoh  T. Ikai (Sharp) |
| JVET-AL0172 |  |  |  |  | Withdrawn |  |
| [JVET-AL0173](https://jvet-experts.org/doc_end_user/current_document.php?id=15498) | m71986 | 2025-03-19 14:07:36 | 2025-03-24 11:11:27 | 2025-03-24 11:11:27 | Crosscheck of JVET-AL0164 (EE1-1.1: Multiscale blocks in LOP5 and VLOP3 filters) | Y. Li (Qualcomm) |
| [JVET-AL0174](https://jvet-experts.org/doc_end_user/current_document.php?id=15499) | m71987 | 2025-03-19 14:08:14 | 2025-03-19 14:13:23 | 2025-03-28 09:15:13 | Non-EE2: TIMD fusion with neural network based intra prediction | Y.-H. Lin  K.-W. Liang  C.-Y. Teng  Y.-C. Yang (Sharp)  K. Naser  T. Dumas  E. François  F. Le Léannec (InterDigital) |
| [JVET-AL0175](https://jvet-experts.org/doc_end_user/current_document.php?id=15500) | m71988 | 2025-03-19 14:20:56 | 2025-03-19 16:09:40 | 2025-04-02 16:12:33 | AHG9: On Target Mastering Colour Volume Information in the NNPFC SEI message for Tone Mapping | C-H. Demarty  E. François  F. Aumont  O. Le Meur (InterDigital) |
| [JVET-AL0176](https://jvet-experts.org/doc_end_user/current_document.php?id=15501) | m71989 | 2025-03-19 14:23:35 | 2025-03-20 00:29:55 | 2025-04-02 08:36:10 | AHG18: Proposed methodology and test conditions for ultra-low latency and error resilience performance evaluation | S. Ikonin  X. Ma  I. Gribushin  M. Sychev  E. Alshina (Huawei) |
| [JVET-AL0177](https://jvet-experts.org/doc_end_user/current_document.php?id=15502) | m71990 | 2025-03-19 14:23:43 | 2025-03-19 16:11:25 | 2025-03-31 11:19:35 | AHG9: On Signalling Tone Mapping Related Information in NNPFA | C-H. Demarty  E. François  F. Aumont  O. Le Meur (InterDigital) |
| [JVET-AL0178](https://jvet-experts.org/doc_end_user/current_document.php?id=15503) | m71991 | 2025-03-19 15:18:08 | 2025-03-19 17:48:39 | 2025-03-19 17:48:39 | AHG9: Use cases for energy savings information in SPO SEI messages | C-H. Demarty  E. François,  F. Aumont  O. Le Meur (InterDigital) |
| [JVET-AL0179](https://jvet-experts.org/doc_end_user/current_document.php?id=15504) | m71992 | 2025-03-19 15:25:21 | 2025-03-19 17:02:21 | 2025-04-01 16:24:39 | Non-EE2: Intra Merge Mode Enhancements | M. Blestel  P. Andrivon (Ofinno)  Y. Chang  V. Seregin  M. Karczewicz (Qualcomm) |
| JVET-AL0180 |  |  |  |  | Withdrawn |  |
| [JVET-AL0181](https://jvet-experts.org/doc_end_user/current_document.php?id=15506) | m71994 | 2025-03-19 15:37:20 | 2025-03-19 19:08:06 | 2025-03-24 10:33:03 | EE2: Tests 4.1 on Advanced SBT with direction and position inference | G. Laroche  P. Onno (Canon) |
| [JVET-AL0182](https://jvet-experts.org/doc_end_user/current_document.php?id=15507) | m71995 | 2025-03-19 15:37:28 | 2025-03-19 19:29:04 | 2025-03-30 23:05:28 | AhG-12: On TALF reference picture extensions | P. Onno  B. Galmiche  G. Laroche (Canon) |
| [JVET-AL0183](https://jvet-experts.org/doc_end_user/current_document.php?id=15508) | m71996 | 2025-03-19 15:45:38 | 2025-03-19 15:48:13 | 2025-04-01 08:43:41 | Non-EE2: Block Vector-based Intra Mode Derivation | J.-K Lee  D. Ruiz Coll  M. Blestel (Ofinno) |
| [JVET-AL0184](https://jvet-experts.org/doc_end_user/current_document.php?id=15509) | m71997 | 2025-03-19 15:48:26 | 2025-03-19 16:00:05 | 2025-03-30 06:40:10 | EE1-related: Deep Reference Frame Generation for Inter Prediction Enhancement | D. Ding  X. Chen  Z. Chen (Wuhan Univ.) |
| [JVET-AL0185](https://jvet-experts.org/doc_end_user/current_document.php?id=15510) | m71998 | 2025-03-19 15:54:09 | 2025-04-01 07:26:57 | 2025-04-01 07:26:57 | Crosscheck of JVET-AL0169 (EE1-1.3 Dimension-wise decomposed representation of multiplier for content-adaptive loop filtering) | M. Santamaria (Nokia) |
| [JVET-AL0186](https://jvet-experts.org/doc_end_user/current_document.php?id=15511) | m71999 | 2025-03-19 16:35:30 | 2025-03-19 16:46:53 | 2025-03-19 16:46:53 | AHG9: Subpicture support for digitally signed content SEI messages | M. Pettersson  R. Sjöberg  M. Damghanian (Ericsson) |
| [JVET-AL0187](https://jvet-experts.org/doc_end_user/current_document.php?id=15512) | m72000 | 2025-03-19 16:50:30 | 2025-03-24 11:57:43 | 2025-03-26 23:07:02 | EE1-3.1: NNVC-LOP4 and LOP5 retraining with additional BVI-AOM dataset | T. Dumas  A. Monier  F. Galpin (InterDigital) |
| [JVET-AL0188](https://jvet-experts.org/doc_end_user/current_document.php?id=15513) | m72001 | 2025-03-19 16:50:49 | 2025-03-19 17:00:45 | 2025-03-26 05:55:09 | EE2-2.5: Flip-aware BV prediction in SGPM | J. Huo  Y. Fei  L. Wang  Y. Ma  F. Yang (Xidian Univ.) |
| [JVET-AL0189](https://jvet-experts.org/doc_end_user/current_document.php?id=15514) | m72002 | 2025-03-19 16:53:16 | 2025-03-20 16:36:45 | 2025-03-27 08:55:41 | EE1-3.2 – NNVC-HOP5 retraining adding BVI-AOM | F. Galpin (InterDigital) |
| [JVET-AL0190](https://jvet-experts.org/doc_end_user/current_document.php?id=15515) | m72003 | 2025-03-19 16:53:40 | 2025-03-21 08:33:12 | 2025-03-26 07:06:21 | EE1-3.3 – NNVC-VLOP3 retraining adding BVI-AOM | F. Galpin  Z. Ameur (InterDigital)  R. Chang  L. Wang  X. Xu  S. Liu (Tencent) |
| [JVET-AL0191](https://jvet-experts.org/doc_end_user/current_document.php?id=15516) | m72004 | 2025-03-19 16:53:56 | 2025-03-19 21:58:48 | 2025-03-27 04:39:58 | EE2-2.2: On cross-component intra prediction | Y.-J. Chang  V. Seregin  M. Karczewicz (Qualcomm) |
| [JVET-AL0192](https://jvet-experts.org/doc_end_user/current_document.php?id=15517) | m72005 | 2025-03-19 17:05:51 | 2025-03-19 17:08:10 | 2025-04-01 11:31:22 | EE2-related: Harmonization of SGPM-BV and LIC | J. Huo  Y. Fei  L. Wang  Y. Ma  F. Yang (Xidian Univ.) |
| [JVET-AL0193](https://jvet-experts.org/doc_end_user/current_document.php?id=15518) | m72006 | 2025-03-19 17:10:50 | 2025-03-19 17:21:41 | 2025-03-27 16:19:11 | Non-EE2: Extension of Template Types in Regression-Based GPM | Y. Yao  J. Huo  W. Zhang  F. Yang (Xidian Univ.)  B. Li  F. Xing  P. Han  Z. Wang (Hisense) |
| [JVET-AL0194](https://jvet-experts.org/doc_end_user/current_document.php?id=15519) | m72007 | 2025-03-19 17:14:06 | 2025-03-19 17:19:06 | 2025-03-19 17:19:06 | AHG7: Assessment Perspectives of Codec/Coding Tools | X. Li (Google) |
| [JVET-AL0195](https://jvet-experts.org/doc_end_user/current_document.php?id=15520) | m72008 | 2025-03-19 17:30:00 | 2025-03-20 03:49:46 | 2025-03-26 09:41:46 | Non-EE2: TIMD-BV extension with enhanced IntraTMP merge list | J. Fu  J. Zhang  Y. Zhao  S. Ma (PKU)  Y. Gao  C. Huang (ZTE)  K. Naser  M. Radosavljević  S. Puri  T. Dumas (InterDigital)  D. Ruiz Coll  J.-K Lee (Ofinno) |
| [JVET-AL0196](https://jvet-experts.org/doc_end_user/current_document.php?id=15521) | m72009 | 2025-03-19 18:09:03 | 2025-03-19 20:08:19 | 2025-04-03 07:30:22 | AHG 11: Neural Network Coded Reference Frame for Intra Coding with Residual Coding and Intra Blocks | F. Brand  T. Solovyev  E. Alshina (Huawei) |
| [JVET-AL0197](https://jvet-experts.org/doc_end_user/current_document.php?id=15522) | m72010 | 2025-03-19 18:39:19 | 2025-03-19 20:44:42 | 2025-03-19 20:44:42 | AHG3: Intra period for random access set in configuration files | A. Dziembowski  D. Mieloch (PUT) |
| [JVET-AL0198](https://jvet-experts.org/doc_end_user/current_document.php?id=15523) | m72011 | 2025-03-19 18:41:41 | 2025-03-19 20:44:57 | 2025-04-02 14:45:39 | Non-EE2: Optimization of probability estimation in CABAC | D. Karwowski  D. Mieloch  M. Lorkiewicz  J. Stankowski (PUT) |
| [JVET-AL0199](https://jvet-experts.org/doc_end_user/current_document.php?id=15524) | m72012 | 2025-03-19 18:43:47 | 2025-03-19 20:45:06 | 2025-04-01 15:15:08 | EE2-6.1: Adaptive picture-level vertical mirroring | D. Mieloch  J. Stankowski  M. Lorkiewicz  A. Dziembowski  D. Karwowski (PUT) |
| [JVET-AL0200](https://jvet-experts.org/doc_end_user/current_document.php?id=15525) | m72013 | 2025-03-19 18:44:52 | 2025-03-19 22:37:30 | 2025-03-19 22:37:30 | AHG18: Simulation software description | S. Ikonin  V. Khamidullin  R. Shabaev  I. Gribushin  M. Sychev  E. Alshina (Huawei) |
| [JVET-AL0201](https://jvet-experts.org/doc_end_user/current_document.php?id=15526) | m72014 | 2025-03-19 18:45:26 | 2025-03-20 01:06:58 | 2025-04-01 23:37:00 | AHG18: Performance evaluation of VTM under proposed ULL test conditions and proposed software modifications | S. Ikonin  V. Khamidullin  R. Shabaev  I. Gribushin  M. Sychev  E. Alshina (Huawei) |
| [JVET-AL0202](https://jvet-experts.org/doc_end_user/current_document.php?id=15527) | m72015 | 2025-03-19 18:45:42 | 2025-03-19 20:45:14 | 2025-03-19 20:45:14 | EE2-related: Adaptive picture-level vertical mirroring based on decimated video | D. Mieloch  M. Lorkiewicz  A. Dziembowski (PUT) |
| [JVET-AL0203](https://jvet-experts.org/doc_end_user/current_document.php?id=15528) | m72016 | 2025-03-19 19:26:02 | 2025-03-19 19:36:12 | 2025-03-25 16:04:05 | [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) |
| [JVET-AL0204](https://jvet-experts.org/doc_end_user/current_document.php?id=15529) | m72017 | 2025-03-19 19:59:19 | 2025-03-19 20:02:17 | 2025-03-19 20:02:17 | AHG9: On picture width and height for the film grain characteristics SEI message | M. M. Hannuksela  J. Boyce (Nokia) |
| [JVET-AL0205](https://jvet-experts.org/doc_end_user/current_document.php?id=15530) | m72018 | 2025-03-19 20:15:05 | 2025-03-19 20:24:43 | 2025-03-26 20:09:09 | EE2-2.1: EIP filters with diagonal shapes | K. Panusopone  M. He  S. Hong  L. Wang  J. Lainema  D. Rusanovskyy (Nokia) |
| [JVET-AL0206](https://jvet-experts.org/doc_end_user/current_document.php?id=15531) | m72019 | 2025-03-19 20:17:52 | 2025-03-19 20:47:18 | 2025-03-27 05:39:20 | EE2-2.9: Test 2.1 + Test 2.4 | K. Panusopone  M. He  S. Hong  L. Wang  J. Lainema  D. Rusanovskyy (Nokia)  Z. Xie  Y. Yu  H. Yu  D. Wang (OPPO) |
| [JVET-AL0207](https://jvet-experts.org/doc_end_user/current_document.php?id=15532) | m72020 | 2025-03-19 20:23:52 | 2025-03-20 00:12:01 | 2025-04-03 09:28:28 | AHG10/AHG17: On matching target bitrate for subjective quality evaluation | K. Andersson  P. Wennersten (Ericsson) |
| [JVET-AL0208](https://jvet-experts.org/doc_end_user/current_document.php?id=15533) | m72021 | 2025-03-19 20:32:49 | 2025-03-19 21:12:11 | 2025-03-19 21:12:11 | AHG9: On SPO root-process signalling constraint | T. M. Borges  Y. Sanchez  R. Skupin,  C. Hellge  T. Schierl (Fraunhofer HHI) |
| [JVET-AL0209](https://jvet-experts.org/doc_end_user/current_document.php?id=15534) | m72022 | 2025-03-19 20:36:07 | 2025-03-19 21:11:18 | 2025-03-19 21:11:18 | AHG9: On providing robustness against layer dropping in multi-layer NNPF | T. M. Borges  Y. Sanchez  R. Skupin  C. Hellge  T. Schierl (Fraunhofer HHI) |
| [JVET-AL0210](https://jvet-experts.org/doc_end_user/current_document.php?id=15535) | m72023 | 2025-03-19 20:44:50 | 2025-03-19 20:47:18 | 2025-03-19 20:47:18 | AHG9: On SEI processing order SEI message for HEVC and AVC | Y. Sanchez  T. M. Borges  R. Skupin  C. Hellge  T. Schierl (Fraunhofer HHI) |
| [JVET-AL0211](https://jvet-experts.org/doc_end_user/current_document.php?id=15536) | m72024 | 2025-03-19 20:47:43 | 2025-03-19 20:51:13 | 2025-03-19 20:51:13 | AHG9: Resolution nesting for FGC SEI message | R. Skupin  Y. Sanchez  A. Wieckowski  T. M. Borges  C. Hellge  T. Schierl (Fraunhofer HHI) |
| [JVET-AL0212](https://jvet-experts.org/doc_end_user/current_document.php?id=15539) | m72027 | 2025-03-19 21:47:44 | 2025-03-19 22:40:37 | 2025-04-03 18:06:49 | AHG9/AHG15: Depth-adaptive picture scaling information SEI | V. Zakharchenko  T. Biatek  J. Boyce (Nokia) |
| [JVET-AL0213](https://jvet-experts.org/doc_end_user/current_document.php?id=15540) | m72028 | 2025-03-19 22:00:11 | 2025-03-19 22:18:38 | 2025-03-20 00:06:39 | AHG7: On common test conditions for fixed-QP objective rate-distortion testing of "low delay" encoding | G. J. Sullivan  P. Yin  T. N. Canh (Dolby Labs) |
| [JVET-AL0214](https://jvet-experts.org/doc_end_user/current_document.php?id=15541) | m72029 | 2025-03-19 22:02:15 | 2025-03-19 22:13:21 | 2025-03-20 21:28:11 | EE2-3.6: MV refinement for TMVP | Z. Zhang  J.-L. Lin  Y. Zhang  H. Huang  V. Seregin  M. Karczewicz (Qualcomm) |
| [JVET-AL0215](https://jvet-experts.org/doc_end_user/current_document.php?id=15542) | m72030 | 2025-03-19 22:02:19 | 2025-03-20 00:15:46 | 2025-03-28 18:04:26 | EE2-4.4: IntraNN NSPT set | G. Verba  M. Coban  V. Seregin  M. Karczewicz (Qualcomm) |
| [JVET-AL0216](https://jvet-experts.org/doc_end_user/current_document.php?id=15543) | m72031 | 2025-03-19 22:02:57 | 2025-03-19 23:07:58 | 2025-04-02 15:49:30 | [AHG9] Lens Optical Correction SEI – floating point parameters representation | G. Teniou  S. Wenger  A. Hinds (Tencent) |
| [JVET-AL0217](https://jvet-experts.org/doc_end_user/current_document.php?id=15544) | m72032 | 2025-03-19 22:14:56 | 2025-03-19 22:22:29 | 2025-04-01 02:30:03 | CICP support for monochrome content | J. Boyce  T. Biatek  M. M. Hannuksela (Nokia) |
| [JVET-AL0218](https://jvet-experts.org/doc_end_user/current_document.php?id=15545) | m72033 | 2025-03-19 22:15:01 | 2025-03-19 22:25:01 | 2025-03-27 05:11:39 | CICP support for colour mapping | J. Boyce  T. Biatek  M. M. Hannuksela (Nokia) |
| [JVET-AL0219](https://jvet-experts.org/doc_end_user/current_document.php?id=15546) | m72034 | 2025-03-19 22:15:05 | 2025-03-19 22:35:18 | 2025-04-03 20:31:49 | AHG9: Colour mapping information SEI | J. Boyce  T. Biatek  M. M. Hannuksela (Nokia) |
| [JVET-AL0220](https://jvet-experts.org/doc_end_user/current_document.php?id=15547) | m72035 | 2025-03-19 22:51:22 | 2025-03-20 00:06:54 | 2025-04-01 08:44:26 | AHG12: Reuse of ALF control information | N. Hu  H. Wang  M. Karczewicz  V. Seregin (Qualcomm) |
| [JVET-AL0221](https://jvet-experts.org/doc_end_user/current_document.php?id=15548) | m72036 | 2025-03-19 23:21:31 | 2025-03-19 23:27:14 | 2025-03-26 18:29:20 | AHG9: EOI SEI message with luma range adaptation for machine analysis | T. Partanen  M. M. Hannuksela  H. Zhang  A. Aminlou (Nokia) |
| [JVET-AL0222](https://jvet-experts.org/doc_end_user/current_document.php?id=15549) | m72037 | 2025-03-19 23:30:13 | 2025-03-19 23:31:22 | 2025-03-27 13:46:34 | AHG9: On Digitally Signed Content SEI messages | K. Sühring  T. Hinz  Y. Sanchez  J. Pfaff  H. Schwarz  D. Marpe  T. Wiegand (Fraunhofer HHI) |
| [JVET-AL0223](https://jvet-experts.org/doc_end_user/current_document.php?id=15550) | m72038 | 2025-03-19 23:35:42 | 2025-03-19 23:55:32 | 2025-04-01 09:33:23 | AHG2: Corrections and clarifications for profile-related aspects of the draft text for HEVC | G. J. Sullivan (Dolby Labs) |
| [JVET-AL0224](https://jvet-experts.org/doc_end_user/current_document.php?id=15551) | m72039 | 2025-03-19 23:37:31 | 2025-03-19 23:39:12 | 2025-03-28 08:33:52 | AHG9: Auxiliary sampling alignment information SEI | V. Zakharchenko  J. Boyce  D. Rusanovskyy  M. M. Hannuksela (Nokia) |
| [JVET-AL0225](https://jvet-experts.org/doc_end_user/current_document.php?id=15552) | m72040 | 2025-03-19 23:42:58 | 2025-03-20 01:34:23 | 2025-04-03 01:52:05 | EE2-related: On In-Loop Filtering in ECM | D. Rusanovskyy  M. Santamaria  N. Le  F. Cricri  K. Panusopone  S. Hong  L. Wang  J. Lainema (Nokia)  Y. Li  M. Karczewicz  J. Wang  L. Kerofsky (Qualcomm) |
| [JVET-AL0226](https://jvet-experts.org/doc_end_user/current_document.php?id=15553) | m72041 | 2025-03-19 23:51:27 | 2025-03-19 23:57:36 | 2025-03-24 10:19:27 | AHG9: Proposed segmentation plane test sequences (AUX\_SEGMENT) | E. Thomas  E. Potetsianakis  E. Alexiou  M.-L. Champel (Xiaomi) |
| [JVET-AL0227](https://jvet-experts.org/doc_end_user/current_document.php?id=15554) | m72042 | 2025-03-20 00:24:18 | 2025-03-20 00:34:48 | 2025-03-22 02:10:40 | EE2-4.2a: Advanced SBT with simplified search method | Y. Zhang  E. Ye  H. Wang  V. Seregin  M. Karczewicz (Qualcomm) |
| [JVET-AL0228](https://jvet-experts.org/doc_end_user/current_document.php?id=15555) | m72043 | 2025-03-20 00:41:05 | 2025-03-20 00:47:28 | 2025-04-03 07:42:51 | EE2-related: NNLF interface in ECM | T. Poirier  F. Galpin  G. Boisson (InterDigital)  Y. Li  M. Karczewicz  J. Wang  L. Kerofsky  H. Wang  N. Hu  R. Yu  M. Coban  V. Seregin (Qualcomm)  D. Rusanovskyy  K. Panusopone  S. Hong  L. Wang (Nokia) |
| [JVET-AL0229](https://jvet-experts.org/doc_end_user/current_document.php?id=15556) | m72044 | 2025-03-20 00:45:42 | 2025-03-20 01:04:17 | 2025-03-26 01:39:26 | EE2-4.2b: Combination test of EE2-4.1 and EE2-4.2a | G. Laroche  P. Onno (Canon)  Y. Zhang  E. Ye  H. Wang  V. Seregin  M. Karczewicz (Qualcomm) |
| [JVET-AL0230](https://jvet-experts.org/doc_end_user/current_document.php?id=15557) | m72045 | 2025-03-20 01:47:25 | 2025-03-20 03:01:10 | 2025-03-20 03:01:10 | AhG11/AhG12: Performance of the NNVC ILF in ECM | D. Rusanovskyy  K. Panusopone  S. Hong  L. Wang (Nokia) |
| [JVET-AL0231](https://jvet-experts.org/doc_end_user/current_document.php?id=15558) | m72046 | 2025-03-20 01:54:14 | 2025-03-20 02:03:23 | 2025-04-01 13:19:08 | Non-EE2: On interpolation filter for TIMD | Y. Wang  W. Yin  K. Zhang  Z. Deng  N. Zhang  L. Zhao  M. Salehifar  L. Zhang (Bytedance) |
| [JVET-AL0232](https://jvet-experts.org/doc_end_user/current_document.php?id=15559) | m72047 | 2025-03-20 03:48:09 | 2025-03-20 07:28:23 | 2025-04-02 19:11:30 | Non-EE2: on TALF input extension | C. Ma  X. Xiu  X. Wang (Kwai) |
| [JVET-AL0233](https://jvet-experts.org/doc_end_user/current_document.php?id=15560) | m72049 | 2025-03-20 07:10:44 | 2025-03-20 07:22:46 | 2025-03-26 15:28:55 | Information on low complexity encoding experiments | L. Li  M. W. Park  M. Park  Y. Kim  K. P. Choi (Samsung) |
| [JVET-AL0234](https://jvet-experts.org/doc_end_user/current_document.php?id=15561) | m72052 | 2025-03-20 07:41:32 | 2025-03-20 07:45:43 | 2025-03-28 06:19:46 | EE2-related: affine bilateral matching merge mode | H. Huang  V. Seregin  M. Karczewicz (Qualcomm) |
| [JVET-AL0235](https://jvet-experts.org/doc_end_user/current_document.php?id=15562) | m72054 | 2025-03-20 10:41:32 | 2025-03-20 10:44:37 | 2025-03-20 10:44:37 | On the immersive requirements for the next generation video codec | B. Kroon  C. Varekamp (Philips) |
| [JVET-AL0236](https://jvet-experts.org/doc_end_user/current_document.php?id=15563) | m72058 | 2025-03-20 11:39:59 | 2025-03-27 07:06:54 | 2025-03-28 06:13:25 | Crosscheck of JVET-AL0199 (EE2-6.1: Adaptive picture-level vertical mirroring) | M. Abdoli (Xiaomi) |
| [JVET-AL0237](https://jvet-experts.org/doc_end_user/current_document.php?id=15564) | m72059 | 2025-03-20 11:46:56 | 2025-03-26 06:11:53 | 2025-03-26 06:11:53 | Crosscheck of JVET-AL0188 (EE2-2.5: Flip-aware BV prediction in SGPM) | X. Li (Alibaba) |
| [JVET-AL0238](https://jvet-experts.org/doc_end_user/current_document.php?id=15565) | m72060 | 2025-03-20 11:48:41 | 2025-03-26 05:56:50 | 2025-03-27 06:25:58 | Crosscheck of JVET-AL0153 (EE2-5.1: ALF-CCCM) | R. G. Youvalari (Xiaomi) |
| [JVET-AL0239](https://jvet-experts.org/doc_end_user/current_document.php?id=15566) | m72061 | 2025-03-20 11:49:35 | 2025-03-24 11:46:54 | 2025-04-03 17:38:51 | [AHG17] Proposal of a new sequence in HD-SDR-LB category | A. Tissier  M. Abdoli  R. G. Youvalari  F. Plowman  M. -L. Champel (Xiaomi) |
| [JVET-AL0240](https://jvet-experts.org/doc_end_user/current_document.php?id=15567) | m72062 | 2025-03-20 13:15:46 | 2025-03-26 06:14:40 | 2025-03-26 06:14:40 | Crosscheck of JVET-AL0158 (EE2-4.3: On coefficient level binarization in Transform Skip) | P. Astola (Nokia) |
| [JVET-AL0241](https://jvet-experts.org/doc_end_user/current_document.php?id=15568) | m72064 | 2025-03-20 14:26:37 | 2025-03-20 14:31:37 | 2025-03-28 07:54:29 | Non-EE2: Intra TMP sub-modes depending on the template type information | T. Dumas  K. Naser  M. Radosavljević  F. Le Léannec (InterDigital) |
| [JVET-AL0242](https://jvet-experts.org/doc_end_user/current_document.php?id=15569) | m72065 | 2025-03-20 17:27:19 | 2025-03-20 18:49:47 | 2025-03-26 19:53:55 | [AHG7][AHG17] ECM performance under different MTT configurations | S. Puri  K. Naser  F. Le Léannec  E. François (InterDigital) |
| [JVET-AL0243](https://jvet-experts.org/doc_end_user/current_document.php?id=15570) | m72076 | 2025-03-21 09:01:36 | 2025-03-21 16:56:40 | 2025-03-27 17:33:06 | [AHG11] Multilayer framework for supporting a hybrid codec using End-to-End Learned Image Codec and Conventional Video Codec | F. Urban  Y. Chen  F. Galpin  E. François (InterDigital) |
| [JVET-AL0244](https://jvet-experts.org/doc_end_user/current_document.php?id=15571) | m72079 | 2025-03-21 10:26:24 | 2025-03-27 07:43:13 | 2025-03-27 07:43:13 | Crosscheck of JVET-AL0215 (EE2-4.4cd: IntraNN NSPT set) | M. Abdoli (Xiaomi) |
| [JVET-AL0245](https://jvet-experts.org/doc_end_user/current_document.php?id=15572) | m72084 | 2025-03-21 12:48:25 | 2025-03-21 13:34:37 | 2025-04-04 10:34:28 | [AHG7][AHG17] Further consideration of common test condition | T. Ikai  K.-W. Liang (Sharp) |
| [JVET-AL0246](https://jvet-experts.org/doc_end_user/current_document.php?id=15573) | m72091 | 2025-03-21 15:39:18 | 2025-03-21 17:34:13 | 2025-03-31 01:07:48 | Crosscheck of JVET-AL0084 (EE1-1.2: LOP5 improvement with parallel 1x3/3x1 Backbone) | Y. Li  C. Lin  J. Li (Bytedance) |
| [JVET-AL0247](https://jvet-experts.org/doc_end_user/current_document.php?id=15574) | m72092 | 2025-03-21 15:44:06 | 2025-03-21 15:47:36 | 2025-04-04 07:25:24 | [AHG-7] On Max Transform Size in ECM | K. Naser  F. Le Léannec  S. Puri  C. Bonnineau  E. François (InterDigital) |
| [JVET-AL0248](https://jvet-experts.org/doc_end_user/current_document.php?id=15575) | m72099 | 2025-03-21 22:39:37 | 2025-03-21 22:57:59 | 2025-04-01 09:55:57 | AHG12: On Motion Vector Prediction | D. Bugdayci Sansli  P. Astola  J. Lainema (Nokia) |
| [JVET-AL0249](https://jvet-experts.org/doc_end_user/current_document.php?id=15576) | m72103 | 2025-03-22 00:49:13 | 2025-03-22 00:55:45 | 2025-03-22 00:55:45 | AHG9: Proposed modifications to VSEI to address national body comments | J. Boyce (Nokia) |
| [JVET-AL0250](https://jvet-experts.org/doc_end_user/current_document.php?id=15577) | m72132 | 2025-03-22 10:28:31 | 2025-03-22 10:30:52 | 2025-03-26 07:33:46 | AHG11: Cross-component enhanced NNSR | T. Yang  W.-X. He  Y.-Q. Zhu  J.-D. Ye  X.-T. Xie  J.-S. Gong  Q. Liu (HUST)  Z.-Y. Lv (vivo) |
| [JVET-AL0251](https://jvet-experts.org/doc_end_user/current_document.php?id=15578) | m72152 | 2025-03-24 01:18:04 | 2025-03-26 05:59:47 | 2025-03-26 05:59:47 | Crosscheck of JVET-AL0160 (EE2-3.1: Subblock-based spatial MVP) | Z. Lyu (vivo) |
| [JVET-AL0252](https://jvet-experts.org/doc_end_user/current_document.php?id=15579) | m72155 | 2025-03-24 02:51:27 | 2025-03-26 09:19:27 | 2025-03-26 09:19:27 | Crosscheck of JVET-AL0081 (EE2-3.9: Extended BDOF usage for MV refinement) | Y. Wang (Bytedance) |
| [JVET-AL0253](https://jvet-experts.org/doc_end_user/current_document.php?id=15580) | m72157 | 2025-03-24 03:17:01 | 2025-03-28 07:21:10 | 2025-03-28 07:21:10 | Crosscheck of JVET-AL0142 (EE2-5.2: CCSAO with Reused CTU Control) | W. Yin (Bytedance) |
| [JVET-AL0254](https://jvet-experts.org/doc_end_user/current_document.php?id=15581) | m72175 | 2025-03-24 07:29:26 | 2025-03-26 09:17:44 | 2025-03-26 09:17:44 | Crosscheck of JVET-AL0182 (AhG-12: On TALF reference picture extensions) | L. Xu (OPPO) |
| [JVET-AL0255](https://jvet-experts.org/doc_end_user/current_document.php?id=15582) | m72178 | 2025-03-24 07:31:04 | 2025-03-26 09:15:15 | 2025-03-26 09:15:15 | Crosscheck of JVET-AL0161 (EE2-3.7: On interpolation filter for template matching)) | L. Xu (OPPO) |
| [JVET-AL0256](https://jvet-experts.org/doc_end_user/current_document.php?id=15583) | m72190 | 2025-03-24 08:07:39 | 2025-03-27 17:11:55 | 2025-03-27 17:11:55 | Crosscheck of JVET-AL0082 (AHG12: Modifications to regression-based GPM with intra and inter prediction) | K. Jia (Alibaba) |
| [JVET-AL0257](https://jvet-experts.org/doc_end_user/current_document.php?id=15584) | m72206 | 2025-03-24 08:49:51 | 2025-03-27 17:30:48 | 2025-03-27 17:30:48 | Crosscheck of JVET-AL0214 (EE2-3.6 MV refinement for TMVP) | Z. Deng (Bytedance) |
| [JVET-AL0258](https://jvet-experts.org/doc_end_user/current_document.php?id=15585) | m72207 | 2025-03-24 08:50:14 | 2025-03-27 17:31:10 | 2025-03-27 17:31:10 | Crosscheck of JVET-AL0124 (EE2-2.10 Multiple filter taps for EIP) | Z. Deng (Bytedance) |
| [JVET-AL0259](https://jvet-experts.org/doc_end_user/current_document.php?id=15586) | m72230 | 2025-03-24 11:38:21 | 2025-03-24 14:19:05 | 2025-03-24 14:19:05 | Crosscheck of JVET-AL0227 (EE2-4.2a: Advanced SBT with simplified search method) | G. Laroche (Canon) |
| [JVET-AL0260](https://jvet-experts.org/doc_end_user/current_document.php?id=15587) | m72239 | 2025-03-24 13:42:06 | 2025-04-01 18:54:14 | 2025-04-01 18:54:14 | Crosscheck of JVET-AL0229 (EE2-4.2b: Combination test of EE2-4.1 and EE2-4.2a) | L. Zhao (Bytedance) |
| [JVET-AL0261](https://jvet-experts.org/doc_end_user/current_document.php?id=15588) | m72240 | 2025-03-24 13:42:55 | 2025-04-01 18:54:32 | 2025-04-01 18:54:32 | Crosscheck of JVET-AL0162 (EE2-3.8: CMVP extension for constructed affine merge candidates) | L. Zhao (Bytedance) |
| [JVET-AL0262](https://jvet-experts.org/doc_end_user/current_document.php?id=15589) | m72272 | 2025-03-24 15:17:05 | 2025-03-26 04:35:05 | 2025-03-26 04:35:05 | Crosscheck of JVET-AL0125 (EE2-2.6a/c: Improvement on MPM) | J. Fu  Z. Li (PKU) |
| [JVET-AL0263](https://jvet-experts.org/doc_end_user/current_document.php?id=15590) | m72285 | 2025-03-24 15:52:55 | 2025-03-24 16:45:21 | 2025-03-28 16:10:32 | Crosscheck of JVET-AL0055 (AhG10: On constrained encoder configuration of VTM) | H. Le Lais  P. de Lagrange (InterDigital) |
| [JVET-AL0264](https://jvet-experts.org/doc_end_user/current_document.php?id=15591) | m72305 | 2025-03-24 16:55:12 | 2025-03-26 11:18:16 | 2025-03-26 11:18:16 | Crosscheck of JVET-AL0206 (EE2-2.9: Test 2.1 + Test 2.4) | P. Andrivon (Ofinno) |
| [JVET-AL0265](https://jvet-experts.org/doc_end_user/current_document.php?id=15592) | m72339 | 2025-03-24 18:42:14 | 2025-03-24 18:44:13 | 2025-04-02 16:49:27 | AhG14: SADL update | F. Galpin (InterDigital) |
| [JVET-AL0266](https://jvet-experts.org/doc_end_user/current_document.php?id=15593) | m72340 | 2025-03-24 18:45:47 | 2025-04-01 02:19:11 | 2025-04-01 02:19:11 | Crosscheck of JVET-AL0247 On Max Transform Size in ECM | X. Li (Google) |
| JVET-AL0267 |  |  |  |  | Withdrawn |  |
| [JVET-AL0268](https://jvet-experts.org/doc_end_user/current_document.php?id=15595) | m72455 | 2025-03-25 03:24:35 | 2025-03-26 14:30:41 | 2025-03-26 14:30:41 | Crosscheck of Test 2.2c and d in JVET-AL0191 (EE2-2.2: On cross-component intra prediction) | H. Huang (OPPO) |
| [JVET-AL0269](https://jvet-experts.org/doc_end_user/current_document.php?id=15596) | m72456 | 2025-03-25 03:27:36 | 2025-03-27 14:04:04 | 2025-03-27 14:04:04 | Crosscheck of JVET-AL0157 (EE2-3.3: Additional inter merge candidates) | X. Li (Alibaba) |
| [JVET-AL0270](https://jvet-experts.org/doc_end_user/current_document.php?id=15597) | m72457 | 2025-03-25 03:28:44 | 2025-03-28 05:01:12 | 2025-04-01 11:54:05 | Crosscheck of JVET-AL0192 (EE2-related: Harmonization of SGPM-BV and LIC) | X. Li (Alibaba) |
| [JVET-AL0271](https://jvet-experts.org/doc_end_user/current_document.php?id=15598) | m72458 | 2025-03-25 03:29:45 | 2025-03-28 05:01:33 | 2025-03-28 05:01:33 | Crosscheck of JVET-AL0195 (Non-EE2: TIMD-BV extension with enhanced IntraTMP merge list) | X. Li (Alibaba) |
| [JVET-AL0272](https://jvet-experts.org/doc_end_user/current_document.php?id=15599) | m72459 | 2025-03-25 03:30:32 | 2025-03-28 05:01:57 | 2025-04-01 11:54:29 | Crosscheck of JVET-AL0111 (Non-EE2: Matrix-based position dependent intra prediction for GPM/CIIP) | X. Li (Alibaba) |
| [JVET-AL0273](https://jvet-experts.org/doc_end_user/current_document.php?id=15600) | m72460 | 2025-03-25 03:46:18 | 2025-03-25 04:39:13 | 2025-03-25 04:39:13 | Crosscheck of JVET-AL0079 (EE2-3.5: On affine motion compensation) | C. Ma (Kwai) |
| [JVET-AL0274](https://jvet-experts.org/doc_end_user/current_document.php?id=15601) | m72462 | 2025-03-25 04:09:30 | 2025-03-31 06:04:36 | 2025-03-31 06:04:36 | Crosscheck of JVET-AL0126 (EE2-2.3: CCP merge mode with adjustment) | C. Ma (Kwai) |
| [JVET-AL0275](https://jvet-experts.org/doc_end_user/current_document.php?id=15602) | m72467 | 2025-03-25 06:24:52 | 2025-03-25 06:35:53 | 2025-04-01 18:43:38 | Non-EE2: Non-linear clipping for CCALF | N. Song  L. Xu  Y. Yu  H. Yu  D. Wang (OPPO) |
| [JVET-AL0276](https://jvet-experts.org/doc_end_user/current_document.php?id=15603) | m72468 | 2025-03-25 07:00:42 | 2025-03-28 07:36:16 | 2025-03-28 07:36:16 | Crosscheck of JVET-AL0110 (EE2-related: On ALF-CCCM) | N. Hu (Qualcomm) |
| [JVET-AL0277](https://jvet-experts.org/doc_end_user/current_document.php?id=15604) | m72469 | 2025-03-25 07:01:01 | 2025-03-27 17:05:02 | 2025-03-27 17:05:02 | Crosscheck of JVET-AL0135 (EE2-5.3: Cross-Chroma Input for Chroma-ALF and CC-ALF)) | N. Hu (Qualcomm) |
| [JVET-AL0278](https://jvet-experts.org/doc_end_user/current_document.php?id=15605) | m72471 | 2025-03-25 07:26:36 | 2025-03-25 08:09:51 | 2025-03-31 10:17:17 | Huawei comments on use case and requirements for NextGenVideoCodec | T. Solovyev  S. Ikonin  E. Alshina (Huawei) |
| [JVET-AL0279](https://jvet-experts.org/doc_end_user/current_document.php?id=15606) | m72473 | 2025-03-25 08:04:47 | 2025-03-26 07:41:10 | 2025-03-26 07:41:10 | Crosscheck of JVET-AL0143 (EE2-1.1: Chroma partition prediction in separate tree condition) | R.-L. Liao (Alibaba) |
| [JVET-AL0280](https://jvet-experts.org/doc_end_user/current_document.php?id=15607) | m72474 | 2025-03-25 08:06:52 | 2025-03-27 02:56:39 | 2025-03-27 02:56:39 | Crosscheck of JVET-AL0108 (EE2-2.7: Block vector guided DIMD) | Y. Wang (Bytedance) |
| [JVET-AL0281](https://jvet-experts.org/doc_end_user/current_document.php?id=15608) | m72477 | 2025-03-25 10:25:08 | 2025-03-27 12:38:12 | 2025-03-27 14:10:19 | Crosscheck of JVET-AL0215 (EE2-4.4ab: IntraNN NSPT set) | T. Dong  V. Rufitskiy  A. Filippov(TCL) |
| [JVET-AL0282](https://jvet-experts.org/doc_end_user/current_document.php?id=15609) | m72483 | 2025-03-25 13:01:12 | 2025-03-28 15:05:46 | 2025-03-28 15:05:46 | AHG13: Film grain analysis improvement | M. Radosavljević  F. Lefebvre  Z. Ameur  P. de Lagrange (InterDigital) |
| [JVET-AL0283](https://jvet-experts.org/doc_end_user/current_document.php?id=15610) | m72484 | 2025-03-25 13:02:03 | 2025-03-25 13:31:35 | 2025-03-25 13:31:35 | Crosscheck of JVET-AL0191 (EE2-2.2: On cross-component intra prediction) for tests EE2-2.2a and EE2-2.2b | J. Lainema (Nokia) |
| [JVET-AL0284](https://jvet-experts.org/doc_end_user/current_document.php?id=15611) | m72486 | 2025-03-25 13:52:06 | 2025-03-26 07:42:57 | 2025-03-31 15:08:41 | Crosscheck of JVET-AL0145 (EE1-1.4: Conditional loop-filter) | J. Ström (Ericsson) |
| [JVET-AL0285](https://jvet-experts.org/doc_end_user/current_document.php?id=15612) | m72487 | 2025-03-25 13:55:06 | 2025-03-27 03:37:32 | 2025-03-27 03:37:32 | Crosscheck of JVET-AL0143 (EE2-1.1: Chroma partition prediction in separate tree condition) | C.-W. Kuo (Kwai) |
| [JVET-AL0286](https://jvet-experts.org/doc_end_user/current_document.php?id=15613) | m72490 | 2025-03-25 14:32:22 | 2025-03-25 20:34:31 | 2025-04-03 20:21:34 | AHG9: On dual-lens optical correction SEI message | A. Karabutov  E. Alshina (Huawei) |
| [JVET-AL0287](https://jvet-experts.org/doc_end_user/current_document.php?id=15614) | m72492 | 2025-03-25 14:38:50 | 2025-03-25 15:58:42 | 2025-04-03 16:34:20 | AHG12: Generated Merge Candidates | D. Bugdayci Sansli  P. Astola  J. Lainema (Nokia) |
| [JVET-AL0288](https://jvet-experts.org/doc_end_user/current_document.php?id=15615) | m72493 | 2025-03-25 15:23:40 | 2025-03-26 01:07:09 | 2025-04-03 13:46:00 | AHG2, AHG9, AHG13: on FGC SEI reference picture size | P. de Lagrange  E. François (InterDigital) |
| [JVET-AL0289](https://jvet-experts.org/doc_end_user/current_document.php?id=15616) | m72494 | 2025-03-25 15:24:58 | 2025-03-26 01:06:49 | 2025-03-26 01:06:49 | AHG4: potential updates for VVC multi-layer verification test plan | P. de Lagrange (InterDigital) |
| [JVET-AL0290](https://jvet-experts.org/doc_end_user/current_document.php?id=15617) | m72497 | 2025-03-25 15:49:04 | 2025-03-25 15:54:57 | 2025-03-28 17:25:07 | [AHG12] Combination of JVET-AL0174, JVET-AL0195 and JVET-AL0241 on Enhanced TIMD with NNIP and Optimized Block Vector Derivation | K. Naser  S. Puri  T. Dumas  M. Radosavljević  F. Le Léannec  E. François (InterDigital)  J. Fu  Y. Zhao  J. Zhang  S. Ma (PKU)  C. Huang (ZTE)  D. Ruiz Coll  J.-K. Lee (Ofinno)  Y.-H. Lin  C.-Y. Teng  K.-W. Liang  Y.-C. Yang (Sharp Corporation) |
| [JVET-AL0291](https://jvet-experts.org/doc_end_user/current_document.php?id=15618) | m72504 | 2025-03-25 20:46:14 | 2025-03-25 20:49:29 | 2025-03-25 20:49:29 | EE1-related: Recommendations for resolving mismatches between LOP5 description and implementation | N. Le  F. Cricri (Nokia) |
| [JVET-AL0292](https://jvet-experts.org/doc_end_user/current_document.php?id=15619) | m72505 | 2025-03-25 21:34:42 | 2025-03-25 21:40:04 | 2025-03-26 18:25:37 | AHG9: On Signalling NNPF Characteristics in NNPFA upon Updates of Purposes | C.-H. Demarty  E. François  F. Aumont  O. Le Meur (InterDigital) |
| [JVET-AL0293](https://jvet-experts.org/doc_end_user/current_document.php?id=15620) | m72508 | 2025-03-26 02:32:52 | 2025-03-27 04:58:42 | 2025-03-27 04:58:42 | Crosscheck of JVET-AL0151 (EE2-3.2: Extension on spatial and temporal merge candidates) | L. Zhang (OPPO) |
| [JVET-AL0294](https://jvet-experts.org/doc_end_user/current_document.php?id=15621) | m72509 | 2025-03-26 02:36:34 | 2025-03-27 05:00:49 | 2025-03-27 05:00:49 | Crosscheck of JVET-AL0157 (EE2-3.3e: Additional inter merge candidates) | L. Zhang (OPPO) |
| [JVET-AL0295](https://jvet-experts.org/doc_end_user/current_document.php?id=15622) | m72514 | 2025-03-26 05:00:22 | 2025-03-27 02:45:49 | 2025-03-27 12:22:45 | Crosscheck of JVET-AL0125 (EE2-2.6b/c: Improvement on MPM) | Y. Liu  Y. Huo (Transsion) |
| [JVET-AL0296](https://jvet-experts.org/doc_end_user/current_document.php?id=15623) | m72515 | 2025-03-26 05:50:36 | 2025-03-27 17:31:41 | 2025-03-27 17:31:41 | Crosscheck of JVET-AL0107 (EE2-2.11: a combination of EE2-2.4 and EE2-2.10) | Z. Deng (Bytedance) |
| [JVET-AL0297](https://jvet-experts.org/doc_end_user/current_document.php?id=15624) | m72516 | 2025-03-26 05:54:42 | 2025-03-26 05:56:08 | 2025-03-26 05:56:08 | Crosscheck of JVET-AL0104 (EE1-2.1: Lightweight Multiscale Reference Frame Generation for VVC Inter Coding) | L. Murn (Nokia) |
| [JVET-AL0298](https://jvet-experts.org/doc_end_user/current_document.php?id=15625) | m72517 | 2025-03-26 05:56:56 | 2025-03-26 05:57:36 | 2025-03-27 02:26:59 | Crosscheck of JVET-AL0105 (EE1-2.2: RA/LDB Unified Reference Frame Synthesis for VVC Inter Coding) | L. Murn (Nokia) |
| [JVET-AL0299](https://jvet-experts.org/doc_end_user/current_document.php?id=15626) | m72518 | 2025-03-26 06:00:34 | 2025-03-28 05:59:21 | 2025-03-28 05:59:21 | Crosscheck of JVET-AL0109 (EE2-related: On binarization of a coefficient level in TSRC) | K. Panusopone (Nokia) |
| [JVET-AL0300](https://jvet-experts.org/doc_end_user/current_document.php?id=15627) | m72520 | 2025-03-26 06:25:00 | 2025-03-27 10:50:57 | 2025-03-27 10:50:57 | Crosscheck of JVET-AL0110 (EE2-related: On ALF-CCCM) | P. Astola (Nokia) |
| [JVET-AL0301](https://jvet-experts.org/doc_end_user/current_document.php?id=15628) | m72521 | 2025-03-26 07:29:59 | 2025-03-26 07:34:00 | 2025-03-26 07:34:00 | AHG9: VSEI specification changes to reference the 3rd edition of video CICP | J. Xu  Y.-K. Wang (Bytedance) |
| [JVET-AL0302](https://jvet-experts.org/doc_end_user/current_document.php?id=15629) | m72522 | 2025-03-26 08:09:39 | 2025-03-26 08:11:12 | 2025-03-26 08:11:12 | Updates of the enhanced colour format information SEI message | D. Podborski  A.M. Tourapis (Apple) |
| [JVET-AL0303](https://jvet-experts.org/doc_end_user/current_document.php?id=15630) | m72527 | 2025-03-26 11:34:50 | 2025-03-26 14:59:16 | 2025-03-28 08:00:41 | AHG9: Editorial fixes to the packed regions information SEI message | F. Urban  E. François  D. Doyen  C.-H. Demarty (InterDigital) |
| [JVET-AL0304](https://jvet-experts.org/doc_end_user/current_document.php?id=15631) | m72532 | 2025-03-26 14:26:10 | 2025-03-27 18:44:49 | 2025-03-27 18:44:49 | Crosscheck of JVET-AL0245 ([AHG7][AHG17] Further consideration of common test condition) | J. Pardo |
| [JVET-AL0305](https://jvet-experts.org/doc_end_user/current_document.php?id=15632) | m72534 | 2025-03-26 17:22:51 | 2025-03-30 21:40:05 | 2025-03-30 21:40:05 | Crosscheck of JVET-AL0113 (on directionnal sign prediction) | P. Onno (Canon) |
| [JVET-AL0306](https://jvet-experts.org/doc_end_user/current_document.php?id=15633) | m72535 | 2025-03-26 17:48:08 | 2025-03-26 17:51:09 | 2025-04-02 17:16:40 | Cross-check of JVET-AL0087 AhG12: Predictive transform coefficient coding | F. Le Léannec (InterDigital) |
| [JVET-AL0307](https://jvet-experts.org/doc_end_user/current_document.php?id=15634) | m72537 | 2025-03-26 19:45:32 | 2025-03-27 05:47:13 | 2025-03-27 05:47:13 | Crosscheck of JVET-AL0106 (EE2-2.4: block vector guided EIP) | K. Panusopone (Nokia) |
| [JVET-AL0308](https://jvet-experts.org/doc_end_user/current_document.php?id=15635) | m72540 | 2025-03-26 22:44:33 | 2025-03-26 22:47:55 | 2025-03-26 22:47:55 | AHG9: On layer ID syntax elements in VSEI TuC | J. Xu  Y.-K. Wang (Bytedance) |
| [JVET-AL0309](https://jvet-experts.org/doc_end_user/current_document.php?id=15636) | m72543 | 2025-03-27 02:12:19 | 2025-03-27 02:21:42 | 2025-03-27 02:21:42 | Crosscheck of JVET-AL0206 (EE2-2.9: Test 2.1 + Test 2.4) | Z. Lyu (vivo) |
| [JVET-AL0310](https://jvet-experts.org/doc_end_user/current_document.php?id=15637) | m72544 | 2025-03-27 02:56:56 | 2025-03-27 02:59:51 | 2025-03-27 02:59:51 | AHG 9: On signalling of resampling type for EOI SEI message | C. Kim  H. Tan (LGE)  J. Xu  Y.-K. Wang (Bytedance) |
| [JVET-AL0311](https://jvet-experts.org/doc_end_user/current_document.php?id=15638) | m72556 | 2025-03-27 06:57:06 | 2025-03-27 07:20:17 | 2025-03-27 07:20:17 | Crosscheck of JVET-AL0106 (EE2-2.4: block vector guided EIP) | Z. Zhang (Alibaba) |
| [JVET-AL0312](https://jvet-experts.org/doc_end_user/current_document.php?id=15639) | m72557 | 2025-03-27 07:24:35 | 2025-04-02 14:07:09 | 2025-04-02 14:07:09 | Crosscheck of JVET-AL0184 (EE1-related: Deep Reference Frame Generation for Inter Prediction Enhancement) | Z. Xie (OPPO) |
| [JVET-AL0313](https://jvet-experts.org/doc_end_user/current_document.php?id=15640) | m72558 | 2025-03-27 07:26:07 | 2025-03-27 07:28:53 | 2025-03-27 07:28:53 | Crosscheck of JVET-AL0205 (EE2-2.1: EIP filters with diagonal shapes) | Z. Xie (OPPO) |
| [JVET-AL0314](https://jvet-experts.org/doc_end_user/current_document.php?id=15641) | m72559 | 2025-03-27 07:34:37 | 2025-03-27 07:38:18 | 2025-04-12 09:48:51 | Cross-check of JVET-AL0112 (Non-EE2: third transform set selection for intraNN) | T. Dumas (InterDigital) |
| [JVET-AL0315](https://jvet-experts.org/doc_end_user/current_document.php?id=15642) | m72563 | 2025-03-27 09:27:24 | 2025-03-27 09:56:50 | 2025-03-27 09:56:50 | Crosscheck of JVET-AL0108 (EE2-2.7: Block vector guided DIMD) | Z. Zhang (Alibaba) |
| [JVET-AL0316](https://jvet-experts.org/doc_end_user/current_document.php?id=15643) | m72564 | 2025-03-27 12:51:39 | 2025-03-27 15:26:11 | 2025-03-27 15:26:11 | Crosscheck of JVET-AL0134 (EE2-3.4: Joint reordering of GPM split modes and partition indices) | K. Jia (Alibaba) |
| [JVET-AL0317](https://jvet-experts.org/doc_end_user/current_document.php?id=15644) | m72570 | 2025-03-27 23:49:43 | 2025-03-29 00:14:14 | 2025-03-29 00:14:14 | On CLVS and SEI messages in HEVC | D. Podborski  A. Tourapis (Apple) |
| JVET-AL0318 |  |  |  |  | Withdrawn |  |
| [JVET-AL0319](https://jvet-experts.org/doc_end_user/current_document.php?id=15646) | m72575 | 2025-03-28 06:55:07 | 2025-04-03 14:51:10 | 2025-04-03 14:51:10 | Crosscheck of JVET-AL0168 (EE2-5.4: On the performance improvement of NN-based ILF in ALF - interface 2) | T. Poirier  F. Galpin (InterDigital) |
| [JVET-AL0320](https://jvet-experts.org/doc_end_user/current_document.php?id=15647) | m72576 | 2025-03-28 07:59:30 | 2025-03-28 08:03:56 | 2025-04-01 02:10:54 | CICP TuC progress on monochrome | Y. Guyon (Google) |
| [JVET-AL0321](https://jvet-experts.org/doc_end_user/current_document.php?id=15648) | m72579 | 2025-03-28 09:19:17 | 2025-03-28 19:31:20 | 2025-03-28 19:31:20 | XYB colour representation support in CICP | J. Alakuijala  S. Boukortt (Google) |
| [JVET-AL0322](https://jvet-experts.org/doc_end_user/current_document.php?id=15649) | m72584 | 2025-03-28 12:01:32 | 2025-03-28 13:49:17 | 2025-03-28 15:02:00 | AhG17: CfE draft: Sequences selection illustration | J. Pardo (Huawei) |
| [JVET-AL0323](https://jvet-experts.org/doc_end_user/current_document.php?id=15650) | m72590 | 2025-03-28 16:06:39 | 2025-03-28 18:06:02 | 2025-03-28 18:06:02 | Cross-check of JVET-AL0114 (AHG 10: On intra mode selection) | P. Bordes (InterDigital) |
| [JVET-AL0324](https://jvet-experts.org/doc_end_user/current_document.php?id=15651) | m72596 | 2025-03-29 09:19:33 | 2025-03-29 12:31:30 | 2025-03-31 14:47:48 | AHG9: A summary of proposals on the PRI SEI message | Y.-K. Wang (Bytedance) |
| [JVET-AL0325](https://jvet-experts.org/doc_end_user/current_document.php?id=15652) | m72617 | 2025-03-31 06:21:55 | 2025-04-04 19:56:28 | 2025-04-04 19:56:28 | Crosscheck of JVET-AL0231 (Non-EE2: On interpolation filter for TIMD) | C. Ma (Kwai) |
| [JVET-AL0326](https://jvet-experts.org/doc_end_user/current_document.php?id=15653) | m72622 | 2025-03-31 08:10:06 | 2025-03-31 08:14:35 | 2025-03-31 08:14:35 | AHG9/AHG18: Modification to error recovery SEI message | H. Tan (LGE)  M. M. Hannuksela  J. Boyce (Nokia) |
| [JVET-AL0327](https://jvet-experts.org/doc_end_user/current_document.php?id=15654) | m72633 | 2025-03-31 14:53:28 | 2025-03-31 18:14:18 | 2025-04-01 06:34:02 | AHG9: Handling of multiple DSC systems | Y.-K. Wang (Bytedance)  S. Deshpande (Sharp)  H. Tan (LGE)  K. Sühring (Fraunhofer HHI) |
| [JVET-AL0328](https://jvet-experts.org/doc_end_user/current_document.php?id=15655) | m72637 | 2025-03-31 18:19:01 | 2025-04-02 08:48:16 | 2025-04-02 08:48:16 | Cross-check of JVET-AL0112 (Non-EE2: Third transform set selection for intraNN) | M.Coban (Qualcomm) |
| [JVET-AL0329](https://jvet-experts.org/doc_end_user/current_document.php?id=15656) | m72648 | 2025-04-01 03:15:54 | 2025-04-01 03:26:40 | 2025-04-01 03:26:40 | Crosscheck of JVET-AL0183 (AHG12: Block Vector-based Intra Mode Derivation) | Y. Kidani (KDDI) |
| [JVET-AL0330](https://jvet-experts.org/doc_end_user/current_document.php?id=15657) | m72649 | 2025-04-01 03:16:30 | 2025-04-01 03:29:46 | 2025-04-01 03:29:46 | Crosscheck of JVET-AL0248 (AHG12: On Motion Vector Prediction) | Y. Kidani (KDDI) |
| [JVET-AL0331](https://jvet-experts.org/doc_end_user/current_document.php?id=15658) | m72653 | 2025-04-01 06:46:04 | 2025-04-01 15:21:09 | 2025-04-01 15:21:09 | Crosscheck of JVET-AL0275 (Non-EE2: Non-Linear Clipping for CCALF) | W. Yin (Bytedance) |
| [JVET-AL0332](https://jvet-experts.org/doc_end_user/current_document.php?id=15659) | m72662 | 2025-04-01 10:05:18 | 2025-04-01 10:12:36 | 2025-04-01 10:12:36 | Crosscheck of JVET-AL0055 (AhG10: On constrained encoder configuration of VTM) | R. Ishimoto  T. Ikai (Sharp) |
| [JVET-AL0333](https://jvet-experts.org/doc_end_user/current_document.php?id=15660) | m72664 | 2025-04-01 11:09:59 | 2025-04-01 11:42:51 | 2025-04-01 11:42:51 | Non-EE2: Interpolation filter switching based on filter types and template matching cost estimation | V. Rufitskiy  T. Dong  A. Filippov (TCL) |
| [JVET-AL0334](https://jvet-experts.org/doc_end_user/current_document.php?id=15661) | m72668 | 2025-04-01 12:14:29 | 2025-04-01 12:22:34 | 2025-04-01 12:22:34 | Non-EE2: On virtual intra prediction mode (VIPM) derivation for transform selection | K. Ding  A. Filippov  V. Rufitskiy  J. Zhang (TCL) |
| [JVET-AL0335](https://jvet-experts.org/doc_end_user/current_document.php?id=15662) | m72672 | 2025-04-01 15:16:37 | 2025-04-01 15:48:02 | 2025-04-04 17:25:44 | Non-EE2: VIPM Adjustment for Multiple Transform Set Selection | J. Zhang  A. Filippov  K. Ding  J. Konieczny (TCL) |
| [JVET-AL0336](https://jvet-experts.org/doc_end_user/current_document.php?id=15663) | m72677 | 2025-04-01 20:21:16 | 2025-04-03 15:14:52 | 2025-04-03 15:14:52 | Crosscheck of JVET-AL0168 (EE2-5.4: On the performance improvement of NN-based ILF in ALF) | V. Rufitskiy  Z. Xu (TCL) |
| [JVET-AL0337](https://jvet-experts.org/doc_end_user/current_document.php?id=15664) | m72680 | 2025-04-01 21:55:54 | 2025-04-01 23:55:17 | 2025-04-04 11:57:50 | BoG report on CfE test conditions for constrained encoder complexity category | F. Bossen  E. Alshina |
| [JVET-AL0338](https://jvet-experts.org/doc_end_user/current_document.php?id=15665) | m72688 | 2025-04-02 07:57:27 | 2025-04-02 08:18:20 | 2025-04-03 17:53:26 | AHG17: target bitrates for non-CTC sequences | M. Wien  E. François  E. Alshina  P. Nikitin  A. Wieckowski  K. Anderson  Y. Ye |
| [JVET-AL0339](https://jvet-experts.org/doc_end_user/current_document.php?id=15666) | m72694 | 2025-04-02 14:55:45 | 2025-04-02 15:00:59 | 2025-04-02 15:00:59 | AHG9: Merged text of JVET-AL0086 and JVET-AL0204 for the FGC SEI message | M. M. Hannuksela  J. Boyce (Nokia)  J. Samuelsson-Allendes  S. Deshpande (Sharp) |
| [JVET-AL0340](https://jvet-experts.org/doc_end_user/current_document.php?id=15667) | m72695 | 2025-04-02 15:01:50 | 2025-04-04 04:01:09 | 2025-04-04 04:01:09 | Crosscheck of JVET-AL0168 (EE2-5.4: On the performance improvement of NN-based ILF in ALF) | Z. Xie (OPPO) |
| [JVET-AL0341](https://jvet-experts.org/doc_end_user/current_document.php?id=15668) | m72696 | 2025-04-02 15:17:35 | 2025-04-02 15:23:16 | 2025-04-02 15:23:16 | AHG9: NNPFA SEI message extension for multi-purpose NNPFs | M. M. Hannuksela  F. Cricri (Nokia)  C.-H. Demarty  E. François  F. Aumont (InterDigital) |
| [JVET-AL0342](https://jvet-experts.org/doc_end_user/current_document.php?id=15669) | m72697 | 2025-04-02 15:38:46 | 2025-04-02 15:42:18 | 2025-04-02 15:42:18 | Cross-check of JVET-AL0344: Non-EE2: On virtual intra prediction mode (VIPM) derivation for transform selection | D. Mieloch  J. Stankowski  A. Dziembowski (PUT) |
| [JVET-AL0343](https://jvet-experts.org/doc_end_user/current_document.php?id=15670) | m72701 | 2025-04-02 20:28:33 | 2025-04-03 17:28:04 | 2025-04-03 17:28:05 | Cross-check of EE2-5.4: On the performance improvement of NN-based ILF in ALF (JVET-AL0168) | D. Rusanovskyy (Nokia) |
| [JVET-AL1000](https://jvet-experts.org/doc_end_user/current_document.php?id=15673) | m72792 | 2025-04-06 12:18:43 |  |  | Meeting Report of the 38th JVET Meeting | J.-R. Ohm |
| [JVET-AL1004](https://jvet-experts.org/doc_end_user/current_document.php?id=15674) | m72793 | 2025-04-06 12:19:33 |  |  | Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP | Y.-K. Wang  B. Bross  I. Moccagatta  C. Rosewarne  G. J. Sullivan |
| [JVET-AL1006](https://jvet-experts.org/doc_end_user/current_document.php?id=15675) | m72794 | 2025-04-06 12:21:15 | 2025-04-14 20:19:31 | 2025-04-14 20:19:31 | HEVC additional profiles and SEI messages (draft 3) | Y.-K. Wang  B. Bross  S. Deshpande  G. J. Sullivan  A. Tourapis |
| [JVET-AL1017](https://jvet-experts.org/doc_end_user/current_document.php?id=15676) | m72795 | 2025-04-06 12:22:26 | 2025-04-16 18:24:50 | 2025-04-16 18:24:50 | Support for additional SEI messages in AVC (draft 2) | B. Bross  J. Boyce  G. J. Sullivan  Y.-K. Wang |
| [JVET-AL1018](https://jvet-experts.org/doc_end_user/current_document.php?id=15677) | m72796 | 2025-04-06 12:23:03 |  |  | HEVC with extensions and corrections (draft 1) | G. J. Sullivan  Y.-K. Wang |
| [JVET-AL2005](https://jvet-experts.org/doc_end_user/current_document.php?id=15678) | m72797 | 2025-04-06 12:23:50 | 2025-04-26 02:47:01 | 2025-04-26 02:47:01 | Additions and corrections for VVC version 4 (Draft 12) | G. J. Sullivan  B. Bross  M. M. Hannuksela  Y.-K. Wang |
| [JVET-AL2006](https://jvet-experts.org/doc_end_user/current_document.php?id=15679) | m72798 | 2025-04-06 12:24:23 | 2025-04-11 18:05:12 | 2025-04-23 23:56:15 | 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 |
| [JVET-AL2010](https://jvet-experts.org/doc_end_user/current_document.php?id=15680) | m72799 | 2025-04-06 12:25:52 |  |  | 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 |
| [JVET-AL2019](https://jvet-experts.org/doc_end_user/current_document.php?id=15681) | m72800 | 2025-04-06 12:26:42 |  |  | Description of algorithms version 11 and software version 13 in neural network-based video coding (NNVC) | F. Galpin  Yue Li  Yun Li  D. Rusanovskyy  T. Shao  J. Ström  L. Wang |
| [JVET-AL2020](https://jvet-experts.org/doc_end_user/current_document.php?id=15682) | m72801 | 2025-04-06 12:28:42 |  |  | Film grain synthesis technology for video applications ed. 2 (Draft 3) | W. Husak  P. de Lagrange  A. Norkin  A. Tourapis |
| [JVET-AL2023](https://jvet-experts.org/doc_end_user/current_document.php?id=15671) | m72784 | 2025-04-04 12:00:20 | 2025-04-04 12:01:31 | 2025-04-21 17:01:31 | EE1: 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 |
| [JVET-AL2024](https://jvet-experts.org/doc_end_user/current_document.php?id=15672) | m72788 | 2025-04-04 14:46:29 | 2025-04-04 14:51:48 | 2025-04-04 14:51:48 | 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 |
| [JVET-AL2025](https://jvet-experts.org/doc_end_user/current_document.php?id=15683) | m72802 | 2025-04-06 12:29:51 |  |  | Algorithm description of Enhanced Compression Model 17 (ECM 17) | M. Coban  R.-L. Liao  K. Naser  J. Ström  L. Zhang |
| [JVET-AL2026](https://jvet-experts.org/doc_end_user/current_document.php?id=15684) | m72803 | 2025-04-06 12:30:26 | 2025-04-15 21:34:20 | 2025-04-23 19:01:45 | Draft Joint Call for Evidence on video compression with capability beyond VVC | J.-R. Ohm  M. Wien |
| [JVET-AL2028](https://jvet-experts.org/doc_end_user/current_document.php?id=15685) | m72804 | 2025-04-06 12:32:23 |  |  | Additions and corrections for VVC conformance (draft 1) | S. Iwamura  P. de Lagrange  I. Moccagatta |
| [JVET-AL2030](https://jvet-experts.org/doc_end_user/current_document.php?id=15686) | m72805 | 2025-04-06 12:32:59 |  |  | Optimization of encoders and receiving systems for machine analysis of coded video content (Draft 9) | S. Liu  J. Chen  J. Ström |
| [JVET-AL2032](https://jvet-experts.org/doc_end_user/current_document.php?id=15687) | m72806 | 2025-04-06 12:33:49 |  |  | Technologies under consideration for future extensions of VSEI (version 8) | S. McCarthy  J. Boyce  J. Chen  S. Deshpande  M. M. Hannuksela  H. Tan  Y.-K. Wang |

# Annex B to JVET report: List of meeting participants

The remote participants of the thirty-eighth meeting of the JVET, according to the participation records from the Zoom teleconferencing tool used for the meeting sessions (approximately 473 people in total, not including those who attended only the joint sessions with other groups), were as follows:

1. Mohsen Abdoli (Xiaomi – FR)
2. Kiyofumi Abe (Panasonic -JP)
3. Mouad Aderdor (BBC – UK)
4. Waqas Ahmad (Ericsson – SE)
5. Yongjo Ahn (LGE – KR)
6. Jukka Ahonen (Nokia – FI)
7. Elena Alshina (Huawei – DE)
8. Zoubida Ameur (InterDigital – FR)
9. Alireza Aminlou (Nokia – FI)
10. Kenneth Andersson (Ericsson – SE)
11. Pierre Andrivon (Ofinno – US)
12. Lujun Ao (Xidian – CN)
13. Pekka Astola (Nokia – FI)
14. Tae Meon Bae (Sharp – US)
15. Suyong Bahk (KHU – KR)
16. Yaxian Bai (ZTE – CN)
17. Vittorio Baroncini (VABTECH – UK)
18. Nisha Bhaskar (Huawei – DE)
19. Thibaud Biatek (Nokia – FR)
20. Saverio Blasi (Nokia – UK)
21. Médéric Blestel (Ofinno – US)
22. Atanas Boev (Huawei – DE)
23. Guillaume Boisson (InterDigital – FR)
24. Charles Bonnineau (InterDigital – CA)
25. Philippe Bordes (InterDigital – FR)
26. Tomás Borges (HHI – DE)
27. Frank Bossen (CA)
28. Sami Boukortt (Google – CH)
29. Atanas Bow (Huawei – DE)
30. Jill Boyce (Nokia – US)
31. Fabian Brand (Huawei – DE)
32. Benjamin Bross (HHI – DE)
33. Angelo Bruccoleri (RAI – IT)
34. Döne Bugdayci Sansli (Nokia – FI)
35. A. Burakhan Koyuncu (Nokia – DE)
36. Joohyung Byeon (Kwangwoon Univ. – KR)
37. Mary-Luc Champel (Xiaomi – CN)
38. Renjie Chang (Tencent – CN)
39. Yao-Jen Chang (Qualcomm – US)
40. Bolin Chen (Alibaba – CN)
41. Ching-Yeh Chen (MediaTek – US)
42. Chun-Chi Chen (Qualcomm – US)
43. Guan-hao Chen (MediaTek – US)
44. Hong-Hui Chen (MediaTek – US)
45. Jie Chen (Alibaba – CN)
46. Lien-Fei Chen (Tencent – US)
47. Lulin Chen (MediaTek – US)
48. Wei Chen (Kwai – US)
49. Xinyao Chen (Huawei – CN)
50. Ya Chen (InterDigital – FR)
51. Yi-Wen Chen (MediaTek – US)
52. Roman Chernyak (Tencent – US)
53. Jingwei Chi (UESTC – CN)
54. Man-Shu Chiang (MediaTek – US)
55. Chih-Yao Chiu (MediaTek – US)
56. Shih-Chun Chiu (MediaTek – US)
57. Hyun Dong Cho (KHU – KR)
58. Giyong Choi (Samsung – KR)
59. Jangwon Choi (Hyundai – KR)
60. Jung-Ah Choi (Hyundai – KR)
61. Kiho Choi (KHU – KR)
62. Keiichi Chono (NEC – JP)
63. Cheng-Yen Chuang (MediaTek – US)
64. Peter Chuang (MediaTek – US)
65. Tzu-Der Chuang (MediaTek – US)
66. Olena Chubach (MediaTek – US)
67. Takeshi Chujoh (Sharp – JP)
68. Gordon Clare (Orange – FR)
69. Tim Claßen (RWTH – DE)
70. Muhammed Coban (Qualcomm – US)
71. Francesco Cricri (Nokia – FI)
72. Kai Cui (Qualcomm – US)
73. Zhenyu Dai (Alibaba – CN)
74. Mitra Damghanian (Ericsson – SE)
75. Claire-Helene Demarty (InterDigital – FR)
76. Zhipin Deng (Bytedance- CN)
77. Franck Denoual (Canon – FR)
78. Sachin Deshpande (Sharp – US)
79. Ding Ding (WHU – CN)
80. Keqin Ding (TCL – CN)
81. Quockhanh Dinh (Samsung – KR)
82. Tianyu Dong (TCL – CN)
83. Didier Doyen (InterDigital – FR)
84. Virginie Drugeon (Panasonic – DE)
85. Alberto Duenas (Warner Bros. Discovery – US)
86. Thierry Dumas (InterDigital – FR)
87. Adrian Dziembowski (PUT – PL)
88. Yulu Fei (Xidian Univ. – CN)
89. Christian Feldmann (Nokia – DE)
90. Christof Fersch (Dolby – DE)
91. Alexey Filippov (TCL – CN)
92. Edouard François (InterDigital – FR)
93. Jiaye Fu (PKU – CN)
94. Nianxiang Fu (WHU – CN)
95. Onur G. Guleryuz (Google – US)
96. Benjamin Galmiche (Canon – JP)
97. Franck Galpin (InterDigital – FR)
98. Jonathan Gan (OPPO – AU)
99. Jingying Gao (Panasonic – SG)
100. Ying Gao (ZTE – CN)
101. Patrick Garus (Qualcomm – US)
102. Simon Gauntlett (Dolby – UK)
103. Tomasz Grajek (PUT – PL)
104. Ivan Gribushin (Huawei – RU)
105. Dan Grois (AnyAI – IL)
106. Onur Guleryuz (Google – US)
107. Tiansheng Guo (Huawei – CN)
108. Yannis Guyon (Google – US)
109. Paul Haase (HHI – DE)
110. Miska Hannuksela (Nokia – FI)
111. So Hasegawa (Canon – JP)
112. Jinwang He (Xidian Univ. – CN)
113. Wenxuan He (HUST – CN)
114. Yong He (Qualcomm – US)
115. Philipp Helle (HHI – DE)
116. Cornelius Hellge (HHI – DE)
117. Félix Henry (Orange – FR)
118. Jin Heo (Hyundai – KR)
119. Viktor Herrmann (HHI – DE)
120. Arianne Hinds (Tencent – US)
121. Christopher Hollmann (TCL – CN)
122. Myungoh Hong (LGE – KR)
123. Seungwook Hong (Nokia – US)
124. Sujun Hong (Sharp – JP)
125. Shih-Ta Hsiang (MediaTek – US)
126. Yuling Hsiao (MediaTek – US)
127. Ted Hsieh (Qualcomm – US)
128. Chih-Wei Hsu (MediaTek – US)
129. Nan Hu (Qualcomm – US)
130. Han Huang (Qualcomm – US)
131. Hang Huang (OPPO – CN)
132. Yu-Wen Huang (MediaTek – US)
133. Junyan Huo (Xidian Univ. – CN)
134. Yongkai Huo (Transsion – CN)
135. Walt Husak (Dolby – US)
136. Atsuro Ichigaya (NHK – JP)
137. Tomohiro Ikai (Sharp – JP)
138. Masaru Ikeda (Sony – JP)
139. Sergey Ikonin (Huawei – RU)
140. Hitomi Imamura (Canon – JP)
141. Takaaki Ishikawa (Canon – JP)
142. Ryo Ishimoto (Sharp – JP)
143. Hsin-Yi Ivy (MediaTek – US)
144. Shunsuke Iwamura (NHK – JP)
145. Byeungwoo Jeon (SKKU – KR)
146. Hyunki Jeong (SKKU – KR)
147. Hong-Jheng Jhu (Kwai – US)
148. Ke Jia (Alibaba – CN)
149. Menghu Jia (ZTE – CN)
150. Xiaoran Jiang (INSA – FR)
151. You-Cheng Jiang (MediaTek – US)
152. Dae-Yeon Ju (KWU – KR)
153. Ikram Jumakulyyev (Nokia – DE)
154. Cheolkon Jung (Xidian Univ. – CN)
155. Maike Kaiser (HSRM – DE)
156. Jewon Kang (Ewha – KR)
157. Jungwon Kang (ETRI – KR)
158. Kai Kang (OPPO – CN)
159. Wenbo Kang (Xidian Univ. – CN)
160. Alexander Karabutov (Huawei – DE)
161. Marta Karczewicz (Qualcomm – US)
162. Kei Kawamura (KDDI – JP)
163. Yoichi Kazama (Canon – JP)
164. Steve Keating (Sony – UK)
165. Joachim Keinert (Fraunhofer IIS – DE)
166. Louie Kerofsky (Qualcomm – US)
167. Yoshitaka Kidani (KDDI – JP)
168. Chulkeun Kim (LGE – KR)
169. Dongha Kim (KAU – KR)
170. Donghyun Kim (ETRI – KR)
171. Jae-Gon Kim (KAU – KR)
172. Jiyoung Kim (HNU – KR)
173. Jongho Kim (ETRI – KR)
174. Kyungah Kim (Samsung – KR)
175. Kyungyong Kim (Wilus – KR)
176. Minsub Kim (KWU – KR)
177. Mintae Kim (KWU – KR)
178. Seonki Kim (LGE – KR)
179. Seung-Hwan Kim (LGE – US)
180. Yangwoo Kim (Samsung – KR)
181. Yongheon Kim (HNU -K R)
182. Youngwook Kim (KWU – KR)
183. Heiner Kirchhoffer (HHI – DE)
184. Jacek Konieczny (TCL Research – PL)
185. Konstantinos Konstantinides (Dolby Labs – US)
186. Moonmo Koo (LGE – KR)
187. Maja Krivokuća (InterDigital – FR)
188. Bart Kroon (Philips – NL)
189. Bowen Ku (MediaTek – US)
190. Gosala Kulupana (Nokia – UK)
191. Che-Wei Kuo (Kwai – US)
192. Toshihiko Kusakabe (Panasonic – JP)
193. Hyukmin Kwon (HYU – KR)
194. Philippe de Lagrange (InterDigital – FR)
195. Chen-Yen Lai (MediaTek – US)
196. Jani Lainema (Nokia – FI)
197. Guillaume Laroche (Canon – FR)
198. Nam Le (Nokia – FI)
199. Pascal Le Guyadec (InterDigital – FR)
200. Fabrice Le Léannec (InterDigital – FR)
201. Olivier Le Meur (InterDigital – FR)
202. Julien Le Tanou (MediaKind – FR)
203. Brian Lee (Dolby Laboratories – US)
204. Jangwon Lee (LGE – KR)
205. Jinho Lee (ETRI – KR)
206. Jong-Min Lee (KAU – KR)
207. Jung-Kyung Lee (Ofinno – US)
208. Minhun Lee (KWU – KR)
209. Soeun Lee (HNU – KR)
210. Sunyoung Lee (Atins – KR)
211. Yung-Lyul Lee (SJU – KR)
212. Frederic Lefebvre (InterDigital – FR)
213. Christian Lehmann (HHI – DE)
214. Julien Lemotheux (Orange – FR)
215. Ao Li (UESTC – CN)
216. Bin Li (Hisense – CN)
217. Binzhe Li (Alibaba – CN)
218. Chen Li (Alibaba – CN)
219. Junru Li (Bytedance – US)
220. Ling Li (Samsung – KR)
221. Ming Li (OPPO – CN)
222. Pengyu Li (Xidian Univ. – CN)
223. Qi Li (OPPO – CN)
224. Xiang Li (Google – US)
225. Xinwei Li (Alibaba – CN)
226. Yue Li (SJTU – CN)
227. Yun Li (Qualcomm – US)
228. Kai-Wen Liang (Sharp – JP)
229. Ru-Ling Liao (Alibaba – US)
230. Jaehyun Lim (LGE – KR)
231. Sung-Chang Lim (ETRI – KR)
232. Sungwon Lim (KT – KR)
233. Wang-Q Lim (HHI – DE)
234. Woong Lim (ETRI – KR)
235. Chaoyi Lin (Bytedance – CN)
236. Ching-Chieh Lin (ITRI – US)
237. Chun-Lung Lin (ITRI – US)
238. Jian-Liang Lin (Qualcomm – US)
239. Jibing-Chieh Lin (ITRI – US)
240. Kai Lin (Huawei – CN)
241. Po-Han Lin (Qualcomm – US)
242. Yi-Hao Lin (Sharp – JP)
243. Yu-Cheng Lin (MediaTek – US)
244. Lukasz Litwic (Ericsson – SE)
245. Du Liu (Ericsson – SE)
246. Lu Liu ( Xidian Univ. – CN)
247. Peter Liu (AMD – CA)
248. Qiong Liu (HUST – CN)
249. Shan Liu (Tencent – US)
250. Xu Liu (Xidian Univ. – CN)
251. Yutian Liu (Transsion – CN)
252. Chih-Hsuan Lo (MediaTek – US)
253. Fedor Loginov (Huawei – RU)
254. Mateusz Lorkiewicz (PUT – PL)
255. Ajay Luthra (Picsel Labs – US)
256. Zhuoyi Lyu (vivo – CN)
257. Changyue Ma (Kwai – US)
258. Yanzhuo Ma (Xidian Univ. – CN)
259. Gwenaelle Marquant (InterDigital – FR)
260. Ismail Marzuki (InterDigital – CA)
261. Ville-Veikko Mattila (Nokia – FI)
262. Sean McCarthy (Dolby – US)
263. Xuewei Meng (Disney – CN)
264. Philipp Merkle (HHI – DE)
265. Dawid Mieloch (PUT – PL)
266. Akira Minezawa (Mitsubishi Electric – JP)
267. Koohyar Minoo (IR)
268. Mikhail Mishurovskiy (Huawei – RU)
269. Iole Moccagatta (Intel – US)
270. Antoine Monier (InterDigital – FR)
271. Gihwa Moon (KAU – KR)
272. Alessandra Mosca (Sisvel Technology – IT)
273. Luka Murn (Nokia – UK)
274. Junghak Nam (LGE – KR)
275. Raj Narayana Gadde (Samsung – IN)
276. Matthias Narroschke (HSRM – DE)
277. Karam Naser (InterDigital – FR)
278. Shimpei Nemoto (NHK – JP)
279. Nicolas Neumann (Nokia – DE)
280. Canh Nguyen (Dolby – US)
281. Rose Nguyen (Canon – AU)
282. Tung Nguyen (HHI – DE)
283. Giuseppe Nicastro (Sisvel Technology – IT)
284. Didier Nicholson (EKTACOM – FR)
285. Pavel Nikitin (Qualcomm – US)
286. Weihong Niu (ZTE – CN)
287. Seungmin Noh (HNU – KR)
288. Jens-Rainer Ohm (RWTH – DE)
289. Patrice Onno (Canon – FR)
290. Krit Panusopone (Nokia – US)
291. Johan Pardo (Huawei – DE)
292. Jaeseung Park (SJU – KR)
293. Jeeyoon Park (Samsung – KR)
294. Minsoo Park (Samsung – KR)
295. Min Woo Park (Samsung – KR)
296. Naeri Park (LGE – KR)
297. Seungwook Park (Hyundai – KR)
298. Maciej Pedzisz (Nokia – UK)
299. Martin Pettersson (Ericsson – SE)
300. Jonathan Pfaff (HHI – DE)
301. Pierrick Philippe (Orange – FR)
302. Yinji Piao (Samsung – KR)
303. Frank Plowman (Xiaomi – UK)
304. Dimitri Podborski (Apple – US)
305. Tangi Poirier (InterDigital – FR)
306. Emmanouil Potetsianakis (Xiaomi – NL)
307. Srivatsa Prativadibhayankaram (Fraunhofer IIS – DE)
308. Saurabh Puri (InterDigital – CA)
309. Kwang Pyo Choi (Samsung – KR)
310. Hongdong Qin (TCL – CN)
311. Qipu Qin (Xidian Univ. – CN)
312. Hamed R. Tavakoli (Nokia – FI)
313. Mohamad Raad (LIU – LB)
314. Miloš Radosavljević (InterDigital – FR)
315. Jeeva Raj Arumugam (Ittiam – IN)
316. Adarsh Ramasubramonian (Qualcomm – US)
317. Gagan Rath (InterDigital – FR)
318. Bappaditya Ray (Qualcomm – US)
319. Jing Ren (OPPO – CN)
320. Kevin Reuzé (InterDigital – FR)
321. Justin Ridge (Nokia – US)
322. Marc Rivière (Ateme – FR)
323. Antoine Robert (InterDigital – FR)
324. Hyungmin Roh (Samsung – KR)
325. Chris Rosewarne (Canon – AU)
326. Vasily Rufitskiy (TCL – CN)
327. Damian Ruiz Coll (Ofinno – US)
328. Dmytro Rusanovskyy (Nokia – US)
329. Changwoo Ryu (KAON – KR)
330. Takahiro Saito (Canon – JP)
331. Yuto Sakai (Canon – JP)
332. Mehdi Salehifar (Bytedance – US)
333. Jonatan Samuelsson-Allendes (Sharp – US)
334. Maria Santamaria (Nokia – FI)
335. Johannes Sauer (Huawei – DE)
336. Thomas Schierl (HHI – DE)
337. Heiko Schwarz (HHI – DE)
338. Sebastian Schwarz (Nokia – DE)
339. Vadim Seregin (Qualcomm – US)
340. Tong Shao (Dolby – US)
341. Yiting Shao (Qualcomm – US)
342. Vladislav Shchukin (Ericsson – SE)
343. Weijing Shi (Samsung – CN)
344. Masato Shima (Canon – JP)
345. Jay Shingala (Ittiam – IN)
346. Ahmed Sidiya (Sharp – US)
347. Rickard Sjöberg (Ericsson – SE)
348. Robert Skupin (HHI – DE)
349. Iraj Sodagar (Dolby – US)
350. Timofey Solovyev (Huawei – DE)
351. Iman Soltani Mohammadi (Univ. of Tehran – IR)
352. John Juhyung Son (WILUS – KR)
353. Nan Song (OPPO – CN)
354. Jakub Stankowski (PUT – PL)
355. Alan Stein (V-Nova – US)
356. Jacob Ström (Ericsson – SE)
357. Karsten Sühring (HHI – DE)
358. Kakeru Sugimoto (Sharp – JP)
359. Toshiyasu Sugio (Panasonic – JP)
360. Jong-Yeul Suh (LGE – KR)
361. Gary Sullivan (SC 29 Chair & VCEG Rapp.)
362. Zexing Sun (OPPO – CN)
363. Kim Sung Min (LGU – KR)
364. Teruhiko Suzuki (Sony – JP)
365. Maxim Sychev (Huawei – RU)
366. Yasser Syed (Comcast – US)
367. Keiichirō Takada (Sharp – JP)
368. Hendry Tan (LG – US)
369. Minhao Tang (Tencent – CN)
370. Chih-Yu Teng (Sharp – JP)
371. Gilles Teniou (Tencent – US)
372. Han Boon Teo (Panasonic – SG)
373. Sylvain Thiebaud (InterDigital – FR)
374. Herbert Thoma (Fraunhofer IIS – DE)
375. Emmanuel Thomas (Xiaomi – NL)
376. Alexandre Tissier (Xiaomi – FR)
377. Yasuaki Tokumo (Sharp – JP)
378. Alexandros Tourapis (Apple – US)
379. Anthony Trioux (Xidian Univ. – CN)
380. Chia-Ming Tsai (MediaTek – US)
381. Fabrice Urban (InterDigital – FR)
382. Renan Utida (InterDigital – CA)
383. Gleb Verba (Qualcomm – US)
384. Biao Wang (Tencent – US)
385. Chen Wang (OPPO – CN)
386. Dong Wang (OPPO – CN)
387. Fan Wang (OPPO – CN)
388. Feng Wang (OPPO – CN)
389. Guiqi Wang (vivo – CN)
390. Haiqiang Wang (Tencent – CN)
391. Hongtao Wang (Qualcomm – US)
392. Jianfeng Wang (Qualcomm – US)
393. Limin Wang (Nokia – US)
394. Liqiang Wang (Tencent – CN)
395. Sheng-Po Wang (ITRI – US)
396. Shurun Wang (Alibaba – CN)
397. Xianglin Wang (Kwai – US)
398. Xinru Wang (UESTC – CN)
399. Yang Wang (Bytedance – CN)
400. Ye-Kui Wang (Bytedance – US)
401. Zhikui Wang (Hisense – CN)
402. Honglian Wei (OPPO – CN)
403. Kai Wen Liang (Sharp – JP)
404. Stephan Wenger (Tencent – US)
405. Adam Wieckowski (HHI – DE)
406. Thomas Wiegand (HHI – DE)
407. Mathias Wien (RWTH – DE)
408. Martin Winken (HHI – DE)
409. Ping Wu (ZTE – UK)
410. Gu Xiaoyun (Huawei – CN)
411. Shaowei Xie (ZTE – CN)
412. Xiatian Xie (HUST – CN)
413. Zhihuang Xie (OPPO – CN)
414. Alisa Xing (Hisense – CN)
415. Xiaoyu Xiu (Kwai – US)
416. Jizheng Xu (Bytedance – US)
417. Luhang Xu (OPPO – CN)
418. Xiaozhong Xu (Tencent – CN)
419. Ning Yan (Kwai – US)
420. Kai-Fa Yang (SJTU – CN)
421. Ruiying Yang (Nokia – FI)
422. Tian Yang (HUST – CN)
423. Yayun Yao (Xidian Univ. – CN)
424. Emma Ye (Qualcomm – US)
425. Feng Ye (PKU – CN)
426. Jiedong Ye (HUST – CN)
427. Yan Ye (Alibaba – US)
428. Sehoon Yea (Intel – US)
429. Shen Yi Lim (Panasonic – SG)
430. Peng Yin (Dolby – US)
431. Shanzhi Yin (CityU – HK)
432. Wenbin Yin (Bytedance – CN)
433. Hui Yong Kim (KHU – KR)
434. Jeeye Yoon (LGE – KR)
435. Hongjie You (Huawei – DE)
436. Jin Young Lee (SJU – KR)
437. Ramin Youvalari (Xiaomi – FI)
438. Haoping Yu (OPPO – CN)
439. Hualong Yu (ZJU – CN)
440. Lu Yu (ZJU – CN)
441. Ruoyang Yu (Qualcomm – US)
442. Yue Yu (OPPO – US)
443. Hui Yuan (OPPO – CN)
444. Jing Yuan Thong (Panasonic – SG)
445. Vladyslav Zakharchenko (Nokia – US)
446. Honglei Zhang (Nokia – FI)
447. Hongli Zhang (OPPO – CN)
448. Jia Zhang (TCL – CN)
449. Kai Zhang (Bytedance – US)
450. Lai Zhang (OPPO – CN)
451. Li Zhang (Bytedance – US)
452. Na Zhang (Bytedance – CN)
453. Wei Zhang (Xidian Univ. – CN)
454. Wenhao Zhang (Disney – CN)
455. Yan Zhang (Qualcomm – US)
456. Yuhuai Zhang (OPPO – CN)
457. Zhi Zhang (Qualcomm – US)
458. Zihan Zhang (CityU – HK)
459. Zixiang Zhang (Alibaba – CN)
460. Jane Zhao (LGE – US)
461. Lei Zhao (Bytedance – CN)
462. Lili Zhao (China Mobile – CN)
463. Shuai Zhao (Qualcomm – US)
464. Yin Zhao (Huawei – CN)
465. Fan Zheming (Sharp – JP)
466. Yuxing Zheng (Samsung – CN)
467. Chuan Zhou (vivo – CN)
468. Minhua Zhou (Broadcom – US)
469. Weijia Zhu (Qualcomm – US)
470. Dan Zou (OPPO – CN)
471. Nannan Zou (FI – Nokia)
472. Naima Zouidi (Ofinno – US)
473. Ivan Zupancic (Nokia – DE)

# Annex C to JVET report: Recommendations of the 19th meeting of ISO/IEC JTC 1/SC 29/WG 5 MPEG Joint Video Experts Team with ITU-T SG21

**ISO/IEC JTC 1/SC 29/WG 5 N 343**

**1. Reports**

**1.1 Meeting Reports**

**1.1.1 WG 5 approves**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **Title** | **In Charge** | **TBP** | **Available** | **S/N** |
|  |  |  |  |  |  |
| **334** | **Report of the 18th JTC 1/SC 29/WG 5 meeting** | **Jens-Rainer Ohm** | **N** | **2024-12-06** | **24708** |

**2. MPEG-4 (ISO/IEC 14496 - Coding of audio-visual objects)**

**2.1 Part 10 - Advanced video coding**

**2.1.1 WG 5 approves the following document**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **Title** | **In Charge** | **TBP** | **Available** | **S/N** |
|  | **ISO/IEC 14496-10 - Advanced video coding** |  |  |  |  |
| **345** | **Text of ISO/IEC 14496-10:202x (11th ed.) CDAM 1 Additional SEI messages** | **Benjamin Bross** | **N** | **2025-04-18** | **25096** |

**3. MPEG-C (ISO/IEC 23002 - MPEG video technologies)**

**3.1 Part 7 - Versatile supplemental enhancement information messages for coded video bitstreams**

**3.1.1 WG 5 approves the following documents**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **Title** | **In Charge** | **TBP** | **Available** | **S/N** |
|  | **ISO/IEC 23002-7 - Versatile supplemental enhancement information messages for coded video bitstreams** |  |  |  |  |
| **346** | **Disposition of comments received on ISO/IEC 23002-7:2024/CDAM1** | **Jill Boyce** | **N** | **2025-04-04** | **25097** |
| **347** | **Text of ISO/IEC 23002-7:2024/DAM1 Additional SEI messages** | **Jill Boyce** | **N** | **2025-04-18** | **25098** |

**4. MPEG-H (ISO/IEC 23008 - High efficiency coding and media delivery in heterogeneous environments)**

**4.1 Part 2 - High efficiency video coding**

**4.1.1 WG 5 approves the following documents**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **Title** | **In Charge** | **TBP** | **Available** | **S/N** |
|  | **ISO/IEC 23008-2 - High efficiency video coding** |  |  |  |  |
| **348** | **Disposition of comments received on ISO/IEC 23008-2:2025/CDAM 1** | **Ye-Kui Wang** | **N** | **2025-04-04** | **25099** |
| **349** | **Text of ISO/IEC 23008-2:2025/DAM 1 Additional profiles and SEI messages** | **Ye-Kui Wang** | **N** | **2025-04-18** | **25100** |

**5. MPEG-I (ISO/IEC 23090 - Coded representation of immersive media)**

**5.1 Part 3 - Versatile video coding**

**5.1.1 WG 5 approves the following documents**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **Title** | **In Charge** | **TBP** | **Available** | **S/N** |
|  | **ISO/IEC 23090-3 - Versatile video coding** |  |  |  |  |
| **350** | **Disposition of comments received on ISO/IEC 23090-3:2024/CDAM1** | **Gary Sullivan** | **N** | **2025-04-04** | **25101** |
| **351** | **Text of ISO/IEC 23090-3:2024/DAM1 Additions and corrections** | **Gary Sullivan** | **N** | **2025-04-18** | **25102** |

**5.2 Part 15 – Conformance testing for versatile video coding**

**5.2.1 WG 5 approves the following document**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | | **Title** | | **In Charge** | **TBP** | **Available** | **S/N** |
|  | | **ISO/IEC 23090-15 - Conformance testing for versatile video coding** | |  |  |  |  |
| **352** | | **Text of CD ISO/IEC 23090-15:202x (3rd ed.) Conformance testing for versatile video** | | **Iole Moccagatta** | **N** | **2025-05-02** | **25103** |
| **6.1.1** |  | | **WG 5 requests not to use the OSD tool for preparation of the text of ISO/IEC 23090-15 Conformance testing for versatile video coding (3rd ed.), as this is a collaborative project with ITU-T SG 21 that requires coordination between the organizations to ensure alignment of the content.** | | | | |

**6. MPEG-AI (ISO/IEC 23888 - MPEG artificial intelligence)**

**6.1 Part 3 - Optimization of encoders and receiving systems for machine analysis of coded video content**

**6.1.1 WG 5 approves the following documents**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **Title** | **In Charge** | **TBP** | **Available** | **S/N** |
|  | **ISO/IEC 23888-3 - Optimization of encoders and receiving systems for machine analysis of coded video content** |  |  |  |  |
| **353** | **Disposition of comments received on ISO/IEC CDTR 23888-3** | **Shan Liu** | **N** | **2025-04-04** | **25104** |
| **354** | **Text of ISO/IEC DTR 23888-3 Optimization of encoders and receiving systems for machine analysis of coded video content** | **Shan Liu** | **N** | **2025-05-02** | **25105** |

**7. Explorations**

**7.1 Enhanced compression beyond VVC capability**

**7.1.1 WG 5 approves the following document**

|  |  |  |  |  |  |
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| **No.** | **Title** | **In Charge** | **TBP** | **Available** | **S/N** |
|  | **ISO/IEC 23888-3 - Optimization of encoders and receiving systems for machine analysis of coded video content** |  |  |  |  |
| **355** | **Draft Joint Call for Evidence on video compression with capability beyond VVC** | **Jens-Rainer Ohm** | **Y** | **2025-04-15** | **25106** |

|  |  |  |
| --- | --- | --- |
| **7.1.2** |  | **WG 5 thanks Huawei, NERC-DTV, TCL, vivo, and Xiaomi for offering test material that could be used in the development of video coding standards.** |

**8. Management**

**8.1 Collaboration with ITU-T**

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| --- | --- | --- |
| **8.1.1** |  | **The JVET chair proposes to hold the 39th JVET meeting during 26 June – 4 July 2025 (with contribution deadline of 19 June 2025) under ISO/IEC JTC 1/SC 29 auspices in Daejeon, KR; subsequent meetings are planned to be held during 3 – 12 October 2025 under ITU-T SG21 auspices in Geneva, CH; during 14 – 23 January 2026 under ISO/IEC JTC 1/SC 29 auspices, to be conducted as teleconference meeting; during 24 April – 1 May 2026 under ISO/IEC JTC 1/SC 29 auspices in Santa Eulària, ES; during 7 – 15 July 2026 under ITU-T SG21 auspices in Geneva, CH; during 14 – 23 October 2026 under ISO/IEC JTC 1/SC 29 auspices in Hangzhou, CN; during January 2027 under ISO/IEC JTC 1/SC 29 auspices, date and location t.b.d.; and during April 2027 under ITU-T SG21 auspices, date and location t.b.d.** |

**8.2 Liaisons**

**8.2.1 WG 5 approves the following document**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **Title** | **In Charge** | **TBP** | **Available** | **S/N** |
|  | **Ad hoc groups** |  |  |  |  |
| **356** | **Liaison statement to ISO/IEC JTC 1/SC 29/WG 1 (JPEG) on JPEG AI and explorations on video coding** | **Elena Alshina** | **N** | **2025-04-04** | **25107** |

**8.3 Ad hoc groups**

**8.3.1 WG 5 approves the following document**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **Title** | **In Charge** | **TBP** | **Available** | **S/N** |
|  | **Ad hoc groups** |  |  |  |  |
| **357** | **List of AHGs established at the 19th WG 5 meeting** | **Jens-Rainer Ohm** | **N** | **2025-04-04** | **25108** |

**8.4 Expression of Thanks**

|  |  |  |
| --- | --- | --- |
| **8.4.1** |  | **WG 5 thanks Marius Preda 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 meeting was closed at 0014 UTC on 2025-04-05.**