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| **Joint Video Experts Team (JVET)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29**  34th Meeting: Rennes, FR, 17–24 April 2024 | Document: JVET-AH\_notes\_d1 |

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| *Title:* | **Meeting Report of the 34th Meeting of the Joint Video Experts Team (JVET), Rennes, 17–24 April 2024** | | |
| *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 WP3/16 and ISO/IEC JTC 1/‌SC 29 held its thirty-fourth meeting during 17–24 April 2024 at Le Couvent des Jacobins Rennes Convention Center in Rennes, France. The meeting was held as a face-to-face meeting, but remote participation was provided on best-effort basis for experts who were unable to travel.

For ISO/IEC purposes, JVET is alternatively designated ISO/IEC JTC 1/‌SC 29/‌WG 5, and this was the fifteenth 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 0830 CEST on Wednesday 17 April 2024. Meeting sessions were held on all days including the weekend days of Saturday and Sunday 20 and 21 April 2024, until the meeting was closed at approximately XXXX hours CEST on Wednesday 26 April 2024. Approximately XXX people attended the JVET meeting (XXX in person and XXX remotely), and approximately XXX input documents (not counting crosschecks, reports, and summary documents), 16 AHG reports, 2 EE summary reports, X BoG reports, and X incoming liaison document(s) were discussed. The meeting took place in a collocated fashion with a meeting of SG16 – one of the two parent bodies of the JVET, under whose auspices this JVET meeting was held. Various SC29 Working Groups and Advisory Groups were also meeting with partial temporal overlap – where WG 5 is representing the Joint Video Coding Team(s) and their activities from the perspective of the SC 29 parent body. The subject matter of the JVET meeting activities consisted of work on further development and maintenance of the twin-text video coding technology standards *Advanced Video Coding* (AVC), *High Efficiency Video Coding* (HEVC), *Versatile Video Coding* (VVC)*, Coding-independent Code Points (Video)* (CICP), and *Versatile Supplemental Enhancement Information Messages for Coded Video Bitstreams* (VSEI), as well as related technical reports, reference software and conformance testing packages. Further important goals were reviewing the results of the Exploration Experiment (EE) on Neural Network-based Video Coding, of the EE on Enhanced Compression beyond VVC capability, of other technical input on novel aspects of video coding technology, and to plan next steps for investigation of candidate technology towards further standard development.

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

a) JVET documents

* [JVET-AG1004](https://jvet-experts.org/doc_end_user/current_document.php?id=12567) Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP
* [JVET-AG2019](https://jvet-experts.org/doc_end_user/current_document.php?id=12563) Description of algorithms and software in neural network-based video coding (NNVC) version 6, also issued as WG 5 N 265
* [JVET-AG2020](https://jvet-experts.org/doc_end_user/current_document.php?id=12563) Film grain synthesis technology for video applications (Draft 6), also issued as WG 5 DTR N 260
* JVET-AG2022 Draft plan for subjective quality testing of the FGC SEI message
* [JVET-AG2023](https://jvet-experts.org/doc_end_user/current_document.php?id=12560) Exploration experiment on neural network-based video coding (EE1), also issued as WG 5 N 264
* [JVET-AG2024](https://jvet-experts.org/doc_end_user/current_document.php?id=12562) Exploration experiment on enhanced compression beyond VVC capability (EE2), also issued as WG 5 N 267
* [JVET-AG2025](https://jvet-experts.org/doc_end_user/current_document.php?id=12580) Algorithm description of Enhanced Compression Model 12 (ECM 12), also issued as WG 5 N 268
* [JVET-AG2027](https://jvet-experts.org/doc_end_user/current_document.php?id=12582) SEI processing order and processing order nesting SEI messages in VVC (Draft 7), also issued as WG 5 preliminary WD N 261
* [JVET-AG2030](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Optimization of encoders and receiving systems for machine analysis of coded video content (draft 4), also issued as WG 5 WD N 263
* [JVET-AG2032](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Technologies under consideration for future extensions of VSEI (draft 3), also issued as WG 5 N 259
* [JVET-AG2034](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) SEI messages for VSEI version 4 (Draft 1), also issued as WG 5 preliminary WD N 258
* [JVET-AG2035](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Test conditions and evaluation procedures for generative face video coding
* [JVET-AG2036](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Call for training materials for neural network-based video coding tool development, also issued as WG 5 N 266

b) documents produced as WG 5 documents only:

* WG 5 N 262 Request for subdivision: ISO/IEC TR 23888-3 Optimization of encoders and receiving systems for machine analysis of coded video content
* WG 5 N 269 Liaison statement to ISO/IEC JTC 1/SC 29/WG 1 (JPEG) on JPEG AI and explorations on video coding

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

* [JVET-AG1004](https://jvet-experts.org/doc_end_user/current_document.php?id=12567) Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP
* [JVET-AG2019](https://jvet-experts.org/doc_end_user/current_document.php?id=12563) Description of algorithms and software in neural network-based video coding (NNVC) version 6, also issued as WG 5 N 265
* [JVET-AG2020](https://jvet-experts.org/doc_end_user/current_document.php?id=12563) Film grain synthesis technology for video applications (Draft 6), also issued as WG 5 DTR N 260
* JVET-AG2022 Draft plan for subjective quality testing of the FGC SEI message
* [JVET-AG2023](https://jvet-experts.org/doc_end_user/current_document.php?id=12560) Exploration experiment on neural network-based video coding (EE1), also issued as WG 5 N 264
* [JVET-AG2024](https://jvet-experts.org/doc_end_user/current_document.php?id=12562) Exploration experiment on enhanced compression beyond VVC capability (EE2), also issued as WG 5 N 267
* [JVET-AG2025](https://jvet-experts.org/doc_end_user/current_document.php?id=12580) Algorithm description of Enhanced Compression Model 12 (ECM 12), also issued as WG 5 N 268
* [JVET-AG2027](https://jvet-experts.org/doc_end_user/current_document.php?id=12582) SEI processing order and processing order nesting SEI messages in VVC (Draft 7), also issued as WG 5 preliminary WD N 261
* [JVET-AG2030](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Optimization of encoders and receiving systems for machine analysis of coded video content (draft 4), also issued as WG 5 WD N 263
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* [JVET-AG2036](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Call for training materials for neural network-based video coding tool development, also issued as WG 5 N 266

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

* WG 5 N XXX …
* …

The following X draft revised ITU-T Recommendations were forwarded by JVET and Q6/16 for ITU-T Consent:

* TDXXX/Plen …
* …

For the organization and planning of its future work, the JVET established XX “ad hoc groups” (AHGs) to progress the work on particular subject areas. At this meeting, X Exploration Experiments (EE) were defined. The next eight JVET meetings were planned for 12 – 19 July 2024 under ISO/IEC JTC 1/‌SC 29 auspices in Sapporo, JP; during 1 – 8 November 2024 under ISO/IEC JTC 1/‌SC 29 auspices, in Antalya, TR; during 14 – 22 January 2025 under ITU-T SG16 auspices in Geneva, CH; during 26 March – 4 April 2025 under ISO/IEC JTC 1/‌SC 29 auspices, to be conducted as teleconference meeting; during 26 June – 4 July 2025 under ISO/IEC JTC 1/‌SC 29 auspices in Daejeon, KR; during XX – XX October 2025 under ITU-T SG 16 auspices in Geneva, CH; during January 2026 under ISO/IEC JTC 1/‌SC 29 auspices, date and location t.b.d.; and during April 2026 under ISO/IEC JTC 1/‌SC 29 auspices, date and location t.b.d.

The document distribution site <https://jvet-experts.org/> was used for distribution of all documents. 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/> are still accessible, but were converted to read-only.

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

# Administrative topics

## Organization

The ITU-T/ISO/IEC Joint Video Experts Team (JVET) is a group of video coding experts from the ITU-T Study Group 16 Visual Coding Experts Group (VCEG) and ISO/IEC JTC 1/‌SC 29/‌WG 5. The parent bodies of the JVET are ITU-T WP3/16 and ISO/IEC JTC 1/‌SC 29.

The Joint Video Experts Team (JVET) of ITU-T WP3/16 and ISO/IEC JTC 1/‌SC 29 held its thirty-fourth meeting during 17–24 April 2024 at Le Couvent des Jacobins Rennes Convention Center in Rennes, France. The meeting was held as a face-to-face meeting, but remote participation was provided on best-effort basis for experts who were unable to travel.

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

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

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

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

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
* 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/2024_01_AG_Virtual/>.

## Primary goals

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

a) JVET documents

* [JVET-AG1004](https://jvet-experts.org/doc_end_user/current_document.php?id=12567) Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP
* [JVET-AG2019](https://jvet-experts.org/doc_end_user/current_document.php?id=12563) Description of algorithms and software in neural network-based video coding (NNVC) version 6, also issued as WG 5 N 265
* [JVET-AG2020](https://jvet-experts.org/doc_end_user/current_document.php?id=12563) Film grain synthesis technology for video applications (Draft 6), also issued as WG 5 DTR N 260
* JVET-AG2022 Draft plan for subjective quality testing of the FGC SEI message
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* [JVET-AG2025](https://jvet-experts.org/doc_end_user/current_document.php?id=12580) Algorithm description of Enhanced Compression Model 12 (ECM 12), also issued as WG 5 N 268
* [JVET-AG2027](https://jvet-experts.org/doc_end_user/current_document.php?id=12582) SEI processing order and processing order nesting SEI messages in VVC (Draft 7), also issued as WG 5 preliminary WD N 261
* [JVET-AG2030](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Optimization of encoders and receiving systems for machine analysis of coded video content (draft 4), also issued as WG 5 WD N 263
* [JVET-AG2032](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Technologies under consideration for future extensions of VSEI (draft 3), also issued as WG 5 N 259
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* WG 5 N 262 Request for subdivision: ISO/IEC TR 23888-3 Optimization of encoders and receiving systems for machine analysis of coded video content
* WG 5 N 269 Liaison statement to ISO/IEC JTC 1/SC 29/WG 1 (JPEG) on JPEG AI and explorations on video coding

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

## Documents and document handling considerations

### General

The document distribution site <https://jvet-experts.org/> was used for distribution of all documents. It was noted that the previous site <http://phenix.int-evry.fr/jvet/> was still accessible, but had been converted to read-only.

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, 10 April 2024. Any documents uploaded after 1159 hours Paris/Geneva time on Thursday 11 April 2024 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-AH0226 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-AH0XXX (a proposal on …), uploaded 04-XX,
* … .

It may be observed that some of the above-listed contributions were submissions made in response to issues that arose in discussions during the meeting or from the study of other contributions, and thus could not have been submitted by the ordinary deadline.

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

* JVET-AH0XXX (a document presenting …), uploaded 04-XX,
* … .

All cross-verification reports at this meeting (except for JVET-AH0185 and JVET-AH0224) 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-AH0044, JVET-AH0140, JVET-AH0146, JVET-AH0194, JVET-AH0258, JVET-AH0300, JVET-AH0302, JVET-AH0304, … .

The following cross-verification reports were still missing by the end of the meeting, but were uploaded later: JVET-AH0XXX, … . The following reports had not become available yet three weeks after the end of the meeting: JVET-AH0XXX, … . 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-AH0XXX and …, which were also categorized as late in the list above, based on the time of the first reasonable document upload; this sentence is kept for future use.

Contributions that had significant problems with uploaded versions were not observed at this meeting.

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-AG1000, the Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP JVET-AG1004, the Description of algorithms and software in neural network-based video coding (NNVC) version 6 JVET-AG2019, the Film grain synthesis technology for video applications (draft 6) JVET-AG2020, the Draft plan for subjective quality testing of the FGC SEI message JVET-AG2022, the Description of the EE on Neural Network-based Video Coding JVET-AG2023, the Description of the EE on Enhanced Compression beyond VVC capability JVET-AG2024, the Algorithm description of Enhanced Compression Model 12 (ECM 12) JVET-AG2025, the SEI processing order SEI message in VVC (draft 7) JVET-AG2027, the Optimization of encoders and receiving systems for machine analysis of coded video content (draft 4) [JVET-AG2030](https://jvet-experts.org/doc_end_user/current_document.php?id=12584), the Technologies under consideration for future extensions of VSEI (version 3) JVET-AG2032, the SEI messages for VSEI version 4 (draft 1) JVET-AG2034, the Test conditions and evaluation procedures for generative face video coding JVET-AG2035, and the Call for training materials for neural network-based video coding tool development JVET-AG2036, had been completed and were approved. In a few cases, the corresponding WG 5 N-numbered documents had not yet been uploaded, and this was requested to be done as soon as possible. The software implementations of VTM version 23.1, ECM versions 12.0 and 12.1, and NNVC version 8.0 were also approved.

Only minor editorial issues were found in the meeting report JVET-AG1000; 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 in Annexes B1 and B2 of this report.

The meeting was open to those qualified to participate either in ITU-T WP3/16 or ISO/IEC JTC 1/‌SC 29/‌WG 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 or through the Q6/16 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
* Adoption 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 experiments on neural-network-based video coding
* Report of exploration experiments on enhanced compression beyond VVC capability
* 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 coding-independent code points for video signal type identification
* Consideration of contributions on film grain synthesis technology
* Consideration of contributions on optimization of encoders and receiving systems for machine analysis of coded video content
* Consideration of contributions on errata relating to standards in the domain of JVET
* Consideration of contributions on technical reports relating to standards and exploration study activities in the domain of JVET
* Consideration of contributions providing non-normative guidance relating to standards and exploration study activities in the domain of JVET
* Consideration of information contributions
* Consideration of future work items
* Coordination of visual quality testing
* Liaisons, coordination activities with other organizations
* Review of project editor and liaison assignments
* Approval of output documents and associated editing periods
* Future planning: Determination of next steps, discussion of working methods, communication practices, establishment of coordinated experiments (if any), establishment of AHGs, future meeting planning, other planning issues
* Other business as appropriate for consideration
* Closing

The agenda was approved as suggested.

The times of meeting sessions followed the needs of the face-to-face meeting, with highest priority given to the aim of achieving the goals of the meeting. Typical meeting hours were expected to be 0830-1900 CEST with coffee breaks and lunch breaks as appropriate, however some early morning or late-night sessions were anticipated to be necessary. Sessions were announced in the online JVET calendar in advance as far as possible, but it was anticipated that some activities (such as breakout sessions) could be held at short notice.

## ISO and IEC Code of Conduct reminders

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

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

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

These include points relating to:

* Complying with legal and statutory obligations
* Performing and acting in good faith, consistent with the purpose, policies and principles of the organization
* Behaving ethically
* Promoting and enabling all voices to be heard
* Engaging constructively in ISO and IEC activities
* Declaring actual and potential conflicts of interest and managing them appropriately
* Protecting confidential information
* Protecting ISO and IEC assets
* Avoiding and preventing any form of bribery or corruption
* Escalating and resolving disputes and upholding agreed resolutions

## 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](http://phenix.it-sudparis.eu/mpeg/doc_end_user/current_document.php?id=27881&id_meeting=16) of the 89th meeting of ISO/IEC JTC 1/‌SC 29/‌WG 11 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 noted that the previous websites <http://phenix.int-evry.fr/jvet/>, <http://phenix.int-evry.fr/jct/>, and <http://phenix.int-evry.fr/jct3v/> are still accessible, but had been converted to read-only. It was reminded to send a notice to the chairs in cases of changes to document titles, authors, etc.

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

It was emphasized that reflector subscriptions and email sent to the reflector must use real names when subscribing and sending messages and subscribers must respond to inquiries regarding the nature of their interest in the work. The current number of subscribers on the JVET email list was 1252 (as of 15 April 2024). 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.

For distribution of test sequences, a password-protected ftp site had been set up at RWTH Aachen University, with a mirror site at FhG-HHI. Accredited members of JVET may contact the responsible JVET coordinators to obtain the password information (but the site is not open for use by others).

It is further emphasized that the document JVET-AD1012 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
* **CIPF**: CABAC initialization from the previous frame
* **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
* **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
* **NNVC**: Neural network-based video coding (experimental software package)
* **NSQT**: Non-square quadtree
* **NSST**: Non-separable secondary transform
* **NUH**: NAL unit header
* **NUT**: NAL unit type (as in AVC and HEVC)
* **OBMC**: Overlapped block motion compensation (e.g., as in H.263 Annex F)
* **OETF**: Opto-electronic transfer function – a function that converts to input light (e.g., light input to a camera) to a representation value
* **OLS**: Output layer set.
* **OOTF**: Optical-to-optical transfer function – a function that converts input light (e.g. l,ight input to a camera) to output light (e.g., light emitted by a display).
* **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 (as in AVC and HEVC).
* **PTL**: Profile/tier/level combination.
* **QM**: Quantization matrix (as in AVC and HEVC).
* **QP**: Quantization parameter (as in AVC and HEVC, sometimes confused with quantization step size).
* **QT**: Quadtree.
* **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
* **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 library
* **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 (as in AVC and HEVC).
* **SH**: Slice header.
* **SHM**: Scalable HM.
* **SHVC**: Scalable high efficiency video coding.
* **SIF**: Switchable (motion) interpolation filter.
* **SIMD**: Single instruction, multiple data.
* **SMVD**: Symmetric MVD.
* **SPS**: Sequence parameter set (as in AVC and HEVC).
* **STMVP**: Spatial-temporal motion vector prediction.
* **STRP**: Short-term reference picture.
* **STSA**: Step-wise temporal sublayer access.
* **TBA/TBD/TBP**: To be announced/determined/presented.
* **TGM**: Text and graphics with motion – a category of content that primarily contains rendered text and graphics with motion, mixed with a relatively small amount of camera-captured content.
* **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.
* **UCBDS**: Unrestricted center-biased diamond search.
* **UGC**: User-generated content.
* **UWP**: Unequal weight prediction.
* **VCEG**: Visual coding experts group (ITU-T Q.6/16, the relevant rapporteur group in ITU-T WP3/16, which is one of the two parent bodies of the JVET).
* **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, the standardization project developed by JVET.
* **WAIP**: Wide-angle intra prediction
* **WCG**: Wide colour gamut.
* **WG**: Working group, a group of technical experts (usually used to refer to WG 11, a.k.a. MPEG).
* **WPP**: Wavefront parallel processing (usually synonymous with ECS).
* Block and unit names in HEVC:
  + **CTB**: Coding tree block (luma or chroma) – unless the format is monochrome, there are three CTBs per CTU.
  + **CTU**: Coding tree unit (containing both luma and chroma, synonymous with LCU), with a size of 16x16, 32x32, or 64x64 for the luma component.
  + **CB**: Coding block (luma or chroma), a luma or chroma block in a CU.
  + **CU**: Coding unit (containing both luma and chroma), the level at which the prediction mode, such as intra versus inter, is determined in HEVC, with a size of 2Nx2N for 2N equal to 8, 16, 32, or 64 for luma.
  + **PB**: Prediction block (luma or chroma), a luma or chroma block of a PU, the level at which the prediction information is conveyed or the level at which the prediction process is performed in HEVC.
  + **PU**: Prediction unit (containing both luma and chroma), the level of the prediction control syntax within a CU, with eight shape possibilities in HEVC:
    - **2Nx2N**: Having the full width and height of the CU.
    - **2NxN (or Nx2N)**: Having two areas that each have the full width and half the height of the CU (or having two areas that each have half the width and the full height of the CU).
    - **NxN**: Having four areas that each have half the width and half the height of the CU, with N equal to 4, 8, 16, or 32 for intra-predicted luma and N equal to 8, 16, or 32 for inter-predicted luma – a case only used when 2N×2N is the minimum CU size.
    - **N/2x2N** paired with **3N/2x2N** or **2NxN/2** paired with **2Nx3N/2**: Having two areas that are different in size – cases referred to as AMP, with 2N equal to 16 or 32 for the luma component.
  + **TB**: Transform block (luma or chroma), a luma or chroma block of a TU, with a size of 4x4, 8x8, 16x16, or 32x32.
  + **TU**: Transform unit (containing both luma and chroma), the level of the residual transform (or transform skip or palette coding) segmentation within a CU (which, when using inter prediction in HEVC, may sometimes span across multiple PU regions).
* Block and unit names in VVC:
  + **CTB**: Coding tree block (luma or chroma) – there are three CTBs per CTU in a P or B slice or in an I slice that uses a single tree, and one CTB per luma CTU and two CTBs per chroma CTU in an I slice that uses separate trees.
  + **CTU**: Coding tree unit (synonymous with LCU, containing both luma and chroma in a P or B slice or in an I slice that uses a single tree, containing only luma or only chroma in an I slice that uses separate trees), with a size of 16x16, 32x32, 64x64, or 128x128 for the luma component.
  + **CB**: Coding block, a luma or chroma block in a CU.
  + **CU**: Coding unit (containing both luma and chroma in P/B slice, containing only luma or chroma in I slice), a leaf node of a QTBT. It’s the level at which the prediction process and residual transform are performed in JEM. A CU can be square or rectangle shape.
  + **PB**: Prediction block, a luma or chroma block of a PU.
  + **PU**: Prediction unit, has the same size as a CU in the VVC context.
  + **TB**: Transform block, a luma or chroma block of a TU.
  + **TU**: Transform unit, has the same size as a CU in the VVC context.

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

* MPEG-2 | H.262 (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 V3 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 V2 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 V2 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 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 to close 2024-04-15, no action at the current meeting.
  + Conformance testing (twin text)
    - ITU-T H.264.1 V6 Approved 2016-02-13, published 2016-06-17
    - Various amendments of ISO/IEC 14496-4:2004, including:
      * ISO/IEC 14496-4:2004/AMD 6:2005 Advanced Video Coding conformance
      * ISO/IEC 14496-4:2004/AMD 9:2006 AVC fidelity range extensions conformance
      * ISO/IEC 14496-4:2004/AMD 30:2009 Conformance testing for new profiles for professional applications
      * ISO/IEC 14496-4:2004/AMD 31:2009 Conformance testing for SVC profiles
      * ISO/IEC 14496-4:2004/AMD 38:2010 Conformance testing for Multiview Video Coding
      * ISO/IEC 14496-4:2004/AMD 41:2014 Conformance testing of MVC plus depth extension of AVC
      * ISO/IEC 14496-4:2004/AMD 42:2014 Conformance testing of Multi-Resolution Frame Compatible Stereo Coding extension of AVC
      * ISO/IEC 14496-4:2004/AMD 43:2015 3D-AVC conformance testing
      * ISO/IEC 14496-4:2004/AMD 45:2016 Conformance Testing for the Multi-resolution Frame Compatible Stereo Coding with Depth Maps Extension of AVC
  + Reference software (twin text)
    - ITU-T H.264.2 V7 Approved 2016-02-13, published 2016-05-30
    - Various amendments of ISO/IEC 14496-5:2001 have been published, including:
      * ISO/IEC 14496-5:2001/AMD 6:2005 Advanced Video Coding (AVC) and High Efficiency Advanced Audio Coding (HE AAC) reference software
      * ISO/IEC 14496-5:2001/AMD 8:2006 AVC fidelity range extensions reference software
      * ISO/IEC 14496-5:2001/AMD 15:2010 Reference software for Multiview Video Coding
      * ISO/IEC 14496-5:2001/AMD 18:2008 Reference software for new profiles for professional applications
      * ISO/IEC 14496-5:2001/AMD 19:2009 Reference software for Scalable Video Coding
      * ISO/IEC 14496-5:2001/AMD 33:2015 Reference software for MVC plus depth extension of AVC
      * ISO/IEC 14496-5:2001/AMD 34:2014 Reference software of the multi-resolution frame compatible stereo coding of AVC
      * ISO/IEC 14496-5:2001/AMD 35:2015 3D-AVC Reference software
      * ISO/IEC 14496-5:2001/AMD 39:2016 Reference software for the Multi-resolution Frame Compatible Stereo Coding with Depth Maps of AVC
      * ISO/IEC 14496-5:2001/AMD 42:2017 Reference software for the alternative depth information SEI message extension of AVC
* HEVC (twin text)
  + ITU-T H.265 V7 approved 2019-11-29, published 2020-01-10
  + ISO/IEC 23008-2:2020 (Ed. 4) FDIS ballot closed 2020-07-16, published 2020-08-27
  + ITU-T H.265 V8 Consented at the 22nd meeting (shutter interval information SEI message and miscellaneous corrections), published 2020-10-13
  + ISO/IEC 23008-2:2020/AMD 1:2021 (shutter interval information SEI message) published 2021-07-12
  + ISO/IEC 23008-2:202x (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, pending publication
  + 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 at 32nd meeting 2023-10, DAM ballot to close 2024-04-08, no action at the current meeting.
  + 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, published 2017-03-01
    - ISO/IEC 23008-5:2017/AMD 1:2017 Reference software for screen content coding extensions, 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, published 2022-09-25
  + ISO/IEC 23090-3:202x (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 2023-07, pending FDIS ballot
  + ITU-T H.266 V3 Consented 2023-07, approved 2023-09-29 and pre-published 2023-09, published 2023-11-29.
  + 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 V1 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 23090-15:2022/Amd.1 Operation range extensions – 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 (awaiting ballot at the time of this meeting)
    - ITU-T H.266.1 V2 Consented 2023-07, approved 2023-09-13 and pre-published 2023-09, published 2023-10-19.
  + 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
* 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 23002-7:202x (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 (pending FDIS ballot)
  + ITU-T H.274 V3 Consent 2023-07, approved 2023-09-29, pre-published 2023-10-11, pending publication.
* CICP (twin text)
  + 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 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 23091-2:202x (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 waiting for publication of SMPTE ST 2128.
  + ITU-T H.273 Consent 2023-07, approved 2023-09, publication waiting for publication of SMPTE ST 2128.
* Conversion and coding practices for HDR/WCG Y′CbCr 4:2:0 video with PQ transfer characteristics (twin text)
  + H.Sup15 V1, approved 2017-01-27, published 2017-04-12
  + ISO/IEC TR 23008-14:2018 published 2018-08
* Signalling, backward compatibility and display adaptation for HDR/WCG video coding (twin text)
  + H.Sup18 V1, approved 2017-10-27, published 2018-01-18
  + ISO/IEC TR 23008-15:2018 published 2018-08
* Usage of video signal type code points (twin text)
  + H.Sup19 V3 approved 2021-04-30, published 2021-06-04
  + ISO/IEC TR 23091-4 (Ed. 3) published 2021-05-23
* Working practices using objective metrics for evaluation of video coding efficiency experiments (twin text)
  + HSTP-VID-WPOM V1: approved 2020-07-03, published 2020-11
  + ISO/IEC TR 23002-8 (Ed. 1) published 2021-05-20
* Film grain synthesis technologies for video applications (twin text)
  + ISO/IEC TR 23002-9 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. A DTR text was issued from the 31st meeting in July 2023 but was put on hold by ISO staff editors.
* The following freely available standards are published here in ISO/IEC:  
  <https://standards.iso.org/ittf/PubliclyAvailableStandards/index.html> as of 2023-10-09:
  + ISO/IEC 13818-4:2004 Conformance 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 23002-7:2022 (Ed. 2) – VSEI
  + ISO/IEC 23008-2:2020 (Ed. 4) HEVC
  + ISO/IEC 23090-3:2022 (Ed. 2) VVC
  + ISO/IEC 23090-15:2022 (Ed. 1) Conformance for VVC
  + ISO/IEC 23090-16:2022 (Ed. 1) Reference software for VVC
  + ISO/IEC 23091-2:2021 (Ed. 2) Video CICP
* 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 2023-05-26 and this was still the case as of 2023-10-06 and 2024-01-15. (These should be checked for previously issued requests for free availability.)
  + ISO/IEC 23008-2:2020 (Ed. 4) Amd.1:2021: Shutter interval information SEI message, published 2021-07-12 (has not been requested)
  + ISO/IEC 23008-5:2017 (Ed. 2) Reference software for high efficiency video coding, published 2017-03-01
  + ISO/IEC 23008-5:2017/AMD 1:2017 Reference software for screen content coding extensions, published 2017-11-09
  + ISO/IEC 23008-8:2018 (Ed. 2) Conformance specification for HEVC, published 2018-08, 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
* It appears necessary to check if all older software and conformance packages are publicly available – it might be that it 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

* AVC colour type indicators for YCgCo-Re, YCgCo-Ro, and SMPTE ST 2128 (IPT-PQ-C2) and the addition of support for the neural-network post-filter characteristics, neural-network activation, and phase indication SEI messages specified in Rec. ITU-T H.274 | ISO/IEC 23002-7 are in a DIS issued at 32nd meeting 2023-10, DAM ballot to close 2024-04-15, no action at the current meeting.
* HEVC 23008-2:202x (5th ed.) DAM1 New profiles, colour descriptors, and SEI messages, with colour type indicators for YCgCo-Re, YCgCo-Ro, and SMPTE ST 2128 (IPT-PQ-C2), the specification of a Multiview Main 10 profile, and the addition of support for the neural-network post-filter characteristics, neural-network activation, and phase indication SEI messages specified in Rec. ITU-T H.274 | ISO/IEC 23002-7 was issued at 32nd meeting 2023-10, DAM ballot to close 2024-04-08, no action at the current meeting.
* HEVC new levels (from JVET-Z1005) – ISO/IEC 23008-2 DIS of new edition of HEVC was issued from the April 2022 26th meeting, incorporating Amd.1 and corrigenda items (ballot closed 2023-01-10, ballot comments in the Summary of Voting document [m61834](https://dms.mpeg.expert/doc_end_user/current_document.php?id=85619&id_meeting=193)); note that Amd.1 = shutter interval SEI is already included in latest ITU-T edition of H.265. It is noted that there are potential additional items (corrigenda+tickets, YCgCo-Re and YCgCo-Ro draft, SMPTE ST 2128, multiview profiles draft) where only corrigenda items were included in the FDIS text based on ballot comments, ballot had not been started yet. ITU-T consent for a new edition is planned for July 2023. It was noted that the referencing of VSEI is also somewhat different in the ITU-T and ISO/IEC versions of HEVC and/or AVC, which might be aligned at the next convenient time (basically editorial – e.g., the ITU version of AVC specifies the annotated regions SEI message without referencing VSEI, whereas the ISO/IEC version references VSEI for the syntax and semantics of that SEI message). However, there is currently no other need for HEVC to reference the VSEI standard. An FDIS for HEVC was issued as an output of the 29th meeting in January 2023 (and it does not reference VSEI). Its ballot began 2023-08-06 and closed 2023-10-02, and it was pending publication. A new edition of H.265 (v9) was Consented in July 2023, approved 2023-09-13, and pre-published 2023-09, and published 2023-11-24 (not referencing VSEI).
* VVC new level and systems-related supplemental enhancement information (from JVET-AA2005) – VVC DAM was issued from 27th meeting, ballot closed 2023-01-03, ballot comments in the Summary of Voting document [m61833](https://dms.mpeg.expert/doc_end_user/current_document.php?id=85618&id_meeting=193). This was converted into a preliminary FDIS of VVC 3rd edition ([WG 5 N 183](https://dms.mpeg.expert/doc_end_user/current_document.php?id=86365&id_meeting=193)) at the 29th meeting of January 2023, anticipating that some alignment would be necessary with the ongoing VSEI amendment. Another preliminary FDIS was issued (WG 5 N 202) from the April meeting. The FDIS was then issued (WG 5 N 228) from the 31st meeting in July 2023. A new edition of H.266 was Consented in July 2023, approved 2023-09-29 and pre-published 2023-09, and published 2023-11-29.
* VVC Conformance testing for operation range extensions – (from JVET-Y2026) – the DAM ballot closed 2022-11-15 (ballot comments in the Summary of Voting document [m61832](https://dms.mpeg.expert/doc_end_user/current_document.php?id=85617&id_meeting=193)), and this was consolidated into an FDIS at the 29th meeting, but the ballot had not been started yet. ITU-T H.266.1 was Consented in July 2023, approved 2023-09-13 and pre-published in 2023-09, and published 2023-10-19.
* VSEI additional SEI messages (from JVET-AB2006) – VSEI DAM (JVET draft 3) was issued from the 28th meeting and a DAM ballot was issued. The FDIS of a new edition of ISO/IEC 23002-7 was issued (WG 5 N 220) from the 31st meeting in July 2023 and also reached ITU-T Consent at that meeting. H.274 v3 was approved 2023-09-29, pre-published 2023-10-11, and currently pending publication.
* Film grain synthesis technology for video applications – JVET draft 4 and the ISO/IEC 23002-9 CDTR were issued at the 29th meeting (JVET-AC2020) (a request to start work on the TR had been made at the 25th meeting), and the CDTR consultation period ended 2023-07-09. A DTR text was issued from the 31st meeting in July 2023 but was put on hold by ISO staff editors, so the ballot had not been issued. (It was noted that a second DTR could become necessary in case of comments). The publication limit date was reportedly 2023-08-09, so action to extend that date may be needed. ITU-T approval would be anticipated in April 2024.
* Video CICP new edition draft for YCgCo-Re and YCgCo-Ro (from JVET-Z1003), an ISO/IEC 23091-2 preliminary FDIS was issued from the 30th meeting and the Summary of Voting document was available as [m62572](https://dms.mpeg.expert/doc_end_user/current_document.php?id=86621&id_meeting=194) and a draft DoC had been issued as WG 5 [N 205](https://sd.iso.org/documents/ui/#!/browse/iso/iso-iec-jtc-1/iso-iec-jtc-1-sc-29/iso-iec-jtc-1-sc-29-wg-5/library/2/Draft%20disposition%20of%20comments%20received%20on%20ISO-IEC%20DIS%2023091-2%3A202X). There was a delay in the submittal of the FDIS due to dependency on the status of SMPTE ST 2128, which was tentatively included in the preliminary FDIS, based on an NB comment. The video CICP colour type indicator for SMPTE ST 2128 had been drafted and incorporated into the preliminary FDIS issued at the 30th meeting of April 2023. It had been reported that the specification was expected to become finalized in the SMPTE meeting in March 2023, but this had not yet happened, so the production of the FDIS was delayed. ITU-T Consent for H.273 v3 proceeded at the 31st meeting of July 2023 (to prevent undue delay since SG16 does not meet very frequently) and the text was approved in September 2023, but the text was on hold pending the publication of SMPTE ST 2128.
* 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 following parts:
  + For the ongoing work items, when they become finalized
  + ISO/IEC 23008-2:2020/Amd.1:2021 – HEVC FDAM issued 20th meeting (October 2020), public availability not yet requested but may not be necessary as it becomes included in next edition

## Opening remarks

Remarks during the opening session of the meeting Wednesday 17 April at 0830 CEST were as follows.

* Timing and organization of the meeting and online access, calendar posting of session plans
  + The initial number of documents was increased relative the previous meetings (approximately 190 by the time of opening the meeting) – parallel sessions will be necessary.
  + Evening sessions (online) seem necessary due to early closing of the meeting site (18:00). Discuss best timing for that -2030-2230
  + The meaning of proposal vs. information input documents was explained. A proposal is anything that suggests action in adopting technology – regardless if it is normative or non-normative.
* Plans for subsequent F2F meetings (with online access) in July 2024 (Sapporo), Nov. 2024 (Antalya), Jan. 2025 (Geneva), June/July 2025 (Daejeon), and Sept./Oct. 2025 (likely Geneva)
* April 2025 meeting will be virtual
* The meeting logistics, agenda, working practices, policies, and document allocation considerations were reviewed.
  + Access to the meeting was provided using Zoom. Recording of the meeting notes by the session chair will also permanently be shared via zoom.
  + Having text and software available is crucial (and not just arriving at the end of the meeting).
  + There were no objections voiced in the opening plenary to the consideration of late contributions.
* The results of the previous meeting and the meeting report JVET-AG1000 were reviewed. The following small issues in the meeting report were noted and were not considered sufficient to warrant issuing a revision. These are obviously left over from a previous report, and the correct information can be found in other places of the report:
  + Only editorial oversights this time.
* There was a somewhat decreased number of late non-cross-check documents, not compared to the last, but compared to other previous meetings. However, not all non-cross-check documents that had been registered before the deadline were also available in time.
* There were again a few documents registered where authors’ given names were not abbreviated, 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
* Experts were asked to always register JVET documents via the “jvet-experts.org” site, not via the MPEG dms site.
* 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.
* The primary goals of the meeting were:
  + Plan for new version of VVC software as standards part, for inclusion of NNPF SEI, software from TRs, layered coding, bug fixes, etc. Consent in ITU, CD of new ed. in ISO. Potentially another ITU version in January 2025.
  + New ed. HEVC software in January 2025 in ITU, CD in ISO at the current meeting. This should also include the software for the new Multiview profile.
  + New edition video CICP FDIS (DIS ballot response in [m62572](https://dms.mpeg.expert/doc_end_user/current_document.php?id=86621&id_meeting=194), draft DoCR in [MDS22710](https://dms.mpeg.expert/doc_end_user/current_document.php?id=87856&id_meeting=194), and preliminary FDIS text in [MDS22711](https://dms.mpeg.expert/doc_end_user/current_document.php?id=87857&id_meeting=194)) – inclusion of ST 2128 descriptor needed clarification of the status, therefore it had not yet been submitted for FDIS yet; was consented and approved in ITU-T, but cannot be published as long as ST 2128 is not available. This was not yet available by the time of the current meeting – therefore it was concluded to still defer the FDIS for July. There are inputs on potential updates of CICP. Discuss whether a new version of preliminary FDIS, or FDIS and update of the yet unpublished ITU version?
  + TR on film grain synthesis technology for video applications – an updated DTR had been issued in January for resolving problems in referencing and other issues. However, the ballot was issued late and will not close before the meeting ends. ITU approval had originally been targeted for April 2024 (final document, no consent, no CfC)9. There is no urgency of getting the current document published, therefore it should be deferred until the final version in ISO exists.
  + Optimization of encoders and receiving systems for machine analysis of coded video content – a new WD of TR 23888-3 was issued from last meeting, as well as a request for subdivision in WG 5. Plan to issue CDTR from the current meeting.
  + New editions of AVC (ISO/ITU)
    - 11th ed. 14496-10 DIS ballot response available in [m67044](https://dms.mpeg.expert/doc_end_user/current_document.php?id=92223&id_meeting=198), FDIS to be issued
    - ITU consent for new H.264 edition
  + New editions of HEVC (ISO/ITU)
    - Amd.1 of 5th ed.: DAM ballot response available in [m67040](https://dms.mpeg.expert/doc_end_user/current_document.php?id=92219&id_meeting=198), FDIS of new edition to be issued
    - ITU consent for next H.265 edition with new elements from DAM
  + New editions of VVC and VSEI (CDs and requests in WG 5)?
    - to include elements from JVET-AG1004, JVET-AG2027, and JVET-AG2034
  + Expert viewing for comparing subjective quality of ECM vs. VTM – discuss further as first item Thu morning.
  + Informal viewing on MPI SEI – not before Monday
  + Preparation of subjective tests for film grain, new content available – expert viewing had been planned for April meeting
  + Expert viewing for multi-layer verification test had also been planned for April meeting
  + Any action items on reference software JM?
  + Status of MV-HEVC software and test conditions (refer to resolution of a previous meeting for the latter)?
  + Exploration Experiments
    - Neural network-based video coding
    - Enhanced compression beyond VVC
* Liaison communication:
  + Incoming liaison statements?
* Joint meetings were expected with MPEG AG 5 (on matters involving visual quality assessment, sec. 4.5 and 4.6) and possibly with other groups such as MPEG WG 2 Requirements, ITU-T VCEG, and MPEG WG 4 Video.
* Principles of standards development were discussed.
* Meeting feedback report (WG 5) of last meeting.
* JVET management structures.
* New standardization projects in the area of video coding?
* Scheduling of sessions was discussed – see under 2.6 and 2.12.
* Closing of JVET meeting likely on Wed. 24 April around lunch time

## Scheduling of discussions

The times of meeting sessions followed the needs of the face-to-face meeting, with highest priority given to the aim of achieving the goals of the meeting. Typical meeting hours were in the range of 0830-1900 CEST with coffee breaks and lunch breaks as appropriate, however some early morning or late-night sessions were anticipated to be necessary. Sessions were announced in the JVET calendar and the ITU posting system in advance as far as possible, although it was acknowledged that some activities (such as breakout sessions) might be held at short notice.

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

Coffee breaks 1030, 1530

* Wed. 17 April, 1st day
  + Morning session:
    - 0830–0930 Opening remarks, review of practices, agenda, IPR policy reminder
    - 0930–1240 Reports of AHGs 1–14
  + Afternoon sessions:
    - 1400–1800 EE2 summary report (continued as online meeting 2030–XXXX
    - 1400–1800 HLS 6.1, 6.2 (chaired by Jill Boyce)
* Thu. 18 April, 2nd day
  + Morning session:
    - 0830–0900 Planning expert viewing ECM vs VTM
    - 0900-XXXX EE2 & related (5.2.1..5.2.3)
    - EE1 review (if time allows)
    - 0830-XXXX HLS 6.2, 6.4 (chaired by Jill Boyce)
  + Afternoon session:
    - XXXX–XXXX tbd
    - …
* Wed. 24 April, 8th day
  + 0900–1030 MPEG information sharing session (out of JVET)
  + 1035–XXXX Closing plenary:
    - Review liaison docs
    - Approval of output docs
    - Establishment of AHGs
    - Approval of meeting recommendations
    - Future planning, a.o.b.
* …
* Fri. 26 April
  + XXXX–XXXX MPEG information sharing session (out of JVET)
  + XXXX–XXXX WG 5 presentation of meeting recommendations

## 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 (16) (section 3)
* Project development (section 4)
  + AHG1: Development, deployment and advertisement of standards (1)
  + AHG2: Text development and errata reporting (4)
  + AHG3: Test conditions (0)
  + AHG3: Software development (0)
  + AHG4: Subjective quality testing and verification testing (2)
  + AHG4: Test and traing material (3)
  + AHG4: Codec performance with alternative test material and non-CTC conditions (2)
  + AHG5: Conformance test development (0)
  + AHG7: ECM tool assessment (1)
  + AHG8: Optimization of encoders and receiving systems for machine analysis of coded video content (9)
  + AHG10: Encoding algorithm optimization (2)
  + AHG13: Film grain synthesis (2)
  + Implementation studies (0)
  + Profile/tier/level specification (1)
  + Gaming content compression (5)
  + Generative face video (8)
* Low-level tool technology proposals (section 4.16) with subtopics (number counts excluding BoG and summary reports)
  + AHG11/AHG14 and EE1: Neural network-based video coding (26) (section 5.1)
  + AHG6/AHG12 and EE2: Enhanced compression beyond VVC capability (87) (section 5.2)
* AHG9: High-level syntax (HLS) proposals (section 6) with subtopics
  + SEI messages in VSEIv4 (5) (section 6.1)
  + SEI messages in TuC doc (13) (section 6.2)
  + SEI messages on NNPF and processing order (7) (section 6.3)
  + SEI messages on other topics (13) (section 6.4)
  + Non-SEI HLS aspects (0) (section 6.5)
* Joint meetings, plenary discussions, BoG reports (X), liaison (X), summary of actions (section 7)
* Project planning (section 8)
* Establishment of AHGs (section 9)
* Output documents (section 10)
* Future meeting plans and concluding remarks (section 11)

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

# AHG reports (16)

These reports were discussed during 0930–1240 on Wednesday 17 April 2024 (chaired by JRO).

[JVET-AH0001](https://jvet-experts.org/doc_end_user/current_document.php?id=14037) JVET AHG report: Project Management (AHG1) [J.-R. Ohm (chair), G. J. Sullivan (vice chair)]

The number of subscribers (on the day before the beginning of the current meeting) was 1252. Furthermore, the previous lists of joint teams (which were still kept open as archives) had the following number of subscribers:

* JCT-VC – 1157 subscribers
* JCT-3V – 680 subscribers
* JVT-experts – 2068 subscribers

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

**Goals and activity**

The work of the JVET overall had proceeded well in the interim period with higher 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 site (<http://wftp3.itu.int/av-arch/jvet-site/2024_01_AG_Virtual/>). It is noted that the previous document sites <http://phenix.int-evry.fr/jvet/>, <http://phenix.int-evry.fr/jct/>, and <http://phenix.int-evry.fr/jct3v/> are still accessible, but were converted to read-only.

The list of documents produced included the following, particularly:

a) JVET documents

* JVET-AG1000 Meeting Report of the 33rd JVET Meeting [Posted 2024-02-23, also submitted as WG 5 N 257]
* [JVET-AG1004](https://jvet-experts.org/doc_end_user/current_document.php?id=12567) Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP [Posted 2023-03-06]
* [JVET-AG2019](https://jvet-experts.org/doc_end_user/current_document.php?id=12563) Description of algorithms and software in neural network-based video coding (NNVC) version 6 [Posted 2024-02-22, also issued as WG 5 N 265]
* [JVET-AG2020](https://jvet-experts.org/doc_end_user/current_document.php?id=12563) Film grain synthesis technology for video applications (Draft 6) [Posted 2024-04-XX, also issued as WG 5 DTR N 260]
* JVET-AG2022 Draft plan for subjective quality testing of the FGC SEI message [Posted 2024-04-16]
* [JVET-AG2023](https://jvet-experts.org/doc_end_user/current_document.php?id=12560) Exploration experiment on neural network-based video coding (EE1) [Posted 2024-01-26, last update 2024-02-13, also issued as WG 5 N 264]
* [JVET-AG2024](https://jvet-experts.org/doc_end_user/current_document.php?id=12562) Exploration experiment on enhanced compression beyond VVC capability (EE2) [Posted 2024-01-26, last update 2024-02-27, also issued as WG 5 N 267]
* [JVET-AG2025](https://jvet-experts.org/doc_end_user/current_document.php?id=12580) Algorithm description of Enhanced Compression Model 12 (ECM 12) [Posted 2024-03-29, also issued as WG 5 N 268]
* [JVET-AG2027](https://jvet-experts.org/doc_end_user/current_document.php?id=12582) SEI processing order and processing order nesting SEI messages in VVC (Draft 7) [Posted 2024-03-15, also issued as WG 5 preliminary WD N 261]
* [JVET-AG2030](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Optimization of encoders and receiving systems for machine analysis of coded video content (draft 4) [Posted 2024-03-08, also issued as WG 5 WD N 263]
* [JVET-AG2032](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Technologies under consideration for future extensions of VSEI (draft 3) [Posted 2024-03-29, also issued as WG 5 N 259]
* [JVET-AG2034](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) SEI messages for VSEI version 4 (Draft 1) [Posted 2024-03-25, also issued as WG 5 preliminary WD N 258]
* [JVET-AG2035](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Test conditions and evaluation procedures for generative face video coding [Posted 2024-02-23, last update 2024-03-27]
* [JVET-AG2036](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Call for training materials for neural network-based video coding tool development [Posted 2024-02-09, also issued as WG 5 N 266]

b) documents produced as WG 5 documents only:

* WG 5 N 262 Request for subdivision: ISO/IEC TR 23888-3 Optimization of encoders and receiving systems for machine analysis of coded video content
* WG 5 N 269 Liaison statement to ISO/IEC JTC 1/SC 29/WG 1 (JPEG) on JPEG AI and explorations on video coding

The sixteen *ad hoc* groups had made progress, and reports from those activities had been submitted. Furthermore, two exploration experiments (EE) on neural network-based video coding and on enhanced compression beyond VVC capability were conducted.

The arrangements for the 34th meeting had been announced in the JVET reflector, in the JVET logistics document (<https://www.itu.int/wftp3/av-arch/jvet-site/2024_04_AH_Rennes/JVET-AH_Logistics.docx>), and in the WG 5 calling notice (N 271) and agenda (N 272) for the 15th 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 190 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, and non-normative guidance information,
* Specification of *Coding-independent Code Points (Video)* (CICP), and associated technical report(s),
* Maintenance and minor 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 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 34th meeting had been made publicly available on the ITU-hosted ftp site as <http://wftp3.itu.int/av-arch/jvet-site/2024_04_AH_Rennes/JVET-AH_notes_d0.docx>.

**Recommendations**

* The AHG suggests appointment of a team supporting the JVET chair in daily business.
* The AHG recommends its continuation.

[JVET-AH0002](https://jvet-experts.org/doc_end_user/current_document.php?id=14038) 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-AH1004 Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP**

Incorporated items at the JVET-AG meeting:

* For VVC:
  + In subclause 7.4.2.4.5, the first bullet item, replace "subpicture level values" with "subpicture index values". (reported by Rickard Sjöberg – thanks!)
* For VSEI:
  + Fix a typo when vui\_chroma\_sample\_loc\_type\_frame is mentioned in the VSEI text. (JVET-AG0192)
  + Fix two bugs for the constraints on nnpfc\_matrix\_coeffs and add two NOTEs in the semantics of nnpfc\_matrix\_coeffs to clarify complicated cases. (JVET-AG0192)
  + Fix an asserted bug on the inference of nnpfc\_full\_range\_flag. (JVET-AG0192)

**JVET-AH2027 SEI processing order and processing order nesting SEI messages in VVC (draft 7)**

This document contains the draft text for changes to the Versatile Video Coding (VVC) standard (Rec. ITU-T H.266 | ISO/IEC 23090-3), to specify the SEI processing order (SPO) and processing order nesting (PON) SEI messages.

**Changes that have been integrated:**

1. Item 2 option 1 from JVET-AG0052v4.
2. Delete “However, if po\_sei\_wrapping\_flag[ i ] is equal to 0 and no SEI message is present …” (and NOTE 2). (Documented under JVET-AG0053.) (NOTE 2 seemed unrelated to the deletion, providing a clarification of po\_sei\_wrapping\_flag[ i ] and hence was kept.)
3. Agreed: An SEI message being present within a PON should be equivalent, from a decoder perspective, to being present outside of a PON. (Documented under JVET-AG0053.)
4. Delete “The persistence of all the SEI messages included in the same processing order nesting SEI message shall be the same.” (Documented under JVET-AG0053.)
5. Add a clarification of the persistence issue (activation/deactivation/persistence). (Documented under JVET-AG0053.)
6. Add a clarifying note in the semantics to describe the flexibility supported when multiple PON SEI messages are sent. (Documented under JVET-AG0165.)
7. Add (editors to develop text): If NNPFC is in a PON, the corresponding NNPFA and any NNPFC updating for that NNPF shall be in a PON (not necessarily the same PON). (Documented under JVET-AG0169.)
8. Add (editors to develop text): For all SEI messages (not just NNPFC), there should be a constraint that there should not be “activation” outside of a PON and then later a deactivation or some update inside of a PON. (Documented under JVET-AG0169.)
9. Use of the film grain characteristics SEI message as a part of a processing order indicated by an SEI processing order SEI message (JVET-AG0180).

**JVET-AH2034 SEI messages for VSEI version 4 (Draft 1)**

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 additional SEI messages, including encoder optimization information, source picture timing information , object mask information, and modality information SEI messages and updates to the neural-network post-filter characteristics SEI message.

**Changes yet to be integrated:** (none)

**Changes that have been integrated:**

*Changes incorporate: JVET-AG0070, JVET-AG0081, JVET-AG-0082v2, JVET-AG0086, JVET-AG0089, JVET-AG0148, JVET-AG0188, JVET-AG0322*

* *NNPFC SEI message: Temporal extrapolation purpose (JVET-AG0089).*
* *Source picture timing information SEI message: Include with the following modifications*
  + *various aspects from JVET-AG0070*
    - *(Proposal 1)\_Editorial clarification of NOTE 1*
    - *(Proposal 2) Forbid the value 0 for spti\_num\_units\_in\_elemental\_interval (option 2)*
    - *(Proposal 3)Modify semantic to fix bug in handling the case spti\_source\_type\_present\_flag equal 0*
  + *option 1 of JVET-AG0188*
  + *Modification from JVET-AG0082v2*
* *Encoder optimization information SEI message:*
  + 2-bit indicators eoi\_for\_human\_viewing\_idc and eoi\_for\_machine\_analysis\_idc (JVET-AG0086, item 1)
  + *new optimization type from JVET-AG0081*
* *Object mask information SEI message: Include with modifications from JVET-AG0148*
* *Modality information SEI message:*
* *NNPFC SEI message application information signaling*
* *payloadType values for the added SEI message (VVC text).*

**Related input contributions**

The following input contributions were noted as relevant to the work of this ad hoc group:

* [JVET-AH0046](https://jvet-experts.org/doc_end_user/current_document.php?id=13928) On MV-HEVC profiles
* [JVET-AH0169](https://jvet-experts.org/doc_end_user/current_document.php?id=14068) Video CICP problem reports and proposed actions

**Remaining VVC bug tickets**

Carried over:

* [#1594](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1594" \o "View ticket) Mismatch between VVC spec and VTM for sample generation in CCLM process
* [#1607](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1607" \o "View ticket) Wrong sign (+ instead of -) in Fig 16 Flowchart for decoding a decision in the ITU text
* [#1609](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1609" \o "View ticket) NoBackwardPredFlag derivation ambiguity
* [#1617](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1617" \o "View ticket) Not initialized NumCtusInSlice[0] to 0.
* [#1618](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1618" \o "View ticket) [Multilayer Profiles] Potential Mismatch of VTM22.0 & Specification Related To Derivation Process For Merge Motion Vector Difference

New:

* [#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"
* [#1629](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1629) mtt\_split\_cu\_vertical\_flag context uses undefined variable chType
* [#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?
* [#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
* [#1635](https://jvet.hhi.fraunhofer.de/trac/vvc/ticket/1635) Incorrect inference for tu\_y\_coded\_flag

**Recommendations**

The AHG recommends to:

* Approve JVET-AH1004, JVET-AH2027, and JVET-AH2034 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.

New bugs were found that need to be added to JVET-AH1004. If a CD of a new VVC is generated, bugs for which solutions are known could already be included. Side activity of editors to clarify.

[JVET-AH0003](https://jvet-experts.org/doc_end_user/current_document.php?id=14039) 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 23.1](https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/-/releases/VTM-23.1) (Feb. 2024)
* [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.

Before the 33rd meeting an issue was found, which prevents the GitLab server from sending out emails to external addresses. This prevents confirmation of new email addresses and thus the registration of new accounts. Email notifications for changes (e.g. updates on merge requests) are also not sent out. Proponents and software coordinators should check manually for updates. The issue was only identified recently and is expected to be resolved soon.

**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 versions 23.1 was tagged on Feb. 9, 2024. VTM 23.2 is expected during the 34th JVET meeting.

VTM 23.1 was tagged on Feb. 9, 2024. Changes include:

* Fix SPS crash for RGB content
* Fix build on macos arm
* Remove unused configuration parameter isSdr
* Remove RDpenalty configuration parameter which has no effect
* fix AlfParam::operator==
* Add new macOS ARM build server
* Update Copyright statement to include 2024
* Clean up code related to BP SEI
* Fix #1626: add missing syntax elements in BP SEI
* JVET-AG0329: Bugfix and code cleanup for multi-profile signalling
* Clean up and fix Picture Timing SEI
* Fix syntax element names
* Clean up Decoding Unit Info SEI

VTM 23.2 is expected to be tagged during the 34th JVET meeting. A release candidate is tagged as VTM 23.2rc1. Changes are expected to include:

* Modified ALF error function
* Removed obsolete isSDR config parameter causing HBD and HDR CTCs to fail
* Clean up Scalable Nesting SEI
* Fix encoder when MMVD=1 and MaxNumMergeCand=1
* JVET-AG0089: Temporal extrapolation purpose for the neural-network post-filter...
* Clean up Window data structure and Picture::isRefScaled and their use
* fix missing xCalDebCost in function xCheckRDCostInterAmvr
* Clean up SLI SEI message

***CTC Performance***

VTM 23.1 shows the same coding performance as VTM 23.0 in SDR CTC.

Partial results for VTM 23.2rc1 show minor differences in SDR coding performance. Full results are not available yet at the time of this report.

For the HDR CTCs, there is also no change in coding performance or run time between VTM 23.1 and VTM 23.0.

For the high bit depth CTCs, there is no change in coding performance or run time between VTM 23.1 and VTM 23.0, although it should be noted that the isSDR flag must be removed from classH1.cfg to run all test conditions (a patch is to be included in VTM 23.2).

***Issues in VTM affecting conformance***

The following issues in VTM master branch may affect conformance:

* A syntax parsing issue was found in Picture Timing SEI ([MR#2722](https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/-/merge_requests/2722)). Checking of conformance streams is still pending.
* Missing HLS features (see sections below)

***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-1.0 was expected to be tagged during the 33rd JVET meeting. It was tagged during the 34th JVET meeting. Changes include:

* JVET-AF0088: object mask info SEI
* JVET-AF0167: MPII SEI message
* Remove unused variable in JVET\_AF0088\_OMI\_SEI
* Update CI pipeline configuration to build jvet-tuc branch and merge requests
* Add macOS on ARM build to CI pipeline

VTM-22.2-TuC-2.0 is expected to be tagged during the 34th JVET meeting. Merge requests were submitted for:

* JVET-AF0107-TuC: Implementation of Encoder Optimization Info SEI message
* JVET-AF2032 SPTI SEI message
* JVET-AG0045
* JVET-AG0044
* JVET-AF0141

**HM related activities**

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

The following MRs are pending [with status indicated]:

* Implement phase indication SEI message (JVET-AE0101) [waiting review]
* Port the Y4M support [one issue remains]
* Mark the current picture as short-term ref (for SCM) [need SCC expert reviewer]

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:

* 43 tickets for “HM”, most of which are more than 5 years,
* 1 ticket for “HM RExt”,
* 9 tickets for “HM SCC”, most of which are at least 3 years old,
* 1 ticket for “RExt Text” (8 years old)
* 1 ticket for “SCC Text” (8 years old)
* 6 tickets for text (3-5 years old)
* 2 tickets for encoder description (3-9 years old)

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% |

**SCM related activities**

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

**SHM related activities**

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

**HTM related activities**

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

One merge request is pending:

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

The next release will include the following changes:

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

**HDRTools related activities**

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

**JM, JSVM, JMVM related activities**

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

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.

**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. For spam fighting reasons account registration is only possible at the HM software bug tracker at

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

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.

**CTC alignment and merging**

There are currently 8 JVET CTC documents:

JVET-Y2010 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

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.

**Guidelines for reference software development**

No further work was conducted on Guidelines for VVC and HEVC reference software development and documents JVET-AC2003 and JVET-AC1001 remain current.

**Recommendations**

The AHG recommends to:

* Continue to develop reference software.
* Improve documentation, especially the software manual.
* Encourage people to test VTM and other reference software more extensively outside of common test conditions.
* Encourage people to report all (potential) bugs that they are finding.
* Encourage people to submit bit-streams/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.

It was suggested to move sw of sei messages in WD for VSEIv4 to the main repository-

[JVET-AH0004](https://jvet-experts.org/doc_end_user/current_document.php?id=14040) 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**

***Preparation of viewing tests for performance assessment of the ECM***

Four AhG meetings have been held together with SC 29/AG 5 for preparation of visual tests of the Enhanced Compression Model 12 (ECM-12) in comparison to the VTM. As an additional test point, a configuration of the ECM disabling temporal template-matching tools is considered.

Meetings were held on 2024-02-13, 2024-03-06, 2024-03-27, and 2024-04-08. The reports the four meetings are aggregated in document JVET-AH0041.

***Verification tests for VVC multilayer coding***

No group activity has been performed in this meeting period.

***Plan for subjective quality testing of FGC SEI message***

The plan for subjective quality testing has been updated as output JVET-AG2022 of the previous JVET meeting. The document includes an update on test material under consideration and a revision of the planned categories, now representing three scenarios: 1) Usage of FGC for compression efficiency improvement, 2) rate saving in the high visual quality range, and 3) replication of actual film grain characteristics.

***Test sequences***

The test sequences used for CfP/CTC are available on <ftp://jvet@ftp.ient.rwth-aachen.de> in directory “/ctc” (accredited members of JVET may contact the JVET chair for login information).

Due to copyright restrictions, the JVET database of test sequences is only available to accredited members of JVET (i.e., members of ISO/IEC MPEG and ITU-T VCEG).

The current JVET ftp site will need to be replaced by a new system. A solution using a NextCloud server has been prepared at RWTH Aachen University. The timeline for the switch to the new server and the access handling are suggested to be discussed at this meeting.

**Related contributions**

|  |  |  |
| --- | --- | --- |
| [JVET number](https://jvet-experts.org/doc_end_user/current_meeting.php?id_meeting=198&type_order=&sql_type=document_number) | [Title](https://jvet-experts.org/doc_end_user/current_meeting.php?id_meeting=198&type_order=&sql_type=title) | [Source](https://jvet-experts.org/doc_end_user/current_meeting.php?id_meeting=198&type_order=&sql_type=authors) |
| [JVET-AH0004](https://jvet-experts.org/doc_end_user/current_document.php?id=14040) | 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-AH0041](https://jvet-experts.org/doc_end_user/current_document.php?id=13922) | [AHG4] AHG meeting report on ECM expert viewing preparations | [M. Wien](mailto:wien@lfb.rwth-aachen.de) |
| [JVET-AH0048](https://jvet-experts.org/doc_end_user/current_document.php?id=13930) | AHG4: ECM test results on some 8K HDR sequences | [Y. Sun](mailto:sunyule@huawei.com), [Y. Zhao](mailto:yin.zhao@huawei.com), [E. Alshina (Huawei)](mailto:elena.alshina@huawei.com), [Y. Li (CMG)](mailto:liyan@cctv.com), [Q. Zhang (ABP)](mailto:zhangqian@abp2003.cn) |
| [JVET-AH0142](https://jvet-experts.org/doc_end_user/current_document.php?id=14024) | AHG4: HDR 4K content for JVET CTCs | E. Francois, S. Puri, P. de Lagrange, D. Doyen (InterDigital) |

**Recommendations**

The AHG recommends:

* To conduct onsite expert viewing tests with the material as prepared and reported by the AhG in JVET-AH0041
* To review the input contributions and the test sequences proposed in JVET-AH0048 and JVET-AH0142 jointly with SC 29/AG 5.
* To collect volunteers to conduct further verification tests and subjective quality tests.
* 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 actively contribute to the verification test development.
* To review the set of available test sequences for the verification tests as well as subjective quality tests and potentially collect more test sequences with a variety of content.
* To continue to collect new test sequences available for JVET with licensing statement.

[JVET-AH0005](https://jvet-experts.org/doc_end_user/current_document.php?id=14041) JVET AHG report: Conformance testing (AHG5) [I. Moccagatta (chair), F. Bossen, K. Kawamura, P. de Lagrange, T. Ikai, S. Iwamura, H.-J. Jhu, 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 33rd and 34th 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
  + H.266.1 V2 forwarded by JVET and Q6/16 for ITU-T Consent: 2023-07
  + H.266.1 V2 approved 2023-09-13
  + H.266.2 V2 pre-published 2023-10-06

**Status on bitstream submission**

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

* conformance bitstreams for VVC:
  + 104 bitstream categories have been identified
  + At least one bitstream has been submitted in each identified category
  + 283 total bitstreams have been provided, checked, and made available
  + No changes in bitstream between 33rd and 34th 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 33rd and 34th meeting.

**Activities and Discussion**

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

VVC 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/](https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVC2ndEd/" \t "_blank)

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/](https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVC2ndEd/" \t "_blank)

VVC Multilayer activities:

The 3 re-generated conformance bitstreams for VVC multilayer configurations provided in JVET-AG0329 (OLSMultiProfile\_A\_NHK\_2, OLSMultiProfile\_A\_NHK\_2, OLSMultiProfile\_A\_NHK\_2) are available in <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVCMultilayer/under_test/VTM-23.0/>. As agreed during the 33rd JVET meeting there is no need to change these bitstream description in JVET-AE2028. The merge request <https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/-/merge_requests/2714> implementing the VTM encoder fix described in JVET-AG0329 has been merged.

Cross check of ILRPL\_B\_InterDigital\_1 is ongoing.

Following cross check, the remaining 3 conformance bitstreams for VVC multilayer configurations (PPSScalWin\_A\_NHK\_1, PPSScalWin\_B\_NHK\_1, PPSScalWin\_C\_NHK\_1) are in the process of being re-generated.

HEVC Multiview supporting extended bit depth activities:

The merge request <https://vcgit.hhi.fraunhofer.de/jvet/HTM/-/merge_requests/5> implementing the new HEVC Multiview Main 10 profile in JVET-AF1006-v2 and in WG5 N0244 is under review.

Cross-checking of the 4 HEVC Multiview Main 10 bitstreams provided in AD0232 and AE0295 is contingent to the merging of this merge request.

No updates on the implementation for the HEVC Multiview monochrome profiles (Multiview Monochrome, Multiview Monochrome 10, and Multiview Monochrome 12) in JVET-AF1006-v2 and in WG5 N0244.

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**

JVET-AH0046 – On MV-HEVC Profiles [Y.-K. Wang, H. Liu, L. Zhang, S. Jiao, C. Hu, J. Cui, A. M. Tourapis, D. Podborski, S. Paluri].

**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 may also be necessary to set the minimum TLS level to 1.0.

**Recommendations**

The AHG recommends the following:

* Proceed with the cross-checking of the additional conformance bitstreams for VVC Multilayer configurations (JVET-AE2028).
* 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.

There are still bitstreams missing for various of the new Multiview monochrome profiles. Multiview main 10 appears OK. Revisit: Check status of software and conformance of the various new Multiview monochrome profiles, and decide which ones are mature enough for the new HEVC edition.

Whatever will be decided for the text of new HEVC editions, should also be included in the CD for HEVC software, and a draft of conformance spec. should be generated.

[JVET-AH0006](https://jvet-experts.org/doc_end_user/current_document.php?id=14042) 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-12.0:

JVET-AG0196 (Tests 5.1 and 5.2), JVET-AG0117 (Test 5.3), JVET-AG0143 (Test 3.1c), JVET-AG0100 (Test 3.2b\*) (MR 585)

JVET-AG0098: AMVP with SbTMVP mode (Test2.7) (MR 587)

JVET-AG0091: Auto-relocated block vector prediction (MR 583)

JVET-AG0094: TIMD enhanced fusion (test 1.22b) (MR 589)

JVET-AG0067: DMVR Extensions (Test 2.8d) (MR 594)

JVET-AG0091: Auto-relocated block vector prediction (Test 1.8a) (MR 583)

JVET-AG0142: CIIP-Affine, GPM-Affine, regression-based GPM blending (Test 2.11f) (MR 586)

JVET-AG0094: TIMD enhanced fusion (Test 1.22b) (MR 589)

JVET-AG0058: Extrapolation filter based intra prediction mode (Test 1.14b) (MR 582)

JVET-AG0157: Fixed filter for chroma ALF (Test 4.2b) (MR 584)

JVET-AG0158: Adaptive precision for luma ALF (Test 4.3) (MR 588)

JVET-AG0145: Adaptive clipping with signalled lower and upper bounds (Test 4.1a) (MR 590)

JVET-AG0137: IntraTMP extensions (Test 1.7b) (MR 596)

JVET-AG0154: Decoder derived CCP (Test 1.1b) (MR 597)

JVET-AG0061: Inter LFNST/NSPT (Test 3.3) (MR 600)

JVET-AG0208: On LFNST/NSPT index signalling (EE2-related) (MR 608)

JVET-AG0059: Enhancements on CCP merge for chroma intra coding (Test 1.15c) (MR 603)

JVET-AG0276: LIC improvements (Test 2.6j) (MR 595)

JVET-AG0334: AHG12: Fix for coding at high QPs (592)

JVET-AG0116: AHG12: GOP-based RPR encoder control for ECM (MR 593)

Bug fixes:

Fix mismatch when dual tree off (MR 581)

Avoid a fault at dtrace blockstatistics collection (MR 577)

Fix the bug of incorrect context state recovery at Intra search (MR 580)

Remove EXTENSION\_CABAC\_TRAINING (MR 618)

The following changes were integrated into ECM-12.1:

RPR related fixes (MRs 624, 625, 626, 628, 632)

Update context training (MR 627)

Fix ECM-12.0 decoder crash for --EnableTMTools=0 (MR 630)

Activate ItmpLicExtension for screen content coding (MR 633)

Fix correct missing default parameters for a context introduced in AG0276 (MR 631)

The following adopted aspects and changes were integrated into VTM-11ecm anchor:

JVET-AD0045: encoder control for DMVR (MR 601)

Add empty config files to match CTC description (MR 578)

ECM-12.0, and VTM-11ecm12.0 were tagged on February 23, 2024.

ECM-12.1 was tagged on April 10, 2024.

***CTC Performance***

In this section, ECM test results following ECM CTC configuration descried in JVET-AF2017 are summarized.

ECM-12.0 performance over ECM-11.0 anchor is summarized in the tables below.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | |
|  | **Over ECM-11.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -0.77% | -2.68% | -2.89% | 116.6% | 111.9% | 99.8% | 104.7% |
| Class A2 | -1.11% | -1.96% | -2.56% | 116.7% | 113.1% | 102.2% | 104.9% |
| Class B | -1.01% | -1.75% | -2.61% | 115.8% | 112.2% | 105.6% | 103.1% |
| Class C | -0.90% | -1.83% | -2.65% | 114.2% | 108.9% | 109.1% | 101.8% |
| Class E | -1.18% | -2.87% | -1.85% | 114.7% | 109.5% | 108.5% | 102.0% |
| **Overall** | -0.99% | -2.15% | -2.53% | 115.6% | 111.1% | 105.3% | 103.2% |
| Class D | -0.75% | -1.38% | -1.95% | 111.8% | 108.7% | 110.3% | 101.3% |
| Class F | -1.65% | -2.37% | -2.70% | 110.7% | 110.1% | 104.5% | 102.3% |
| Class TGM | -2.26% | -2.54% | -2.47% | 109.9% | 110.0% | 107.2% | 103.2% |
|  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | |
|  | **Over ECM-11.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -1.75% | -2.13% | -2.56% | 118.3% | 108.2% | 101.9% | 105.1% |
| Class A2 | -1.76% | -1.89% | -2.29% | 118.3% | 105.1% | 102.3% | 105.1% |
| Class B | -1.91% | -1.77% | -2.52% | 118.4% | 110.2% | 104.5% | 103.9% |
| Class C | -2.02% | -2.06% | -2.94% | 120.0% | 109.3% | 107.8% | 102.3% |
| Class E |  |  |  |  |  |  |  |
| **Overall** | -1.88% | -1.94% | -2.59% | 118.8% | 108.5% | 104.4% | 103.9% |
| Class D | -2.00% | -1.20% | -2.52% | 113.6% | 108.2% | 109.1% | 101.4% |
| Class F | -2.24% | -2.69% | -3.27% | 111.8% | 110.7% | 105.5% | 102.7% |
| Class TGM | -2.34% | -3.50% | -3.52% | 110.2% | 110.4% | 107.2% | 105.7% |
|  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | |
|  | **Over ECM-11.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -1.12% | -0.64% | -1.55% | 121.5% | 105.3% | 104.6% | 108.7% |
| Class C | -1.05% | -1.22% | -2.52% | 118.4% | 107.1% | 106.9% | 103.9% |
| Class E | -1.83% | -4.37% | -1.70% | 115.5% | 106.9% | 105.9% | 102.9% |
| **Overall** | -1.27% | -1.76% | -1.91% | 119.0% | 106.3% | 105.7% | 105.6% |
| Class D | -1.16% | -1.55% | -2.50% | 113.1% | 104.2% | 107.3% | 101.7% |
| Class F | -2.09% | -1.51% | -1.96% | 110.2% | 107.8% | 103.6% | 103.7% |
| Class TGM | -2.10% | -3.23% | -3.22% | 110.0% | 109.7% | 102.6% | 111.1% |
|  |  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | | |
|  | **Over ECM-11.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -1.10% | -1.27% | -2.90% | 124.4% | 106.1% | 104.1% | 103.3% |
| Class C | -1.10% | -1.10% | -2.63% | 121.7% | 105.5% | 106.9% | 101.8% |
| Class E | -1.15% | -4.24% | -2.11% | 116.4% | 105.2% | 104.9% | 102.0% |
| **Overall** | -1.12% | -1.96% | -2.61% | 121.4% | 105.7% | 105.2% | 102.5% |
| Class D | -1.05% | -0.52% | -2.48% | 112.2% | 106.4% | 107.6% | 101.2% |
| Class F | -1.36% | -1.83% | -3.19% | 111.1% | 108.3% | 104.0% | 102.4% |
| Class TGM | -1.94% | -3.43% | -3.36% | 110.1% | 111.9% | 101.4% | 103.8% |

Next tables show ECM-12.1 performance over ECM-12.0 anchor.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | |
|  | **Over ECM-12.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | 0.00% | 0.00% | 0.00% | 100.9% | 102.0% | 100.0% | 100.0% |
| Class A2 | 0.00% | 0.00% | 0.00% | 100.3% | 100.2% | 100.0% | 100.0% |
| Class B | 0.00% | 0.00% | 0.00% | 100.5% | 99.5% | 99.3% | 99.9% |
| Class C | 0.00% | 0.00% | 0.00% | 103.8% | 103.3% | 100.0% | 100.0% |
| Class E | 0.00% | 0.00% | 0.00% | 99.0% | 98.0% | 100.0% | 100.0% |
| **Overall** | 0.00% | 0.00% | 0.00% | 101.0% | 100.6% | 99.8% | 100.0% |
| Class D | 0.00% | 0.00% | 0.00% | 101.7% | 102.4% | 100.0% | 100.0% |
| Class F | -0.08% | -0.04% | -0.09% | 97.3% | 85.5% | 100.0% | 100.0% |
| Class TGM | -0.02% | 0.01% | -0.06% | 97.1% | 85.0% | 100.0% | 99.9% |
|  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | |
|  | **Over ECM-12.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | 0.00% | 0.00% | 0.00% | 99.3% | 98.9% | 100.0% | 100.1% |
| Class A2 | 0.00% | 0.00% | 0.00% | 99.7% | 99.5% | 99.6% | 100.0% |
| Class B | 0.00% | 0.00% | 0.00% | 100.7% | 100.1% | 99.7% | 100.1% |
| Class C | 0.00% | 0.00% | 0.00% | 100.7% | 100.8% | 100.2% | 100.0% |
| Class E |  |  |  |  |  |  |  |
| **Overall** | 0.00% | 0.00% | 0.00% | 100.2% | 99.9% | 99.9% | 100.1% |
| Class D | 0.00% | 0.00% | 0.00% | 100.9% | 100.9% | 100.0% | 100.0% |
| Class F | -0.08% | -0.28% | 0.11% | 96.4% | 83.5% | 99.8% | 100.1% |
| Class TGM | 0.02% | -0.07% | -0.04% | 97.8% | 80.1% | 99.2% | 100.1% |
|  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | |
|  | **Over ECM-12.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | 0.00% | 0.00% | 0.00% | 99.7% | 100.7% | 100.2% | 99.8% |
| Class C | 0.00% | 0.00% | 0.00% | 95.9% | 96.9% | 100.0% | 100.2% |
| Class E | 0.00% | 0.00% | 0.00% | 103.1% | 106.6% | 100.0% | 100.0% |
| **Overall** | 0.00% | 0.00% | 0.00% | 99.3% | 100.8% | 100.1% | 100.0% |
| Class D | 0.00% | 0.00% | 0.00% | 98.4% | 100.0% | 100.1% | 100.0% |
| Class F | 0.12% | -0.29% | -0.21% | 96.1% | 85.1% | 100.4% | 99.2% |
| Class TGM | -0.31% | -0.28% | -0.27% | 97.7% | 79.6% | 101.8% | 99.5% |
|  |  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | | |
|  | **Over ECM-12.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | 0.00% | 0.00% | 0.00% | 102.1% | 105.8% | 100.0% | 100.1% |
| Class C | 0.00% | 0.00% | 0.00% | 99.6% | 100.3% | 100.0% | 100.0% |
| Class E | 0.00% | 0.00% | 0.00% | 98.9% | 100.3% | 100.0% | 100.0% |
| **Overall** | 0.00% | 0.00% | 0.00% | 100.5% | 102.5% | 100.0% | 100.0% |
| Class D | 0.00% | 0.00% | 0.00% | 99.7% | 100.9% | 99.6% | 100.0% |
| Class F | 0.15% | -0.33% | 0.58% | 97.7% | 81.2% | 100.9% | 100.2% |
| Class TGM | -0.07% | -0.07% | -0.13% | 98.9% | 78.3% | 99.1% | 99.8% |

The below tables show ECM-12.0 performance comparing to VTM-11.0ecm12.0 anchor.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | |
|  | **Over VTM-11.0ecm12.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -11.49% | -23.82% | -31.29% | 974.2% | 461.4% | #DIV/0! | #DIV/0! |
| Class A2 | -17.87% | -30.14% | -33.45% | 971.5% | 477.6% | #DIV/0! | #DIV/0! |
| Class B | -12.19% | -28.03% | -26.89% | 886.8% | 469.7% | #DIV/0! | #DIV/0! |
| Class C | -12.19% | -18.16% | -19.27% | 904.0% | 433.4% | #DIV/0! | #DIV/0! |
| Class E | -16.00% | -26.76% | -24.38% | 1115.2% | 773.6% | #DIV/0! | #DIV/0! |
| **Overall** | -13.66% | -25.28% | -26.60% | 954.3% | 501.3% | #DIV/0! | #DIV/0! |
| Class D | -10.16% | -15.74% | -16.30% | 902.9% | 469.7% | #DIV/0! | #DIV/0! |
| Class F | -27.76% | -37.20% | -37.31% | 640.3% | 509.9% | #DIV/0! | #DIV/0! |
| Class TGM | -40.85% | -48.69% | -47.92% | 529.9% | 537.3% | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | |
|  | **Over VTM-11.0ecm12.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -23.81% | -29.45% | -38.33% | 1043.8% | 886.0% | #DIV/0! | #DIV/0! |
| Class A2 | -27.31% | -37.48% | -41.49% | 963.3% | 1047.8% | #DIV/0! | #DIV/0! |
| Class B | -22.31% | -36.57% | -34.80% | 847.1% | 890.3% | #DIV/0! | #DIV/0! |
| Class C | -23.79% | -28.57% | -29.15% | 863.0% | 904.4% | #DIV/0! | #DIV/0! |
| Class E |  |  |  |  |  |  |  |
| **Overall** | -24.01% | -33.20% | -35.34% | 910.7% | 922.8% | #DIV/0! | #DIV/0! |
| Class D | -24.62% | -29.48% | -30.46% | 849.7% | 1013.5% | #DIV/0! | #DIV/0! |
| Class F | -30.29% | -39.15% | -39.87% | 691.2% | 554.5% | #DIV/0! | #DIV/0! |
| Class TGM | -38.31% | -45.25% | -45.36% | 667.0% | 497.8% | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | |
|  | **Over VTM-11.0ecm12.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -18.68% | -41.71% | -39.50% | 884.5% | 750.4% | #DIV/0! | #DIV/0! |
| Class C | -20.33% | -32.55% | -33.40% | 775.5% | 848.1% | #DIV/0! | #DIV/0! |
| Class E | -17.84% | -33.16% | -31.46% | 724.5% | 526.3% | #DIV/0! | #DIV/0! |
| **Overall** | -19.02% | -36.52% | -35.46% | 805.3% | 715.3% | #DIV/0! | #DIV/0! |
| Class D | -22.12% | -35.14% | -34.68% | 749.7% | 881.7% | #DIV/0! | #DIV/0! |
| Class F | -26.41% | -40.45% | -40.19% | 657.3% | 577.2% | #DIV/0! | #DIV/0! |
| Class TGM | -36.79% | -46.01% | -46.24% | 632.4% | 505.1% | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | | |
|  | **Over VTM-11.0ecm12.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -17.28% | -41.55% | -39.49% | 806.6% | 773.3% | #DIV/0! | #DIV/0! |
| Class C | -19.30% | -31.62% | -32.63% | 666.4% | 878.9% | #DIV/0! | #DIV/0! |
| Class E | -16.76% | -32.07% | -31.19% | 666.9% | 550.9% | #DIV/0! | #DIV/0! |
| **Overall** | -17.82% | -35.87% | -35.13% | 721.7% | 741.4% | #DIV/0! | #DIV/0! |
| Class D | -21.91% | -33.52% | -35.19% | 628.6% | 822.2% | #DIV/0! | #DIV/0! |
| Class F | -25.16% | -40.46% | -40.92% | 663.1% | 525.5% | #DIV/0! | #DIV/0! |
| Class TGM | -33.97% | -44.65% | -44.81% | 670.7% | 480.5% | #DIV/0! | #DIV/0! |

1. **ECM memory consumption**

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

|  |  |  |  |
| --- | --- | --- | --- |
|  | AI | RA | LB |
| class A (A1& A2) | 7 | 14 |  |
| class B | 4 | 5 | 4 |
| class C | 2 | 2 | 2 |
| class D | 2 | 2 | 2 |
| class E | 2 |  | 3 |
| class F | 3 | 5 | 4 |
| class TGM | 3 | 7 | 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-AH0007](https://jvet-experts.org/doc_end_user/current_document.php?id=14043) JVET AHG report: ECM tool assessment (AHG7) [X. Li (chair), L.-F. Chen, Z. Deng, J. Gan, E. François, H.-J. Jhu, X. Li, H. Wang (vice chairs)]

**Group off tests**

***Test settings and crosschecking***

The same four groups were used in this meeting cycle.

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

Five group-off tests were performed and crosschecked on top of ECM-12 except Group1 off due to a bug with template matching off. The two anchors are ECM 12.0 and VTM-11ECM12.0. The cfg files used are also attached with this report.

The testers and crosscheckers are summarized in the table below.

|  |  |  |
| --- | --- | --- |
| Tests | Crosschecker | Tester |
| Group 1 off | Jonathan Gan (v-jonathan.gan@oppo.com) | Charles Salmon-Legagneur (charles.salmon-legagneur@interdigital.com) |
| Group 2 off | Jonathan Gan (v-jonathan.gan@oppo.com) | Xinwei Li  ([sid.lxw@alibaba-inc.com](mailto:sid.lxw@alibaba-inc.com)) |
| Group 3 off | Xiang Li (xlxiangli@google.com) | Zhipin Deng (zhipin.deng@bytedance.com) |
| Group 4 off | Xiang Li (xlxiangli@google.com) | Hong-Jheng Jhu (jhuhong-jheng@kwai.com) |
| Group 1-4 off | Lien-Fei Chen (lienfei.chen@global.tencent.com),  Xiang Li (xlxiangli@google.com) | Hongtao Wang  (hongtaow@qti.qualcomm.com) |

***Group 1 off***

Group 1 includes inter template matching tools. The attached offgroup1.cfg was used in addition to ECM CTC settings. Matched results were confirmed by the crosschecker.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | | | | |
|  | **Over ECM-12** | | | | | | **Over VTM-11ecm12** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 0.00% | 0.00% | 0.00% | 100.2% | 100.5% | 100% | -11.50% | -23.82% | -31.30% | 843.0% | 467.5% |
| Class A2 | 0.00% | 0.00% | 0.00% | 100.0% | 99.6% | 99% | -17.87% | -30.14% | -33.46% | 840.1% | 482.8% |
| Class B | 0.00% | 0.00% | 0.00% | 99.9% | 99.9% | 100% | -12.20% | -28.04% | -26.89% | 783.9% | 475.0% |
| Class C | -0.01% | -0.01% | -0.01% | 100.0% | 99.8% | 100% | -12.20% | -18.17% | -19.27% | 793.1% | 390.8% |
| Class E | -0.01% | -0.01% | -0.01% | 99.7% | 99.8% | 100% | -16.02% | -26.77% | -24.39% | 746.3% | 492.5% |
| **Overall** | -0.01% | -0.01% | -0.01% | 99.9% | 99.9% | 100% | -13.66% | -25.28% | -26.61% | 798.2% | 457.6% |
| Class D | -0.03% | -0.02% | -0.02% | 99.9% | 104.7% | 100% | -10.18% | -15.76% | -16.32% | 775.3% | 421.1% |
| Class F | -0.01% | -0.01% | -0.01% | 100.3% | 100.4% | 100% | -27.77% | -37.21% | -37.32% | 520.8% | 455.0% |
| Class TGM | 0.00% | 0.00% | 0.00% | 100.1% | 100.4% | 99% | -40.85% | -48.69% | -47.92% | 442.1% | 550.6% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-12** | | | | | | **Over VTM-11ecm12** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 4.00% | 3.66% | 3.85% | 89.4% | 80.8% | 100% | -20.76% | -26.95% | -35.84% | 946.5% | 761.8% |
| Class A2 | 4.58% | 4.73% | 4.80% | 87.3% | 75.3% | 100% | -23.99% | -34.55% | -38.67% | 857.3% | 837.0% |
| Class B | 3.87% | 3.73% | 3.84% | 83.5% | 74.7% | 100% | -19.28% | -34.17% | -32.26% | 708.4% | 690.3% |
| Class C | 4.23% | 4.06% | 4.27% | 79.9% | 67.7% | 100% | -20.53% | -25.66% | -26.09% | 720.5% | 590.7% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 4.13% | 4.00% | 4.15% | 84.4% | 74.1% | 100% | -20.85% | -30.53% | -32.61% | 783.4% | 701.9% |
| Class D | 3.51% | 3.34% | 3.59% | 79.1% | 65.9% | 100% | -21.92% | -27.07% | -27.92% | 717.8% | 654.0% |
| Class F | 3.30% | 3.22% | 3.24% | 90.1% | 81.0% | 100% | -27.90% | -37.14% | -37.88% | 648.6% | 440.0% |
| Class TGM | 4.07% | 3.98% | 3.93% | 89.9% | 83.4% | 100% | -35.79% | -43.01% | -43.17% | 603.1% | 437.0% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | | | | |
|  | **Over ECM-12** | | | | | | **Over VTM-11ecm12** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 4.62% | 4.99% | 4.99% | 76.9% | 67.6% | 100% | -14.90% | -38.90% | -36.64% | 612.3% | 470.0% |
| Class C | 4.76% | 4.71% | 5.09% | 72.9% | 58.6% | 100% | -16.52% | -29.36% | -29.94% | 529.0% | 413.1% |
| Class E | 5.08% | 5.63% | 4.73% | 81.1% | 76.4% | 99% | -13.67% | -29.54% | -28.33% | 535.1% | 335.3% |
| **Overall (Ref)** | 4.78% | 5.06% | 4.96% | 76.6% | 66.5% | 100% | -15.13% | -33.38% | -32.33% | 563.9% | 413.7% |
| Class D | 3.96% | 4.35% | 3.94% | 72.9% | 58.2% | 101% | -19.01% | -32.28% | -32.09% | 531.6% | 476.2% |
| Class F | 4.38% | 3.25% | 2.99% | 85.6% | 73.8% | 99% | -23.10% | -38.38% | -38.29% | 528.3% | 332.6% |
| Class TGM | 5.85% | 5.70% | 5.78% | 87.1% | 77.0% | 100% | -32.99% | -42.69% | -42.93% | 521.6% | 347.4% |

***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 attached offgroup2.cfg was used in addition to ECM CTC settings. Minor different results were observed by the crosschecker. An ECM issue <https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/issues/66> was created. So far, no fix has been received.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | | | | |
|  | **Over ECM-12** | | | | | | **Over VTM-11ecm12** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 0.36% | 0.53% | 0.68% | 94.0% | 96.4% | 101% | -11.17% | -23.40% | -30.79% | 844.7% | 445.0% |
| Class A2 | 0.44% | 0.75% | 0.70% | 92.8% | 96.6% | 100% | -17.50% | -29.62% | -32.98% | 830.4% | 465.3% |
| Class B | 0.39% | 0.67% | 0.76% | 91.8% | 95.2% | 101% | -11.85% | -27.53% | -26.31% | 772.3% | 450.9% |
| Class C | 0.33% | 0.45% | 0.59% | 90.3% | 93.1% | 100% | -11.89% | -17.80% | -18.79% | 772.0% | 364.3% |
| Class E | 0.65% | 0.92% | 0.81% | 92.2% | 96.3% | 100% | -15.45% | -26.09% | -23.78% | 738.5% | 469.9% |
| **Overall** | 0.42% | 0.65% | 0.71% | 92.1% | 95.4% | 101% | -13.29% | -24.79% | -26.08% | 787.5% | 434.3% |
| Class D | 0.27% | 0.49% | 0.50% | 90.3% | 90.2% | 100% | -9.91% | -15.30% | -15.86% | 749.1% | 360.4% |
| Class F | 1.46% | 1.69% | 1.62% | 91.4% | 97.3% | 101% | -26.76% | -36.25% | -36.35% | 517.2% | 439.1% |
| Class TGM | 0.64% | 0.66% | 0.52% | 91.5% | 99.4% | 100% | -40.47% | -48.35% | -47.66% | 440.6% | 549.8% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-12** | | | | | | **Over VTM-11ecm12** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 3.17% | 1.41% | 2.24% | 85.0% | 97.1% | 100% | -21.38% | -28.32% | -36.96% | 917.9% | 939.4% |
| Class A2 | 2.14% | 1.68% | 2.23% | 84.3% | 100.4% | 99% | -25.73% | -36.40% | -40.14% | 841.4% | 1141.2% |
| Class B | 2.04% | 1.29% | 1.39% | 84.4% | 96.6% | 99% | -20.70% | -35.71% | -33.79% | 684.9% | 878.3% |
| Class C | 1.77% | 1.33% | 1.41% | 81.9% | 94.3% | 99% | -22.41% | -27.63% | -28.13% | 710.3% | 818.0% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 2.21% | 1.40% | 1.74% | 83.8% | 96.8% | 99% | -22.30% | -32.21% | -34.18% | 764.1% | 920.5% |
| Class D | 1.07% | 0.59% | 0.71% | 81.1% | 95.8% | 99% | -23.77% | -29.00% | -29.88% | 707.0% | 956.2% |
| Class F | 2.85% | 2.68% | 2.43% | 85.7% | 95.2% | 99% | -28.28% | -37.49% | -38.36% | 594.3% | 535.9% |
| Class TGM | 1.44% | 1.88% | 1.89% | 88.9% | 97.2% | 99% | -37.40% | -44.28% | -44.39% | 608.6% | 511.3% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | | | | |
|  | **Over ECM-12** | | | | | | **Over VTM-11ecm12** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 2.51% | 3.52% | 4.14% | 75.3% | 94.0% | 100% | -16.61% | -39.72% | -37.07% | 593.5% | 634.9% |
| Class C | 2.33% | 3.21% | 3.90% | 74.5% | 89.3% | 101% | -18.47% | -30.42% | -30.72% | 532.8% | 604.1% |
| Class E | 1.93% | 2.73% | 3.07% | 79.2% | 95.8% | 99% | -16.23% | -31.33% | -29.41% | 524.9% | 403.7% |
| **Overall (Ref)** | 2.31% | 3.22% | 3.79% | 76.0% | 92.8% | 100% | -17.14% | -34.52% | -33.04% | 555.2% | 557.6% |
| Class D | 1.41% | 3.49% | 4.11% | 72.4% | 91.2% | 100% | -20.93% | -32.83% | -32.02% | 530.7% | 722.4% |
| Class F | 3.38% | 2.94% | 3.91% | 82.3% | 94.6% | 99% | -23.92% | -38.72% | -37.80% | 520.6% | 418.9% |
| Class TGM | 1.28% | 3.50% | 4.19% | 88.9% | 96.5% | 103% | -36.01% | -44.42% | -44.42% | 519.1% | 416.4% |

***Group 3 off***

Group 3 includes intra and IBC template matching (with search) related tools. The attached offgroup3.cfg was used in addition to ECM CTC settings. Matched results were confirmed by the crosschecker.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | | | | |
|  | **Over ECM-12** | | | | | | **Over VTM-11ecm12** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 1.16% | 3.88% | 5.61% | 76.1% | 83.6% | 100% | -10.46% | -21.06% | -27.63% | 652.5% | 282.6% |
| Class A2 | 2.26% | 5.63% | 5.72% | 75.5% | 74.4% | 97% | -15.97% | -26.46% | -29.90% | 658.4% | 261.2% |
| Class B | 2.16% | 4.60% | 4.93% | 73.9% | 75.6% | 100% | -10.32% | -24.96% | -23.48% | 683.6% | 352.4% |
| Class C | 1.80% | 2.28% | 2.61% | 73.9% | 76.5% | 101% | -10.63% | -16.35% | -17.23% | 689.7% | 324.1% |
| Class E | 3.12% | 4.19% | 3.95% | 73.8% | 77.6% | 98% | -13.38% | -23.79% | -21.50% | 649.7% | 375.7% |
| **Overall** | 2.09% | 4.07% | 4.50% | 74.5% | 77.2% | 99% | -11.86% | -22.45% | -23.52% | 669.7% | 320.6% |
| Class D | 1.38% | 2.14% | 2.29% | 75.2% | 74.3% | 100% | -8.91% | -13.94% | -14.36% | 679.2% | 329.7% |
| Class F | 5.40% | 6.57% | 6.66% | 76.4% | 69.6% | 99% | -24.01% | -33.36% | -33.36% | 473.7% | 329.4% |
| Class TGM | 10.33% | 12.35% | 12.54% | 80.1% | 59.1% | 97% | -34.89% | -42.56% | -41.59% | 424.2% | 317.7% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-12** | | | | | | **Over VTM-11ecm12** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 1.00% | 2.43% | 5.38% | 93.5% | 99.2% | 100% | -23.04% | -27.76% | -35.53% | 788.1% | 628.4% |
| Class A2 | 1.37% | 3.32% | 3.38% | 94.0% | 98.2% | 100% | -26.31% | -35.48% | -39.55% | 745.7% | 770.5% |
| Class B | 1.15% | 4.03% | 3.96% | 93.6% | 97.2% | 100% | -21.42% | -34.06% | -32.21% | 799.7% | 850.7% |
| Class C | 0.83% | 1.42% | 1.55% | 93.9% | 98.3% | 100% | -23.15% | -27.53% | -28.00% | 855.0% | 906.9% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 1.08% | 2.87% | 3.48% | 93.7% | 98.1% | 100% | -23.18% | -31.34% | -33.22% | 800.4% | 798.5% |
| Class D | 0.77% | 1.30% | 1.68% | 93.9% | 98.4% | 100% | -24.05% | -28.55% | -29.32% | 821.8% | 981.0% |
| Class F | 3.45% | 4.43% | 4.40% | 91.2% | 96.6% | 100% | -28.06% | -36.69% | -37.38% | 655.1% | 514.6% |
| Class TGM | 6.79% | 8.97% | 9.36% | 93.5% | 94.0% | 99% | -34.13% | -40.43% | -40.36% | 639.3% | 469.2% |

***Group 4 off***

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

The attached offgroup4.cfg was used in addition to ECM CTC settings. Matched results were confirmed by the crosschecker.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | | | | |
|  | **Over ECM-12** | | | | | | **Over VTM-11ecm12** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 0.85% | 3.78% | 3.91% | 85.8% | 93.1% | 99% | -10.74% | -21.14% | -28.60% | 735.5% | 314.8% |
| Class A2 | 1.01% | 4.01% | 4.23% | 82.1% | 97.2% | 99% | -17.06% | -27.51% | -30.82% | 715.3% | 341.4% |
| Class B | 0.67% | 3.97% | 3.82% | 86.1% | 97.5% | 100% | -11.61% | -25.44% | -24.29% | 796.4% | 454.4% |
| Class C | 0.83% | 2.37% | 2.47% | 84.1% | 97.4% | 100% | -11.47% | -16.36% | -17.42% | 785.1% | 412.9% |
| Class E | 1.06% | 3.88% | 3.07% | 86.0% | 100.1% | 98% | -15.12% | -24.17% | -22.27% | 757.1% | 484.3% |
| **Overall** | 0.86% | 3.58% | 3.48% | 84.9% | 97.1% | 99% | -12.93% | -22.84% | -24.23% | 763.1% | 403.2% |
| Class D | 0.72% | 2.04% | 1.97% | 84.2% | 95.6% | 100% | -9.52% | -14.05% | -14.66% | 760.7% | 423.9% |
| Class F | 1.05% | 3.67% | 3.74% | 90.6% | 99.3% | 99% | -27.01% | -35.16% | -35.17% | 561.7% | 469.7% |
| Class TGM | 2.22% | 3.99% | 3.71% | 89.4% | 97.4% | 99% | -39.60% | -46.80% | -46.14% | 473.4% | 523.7% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-12** | | | | | | **Over VTM-11ecm12** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 0.49% | 1.27% | 1.63% | 92.2% | 100.8% | 100% | -23.43% | -28.61% | -37.42% | 776.7% | 638.5% |
| Class A2 | 0.50% | 2.21% | 2.26% | 93.7% | 99.4% | 100% | -26.94% | -36.15% | -40.20% | 743.5% | 780.0% |
| Class B | 0.34% | 2.79% | 2.31% | 93.1% | 99.4% | 100% | -22.05% | -34.93% | -33.39% | 795.5% | 869.8% |
| Class C | 0.38% | 1.51% | 1.60% | 94.3% | 100.3% | 100% | -23.51% | -27.49% | -28.02% | 858.2% | 925.4% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 0.41% | 2.03% | 1.97% | 93.4% | 99.9% | 100% | -23.69% | -31.93% | -34.12% | 797.1% | 813.4% |
| Class D | 0.31% | 1.59% | 2.07% | 94.5% | 100.4% | 100% | -24.39% | -28.39% | -29.03% | 826.9% | 1001.4% |
| Class F | 0.81% | 2.64% | 2.81% | 95.7% | 100.5% | 100% | -29.78% | -37.69% | -38.28% | 687.5% | 535.1% |
| Class TGM | 0.82% | 1.86% | 1.60% | 95.0% | 99.2% | 100% | -37.83% | -44.32% | -44.58% | 649.8% | 495.3% |

***Group 1-4 off***

In this test, all the tools in the group 1-4 are switched off. The attached offgroup1-4.cfg was used in addition to ECM CTC settings. Minor different results were observed by the crosscheckers. An ECM issue <https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/issues/65> was created. So far, no fix has been received.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | | | | |
|  | **Over ECM-12** | | | | | | **Over VTM-11ecm12** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 3.67% | 10.85% | 15.02% | 58.2% | 69.9% | 98% | -8.23% | -16.05% | -21.38% | 499.2% | 236.2% |
| Class A2 | 6.15% | 13.67% | 14.23% | 55.1% | 63.6% | 99% | -12.84% | -21.05% | -24.43% | 480.0% | 223.4% |
| Class B | 4.45% | 12.76% | 11.89% | 54.7% | 64.1% | 99% | -8.32% | -19.53% | -18.67% | 506.2% | 298.9% |
| Class C | 3.85% | 6.35% | 6.75% | 52.6% | 61.8% | 100% | -8.86% | -13.20% | -14.01% | 491.2% | 261.8% |
| Class E | 6.64% | 12.60% | 10.26% | 55.4% | 65.7% | 98% | -10.43% | -17.93% | -16.89% | 487.3% | 317.9% |
| **Overall** | 4.83% | 11.14% | 11.39% | 55.0% | 64.7% | 99% | -9.53% | -17.53% | -18.75% | 494.1% | 268.6% |
| Class D | 3.12% | 5.31% | 5.63% | 53.5% | 57.0% | 100% | -7.36% | -11.30% | -11.59% | 483.6% | 252.8% |
| Class F | 12.34% | 16.95% | 17.41% | 61.8% | 61.7% | 100% | -19.28% | -27.52% | -27.21% | 382.8% | 291.8% |
| Class TGM | 16.87% | 20.86% | 21.44% | 63.8% | 53.9% | 98% | -31.16% | -38.35% | -37.15% | 337.8% | 289.5% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-12** | | | | | | **Over VTM-11ecm12** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 10.52% | 11.36% | 18.81% | 61.2% | 76.7% | 99% | -15.78% | -21.52% | -27.63% | 515.6% | 486.2% |
| Class A2 | 10.36% | 14.75% | 16.06% | 60.6% | 72.1% | 99% | -19.76% | -28.46% | -32.18% | 481.1% | 566.0% |
| Class B | 8.71% | 16.18% | 15.36% | 59.1% | 72.4% | 99% | -15.49% | -26.47% | -24.88% | 505.2% | 633.5% |
| Class C | 8.16% | 9.65% | 10.70% | 55.4% | 65.0% | 99% | -17.49% | -21.61% | -21.39% | 504.6% | 599.8% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 9.26% | 13.19% | 14.95% | 58.8% | 71.1% | 99% | -16.93% | -24.58% | -25.96% | 502.2% | 578.9% |
| Class D | 6.26% | 8.45% | 9.31% | 55.1% | 63.7% | 99% | -19.77% | -23.40% | -23.82% | 482.2% | 634.9% |
| Class F | 13.93% | 16.70% | 17.60% | 65.7% | 75.6% | 100% | -20.86% | -29.47% | -29.75% | 471.7% | 402.8% |
| Class TGM | 15.69% | 19.37% | 19.77% | 69.4% | 75.5% | 100% | -28.61% | -34.78% | -34.71% | 475.0% | 376.9% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | | | | |
|  | **Over ECM-12** | | | | | | **Over VTM-11ecm12** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 8.35% | 13.19% | 13.35% | 48.9% | 62.1% | 100% | -11.84% | -34.43% | -31.93% | 383.4% | 474.1% |
| Class C | 8.17% | 10.52% | 11.65% | 45.8% | 53.0% | 100% | -13.79% | -25.47% | -25.48% | 356.1% | 419.1% |
| Class E | 8.19% | 16.41% | 14.42% | 56.8% | 74.4% | 100% | -11.08% | -22.56% | -21.67% | 406.3% | 380.5% |
| **Overall (Ref)** | 8.25% | 13.10% | 13.05% | 49.7% | 61.6% | 100% | -12.30% | -28.48% | -27.22% | 379.5% | 430.7% |
| Class D | 6.24% | 10.25% | 11.12% | 45.2% | 54.2% | 100% | -17.15% | -28.52% | -27.50% | 348.9% | 460.4% |
| Class F | 12.88% | 16.10% | 16.21% | 60.4% | 68.3% | 100% | -17.04% | -31.03% | -30.74% | 387.6% | 338.8% |
| Class TGM | 14.94% | 19.39% | 21.18% | 69.2% | 64.3% | 100% | -27.31% | -35.92% | -35.47% | 424.7% | 301.9% |

***Summary***

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

It was commented that also in groups 1-4 test RA, still run time is significantly increased relative to VTM. Opinions were raised this might be due to loop filter elements, and sign prediction. However, run time is known to be not fully suitable to assess complexity.

[JVET-AH0008](https://jvet-experts.org/doc_end_user/current_document.php?id=14044) JVET AHG report: Optimization of encoders and receiving systems for machine analysis of coded video content (AHG8) [C. Hollmann, S. Liu, S. Wang, M. Zhou (AHG chairs)]

**Activities**

The AHG used the main JVET reflector, jvet@lists.rwth-aachen.de, for email discussion. There was no email exchanges in the main reflector between the last and this meeting. Following the decisions in the last meeting, common test conditions remain unchanged, and an updated version of the technical report was output in JVET-AG2030. There are total 11 input contriubtions related to AHG 8 mandates submitted to this meeting. They are listed in Section 3.

***Common Test Conditions***

Following the decision from the last (AG) meeting, the common test conditions (CTC) for optimization of encoders and receiving systems for machine analysis of coded video content remain unchanged from the output of AF meeting, i.e., JVET-AF2031. This document includes detailed descriptions of test datasets, anchor software and configurations, anchor generation processes, machine task networks used, test and training conditions, evaluation methodologies and metrics. It is available at <https://vcgit.hhi.fraunhofer.de/jvet-ahg-ofm/ofm-ctc>.

***Technical Report***

The fourth draft of the technical report (TR) was generated, i.e., JVET-AG2030 “Optimization of encoders and receiving systems for machine analysis of coded video content (draft 4)” and was uploaded to the JVET document system on March 8, 2024. The draft 4 further included clauses to describe the use of enhancement post-filtering, object mask information SEI and encoder optimization information SEI, together with other editorial improvements. In addition, the editors submitted an input contribution JVET-AH0143 to suggest possible updates to the TR.

Following the request for subdivision at the January JVET meeting, the TR is officially registered as ISO/IEC TR 23888-3. More information to come at <https://www.iso.org/standard/89045.html>.

***Git Management***

AHG 8 related software and documents can be found at <https://vcgit.hhi.fraunhofer.de/jvet-ahg-ofm>. This repository contains two projects, one (<https://vcgit.hhi.fraunhofer.de/jvet-ahg-ofm/ofm-ctc>) containing instrucitons and information for conducting experiements and evaluation, such as evaluation scripts, machine task networks, CTC and reporting template with anchor results, while the other (<https://vcgit.hhi.fraunhofer.de/jvet-ahg-ofm/vtm-ofm>) containing implementation examples. Four software implementation examples are hosted in separate branches:

* JVET-AB0275: a region of interest-based method that uses adaptive QP to reduce the quality in background areas
* JVET-AC0086: a method that uses a pre-analysis to perform content adaptive machine vision oriented preprocessing
* JVET-AE0143: a spatial resampling algorithm and an exemplar software implementation
* JVET-AG0212: a post-processing algorithm for machine consumption

**Input contributions**

There are 11 input contriubtions related to AHG 8 mandates. They are listed below.

|  |  |  |
| --- | --- | --- |
| **Report** | | |
| JVET-AH0008 | JVET AHG report: Optimization of encoders and receiving systems for machine analysis of coded video content (AHG8) | C. Hollmann, S. Liu, S. Wang, M. Zhou (AHG chairs) |
| **Proposals** | | |
| [JVET-AH0125](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=14007) | AHG8/AHG9: Indication of NNPFs and processing chains for machine consumption | [M. M. Hannuksela](mailto:miska.hannuksela@nokia.com), F. Cricri, H. Zhang (Nokia) |
| [JVET-AH0130](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=14012) | AHG8: RPR for machine consumption | [C. Hollmann](mailto:christopher.hollmann@ericsson.com), [J. Ström](mailto:jacob.strom@ericsson.com), [P. Wennersten](mailto:per.wennersten@ericsson.com), [K. Andersson (Ericsson)](mailto:kenneth.r.andersson@ericsson.com) |
| [JVET-AH0143](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=14025) | AHG8: Updates for technical report | [C. Hollmann (Ericsson)](mailto:christopher.hollmann@ericsson.com), [S. Liu (Tencent)](mailto:shanl@global.tencent.com), [J. Chen (Alibaba)](mailto:jiechen.cj@alibaba-inc.com) |
| [JVET-AH0157](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=14056) | AHG8: On combined pre-processing and post-processing for machine vision | [S. Wang](mailto:shurun.wsr@alibaba-inc.com), [B. Li](mailto:libinzhe.lbz@alibaba-inc.com), [J. Chen](mailto:jiechen.cj@alibaba-inc.com), [Y. Ye (Alibaba)](mailto:yan.ye@alibaba-inc.com) |
| [JVET-AH0187](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=14086) | AHG8: Semantic segmentation task for VCM with PandaSet | [H. Zhang](mailto:honglei.1.zhang@nokia.com), N. Le, J. Ahonen, F. Cricri, F. Pakdaman, A. Aminlou, M. M. Hannuksela (Nokia), K. Pham (Tampere University) |
| [JVET-AH0247](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=14146) | AHG8: Multi-layer VVC for hybrid machine-human consumption | J. Laitinen, T. Partanen, A. Mercat, J. Vanne (Tampere University), [A. Aminlou](mailto:alireza.aminlou@nokia.com), M. M. Hannuksela, F. Cricri, H. Zhang (Nokia), |
| [JVET-AH0248](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=14147) | AHG8: Reduced residual encoding in VVC for machine consumption | [A. Aminlou](mailto:alireza.aminlou@nokia.com), A. Hallapuro, H. Zhang (Nokia), |
| [JVET-AH0249](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=14148) | AHG8: An adaptive spatial resampling method for machine vision | [S. Wang](mailto:shurun.wsr@alibaba-inc.com), [B. Li](mailto:libinzhe.lbz@alibaba-inc.com), [J. Chen](mailto:jiechen.cj@alibaba-inc.com), [Y. Ye (Alibaba)](mailto:yan.ye@alibaba-inc.com) |
| **Crosschecks** | | |
| JVET-AH0253 | Crosscheck of JVET-AH0130 (AHG8: RPR for machine consumption) | D. Ding (Tencent) |
| JVET-AH0254 | Crosscheck of JVET-AH0187 (AHG8: Semantic segmentation task for VCM with PandaSet) | D. Ding (Tencent) |

**Recommendations**

The AHG recommends to:

* Review all input contributions.
* Review proposed new machine task and dataset.
* Continue investigating non-normative technologies and their suitability for machine analysis applications.
* Continue improving draft technical report on optimization of encoders and receiving systems for machine analysis of coded video content.
* Continue refining test conditions, evalution and reporting procedures.

Revisit: In the context of reviewing input contributions, decide if the TR is mature enough for CDTR, or if we would expect more improvements towards the next meeting.

[JVET-AH0009](https://jvet-experts.org/doc_end_user/current_document.php?id=14045) JVET AHG report: SEI message studies (AHG9) [S. McCarthy, Y.-K. Wang (co-chairs), T. Chujoh, S. Deshpande, C. Fogg, M. M. Hannuksela, Hendry, P. de Lagrange, G. J. Sullivan, A. Tourapis, S. Wenger (vice-chairs)]

**Related contributions**

A total of 43 contributions are identified relating to the mandates of AHG9. Some contributions also relate to the work of AHG8, AHG16, and CICP.

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

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

JVET-AH0175 [AHG9/CICP] On constraints and reference of MatrixCoefficients (Bytedance)

*JVET-AH0175 relates to CICP*

***Discuss JVET-AG2027, JVET-AG2032, and JVET-AG2034***

**JVET-AG2027 SPO and PON SEI messages in VVC (draft 7)**

[JVET-AH0121](https://jvet-experts.org/doc_end_user/current_document.php?id=14003) AHG9: On the SEI processing order SEI message [M. M. Hannuksela, F. Cricri, J. Boyce (Nokia)]

[JVET-AH0123](https://jvet-experts.org/doc_end_user/current_document.php?id=14005) AHG9: On applying the SEI processing order to generated pictures [M. M. Hannuksela, F. Cricri (Nokia)]

[JVET-AH0124](https://jvet-experts.org/doc_end_user/current_document.php?id=14006) AHG9: Latency signalling in the SEI processing order SEI message [M. M. Hannuksela, F. Cricri (Nokia)]

[JVET-AH0132](https://jvet-experts.org/doc_end_user/current_document.php?id=14014) AHG9: On use of PON SEI messages [L. Chen, O. Chubach, Y.-W. Huang, S. Lei (MediaTek)]

[JVET-AH0134](https://jvet-experts.org/doc_end_user/current_document.php?id=14016) [AHG9] Improvement on the SEI processing order SEI message [Gao, P. Wu, Y.-X. Bai, S.-W. Xie, M.-H. Jia, W.-H. Niu, C. Huang(ZTE)]

[JVET-AH0158](https://jvet-experts.org/doc_end_user/current_document.php?id=14057) AHG9: On association between SEI Processing Order and Processing Order Nesting SEI messages [Hendry, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-AH0159](https://jvet-experts.org/doc_end_user/current_document.php?id=14058) AHG9: On aspects related to SEI processing order and processing order nesting SEI messages [Hendry, J. Nam, S. Kim, J. Lim (LGE)]

**JVET-AG2034 SEI messages for VSEI (Draft 1)**

**Encoder optimization information SEI message**

*Contributions related to the encoder optimization information SEI message are also included in the section on JVET-AG2032 TuC for VSEI*

[JVET-AH0108](https://jvet-experts.org/doc_end_user/current_document.php?id=13990) AHG9: Editorial improvements of the encoder optimization information SEI messages [C. Kim, Hendry, J. Lim, S. Kim (LGE)]

[JVET-AH0111](https://jvet-experts.org/doc_end_user/current_document.php?id=13993) AHG9: Proposed update on the encoder optimization information SEI message [C. Kim, Hendry, J. Lim, S. Kim (LGE)]

[JVET-AH0115](https://jvet-experts.org/doc_end_user/current_document.php?id=13997) AHG9: Bit-depth truncation as optimization type in EOI SEI message [C. Kim, Hendry, J. Lim, S. Kim (LGE), D. Ding, R. Chernyak, G. Teniou, S. Wenger, S. Liu (Tencent)]

**Object mask information SEI message**

[JVET-AH0160](https://jvet-experts.org/doc_end_user/current_document.php?id=14059) AHG9: On persistence cancellation of an object mask information SEI message [Hendry, J. Nam, S. Kim, J. Lim (LGE)]

**Picture modality information**

[JVET-AH0049](https://jvet-experts.org/doc_end_user/current_document.php?id=13931) AHG9: Modality Information SEI for AVC and HEVC [J. Gao, H.-B. Teo, C.-S. Lim, K. Abe, V. Drugeon (Panasonic)]

**JVET-AC2032 TuC for VSEI (version 3)**

**NNPF and PPF SEI messages**

[JVET-AH0047](https://jvet-experts.org/doc_end_user/current_document.php?id=13929) AHG9: On grouping of post-processing filters [Y.-K. Wang, W. Jia, J. Xu, L. Zhang (Bytedance)]

[JVET-AH0125](https://jvet-experts.org/doc_end_user/current_document.php?id=14007) AHG8/AHG9: Indication of NNPFs and processing chains for machine consumption [M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

[JVET-AH0126](https://jvet-experts.org/doc_end_user/current_document.php?id=14008) [AHG9]: Neural network post-filter for recovering images from energy-aware images [C-H Demarty, F. Aumont, L. Blonde, E. Reinhard, O. Le Meur (InterDigital)]

[JVET-AH0164](https://jvet-experts.org/doc_end_user/current_document.php?id=14063) AHG9: Quality metric SEI [J. Boyce, M. M. Hannuksela, F. Cricri (Nokia)]

[JVET-AH0174](https://jvet-experts.org/doc_end_user/current_document.php?id=14073) [AHG9] Spatial extrapolation as a new NNPF purpose and some bug fixes [J. Xu, Y.-K. Wang (Bytedance)]

**Encoder optimization information SEI message**

*Contributions related to the encoder optimization information SEI message are also included in the section on JVET-AG2034 SEI messages for VSEI version 4 (Draft 1)*

[JVET-AH0108](https://jvet-experts.org/doc_end_user/current_document.php?id=13990) AHG9: Editorial improvements of the encoder optimization information SEI messages [C. Kim, Hendry, J. Lim, S. Kim (LGE)]

[JVET-AH0111](https://jvet-experts.org/doc_end_user/current_document.php?id=13993) AHG9: Proposed update on the encoder optimization information SEI message [C. Kim, Hendry, J. Lim, S. Kim (LGE)]

[JVET-AH0115](https://jvet-experts.org/doc_end_user/current_document.php?id=13997) AHG9: Bit-depth truncation as optimization type in EOI SEI message [C. Kim, Hendry, J. Lim, S. Kim (LGE), D. Ding, R. Chernyak, G. Teniou, S. Wenger, S. Liu (Tencent)]

**Image format metadata SEI messages**

[JVET-AH0173](https://jvet-experts.org/doc_end_user/current_document.php?id=14072) AHG9: SEI message for International Color Consortium (ICC) profiles [Arianne Hinds, Stephan Wenger, Gilles Teniou]

**Multiplane image information SEI message**

[JVET-AH0150](https://jvet-experts.org/doc_end_user/current_document.php?id=14032) AHG9: On the proposed MPII SEI message for non-parallel MPI layers [Y. Li (SJTU), Y.-K. Wang (Bytedance), Y. Xu, K. Yang (SJTU)]

[JVET-AH0197](https://jvet-experts.org/doc_end_user/current_document.php?id=14096) AHG9: Showcase on multiplane image SEI message [A. Harinkhede, V. G. R., A. Sarate, J. R. Arumugam, J. Shingala (Ittiam), W. Husak, D. Y. Lee, S. McCarthy, S. Oh, G.-M. Su, G. J. Sullivan (Dolby)]

*JVET-AH0197 also relates to the mandate to collect software and showcase information and to the mandate to coordinate with WG 4 and AG 5 to evaluate MPI visual quality*

**AI and copyright SEI messages**

[JVET-AH0052](https://jvet-experts.org/doc_end_user/current_document.php?id=13934) AHG9: Text Description Information SEI Message [S Deshpande (Sharp)]

*JVET-AH0052 also relates to the mandate to identify potential needs for additional SEI messages*

[JVET-AH0070](https://jvet-experts.org/doc_end_user/current_document.php?id=13952) AHG9: On an extension of AI text data SEI message [T. Chujoh, Z. Fan, T. Ikai (Sharp), L. Jin, H. Watanabe (Waseda Unv.)]

[JVET-AH0112](https://jvet-experts.org/doc_end_user/current_document.php?id=13994) AHG9: Signalling video usage for AI-driven processes in SEI message [C. Kim, Hendry, J. Lim, S. Kim (LGE)]

*JVET-AH0112 also relates to the mandate to identify potential needs for additional SEI*

[JVET-AH0177](https://jvet-experts.org/doc_end_user/current_document.php?id=14076) AGH9: Move the AI Labelling SEI from TuC to VSEI WD for consent/ballot [G. Teniou, S. Wenger, A. Hinds]

**Generative face video SEI message**

[JVET-AH0053](https://jvet-experts.org/doc_end_user/current_document.php?id=13935) AHG9: Comments on Generative Face Video SEI [S. Deshpande (Sharp)]

[JVET-AH0054](https://jvet-experts.org/doc_end_user/current_document.php?id=13936) AHG16: On the generative face video SEI message [H.-B. Teo, J.-Y. Thong, K. Abe, C.-S. Lim, K. Jayashree (Panasonic)]

[JVET-AH0118](https://jvet-experts.org/doc_end_user/current_document.php?id=14000) AHG9/AHG16: Showcase for picture fusion for generative face video SEI message [S. Gehlot, G. Su, P. Yin, S. McCarthy, G. J. Sullivan (Dolby)]

*JVET-AH0118 also relates to the mandate to collect software and showcase information*

[JVET-AH0127](https://jvet-experts.org/doc_end_user/current_document.php?id=14009) AHG9/AHG16: The SEI message design for scalable representation and layered reconstruction for generative face video compression [J. Chen, B. Chen, Y. Ye, R.-L. Liao (Alibaba), S. Yin, S. Wang (CityU)]

[JVET-AH0137](https://jvet-experts.org/doc_end_user/current_document.php?id=14019) AHG9: Indicating timing information for generative face video (GFV) output pictures [L. Chen, O. Chubach, Y.-W. Huang, S. Lei (MediaTek)]

[JVET-AH0138](https://jvet-experts.org/doc_end_user/current_document.php?id=14020) AHG9/AHG16: Pupil position SEI message for Generative Face Video [A. Trioux, Y. Yao, F. Ma, F. Yang(Xidian Univ.), F. Xing, Z. Wang(Hisense)]

[JVET-AH0148](https://jvet-experts.org/doc_end_user/current_document.php?id=14030) AHG9/AHG16: On key point coordinates calculation for the generative face video SEI message [K. Yang (SJTU), Y.-K. Wang (Bytedance), Y. Xu, Y. Li (SJTU)]

[JVET-AH0239](https://jvet-experts.org/doc_end_user/current_document.php?id=14138) AHG9/AHG16: Software Implementation of Generative Face Video SEI Message [B. Chen, J. Chen, R. Zou, Y. Ye, R.-L. Liao (Alibaba), S. Wang (CityU)]

*JVET-AH0239 also relates to the mandate to collect software and showcase information*

**Film grain regions SEI message**

[JVET-AH0166](https://jvet-experts.org/doc_end_user/current_document.php?id=14065) AHG9: Improvements to the film grain regions characteristics SEI message [Shaowei Xie, Ping Wu, Ying Gao, Yaxian Bai, Menghu Jia, Weihong Niu, Cheng Huang (ZTE)]

[JVET-AH0212](https://jvet-experts.org/doc_end_user/current_document.php?id=14111) AHG9/AHG13: Updates on the implementation of film grain regions characteristics SEI message [G. Teniou, P. De Lagrange, E. François]

**Large SEI and versatile RBSP SEI messages**

[JVET-AH0167](https://jvet-experts.org/doc_end_user/current_document.php?id=14066) AHG9: On payload size signalling for SEI messages [M. Pettersson, M. Damghanian, R. Sjöberg (Ericsson)]

***Collect software and showcase information for SEI messages***

[JVET-AH0118](https://jvet-experts.org/doc_end_user/current_document.php?id=14000) AHG9/AHG16: Showcase for picture fusion for generative face video SEI message [S. Gehlot, G. Su, P. Yin, S. McCarthy, G. J. Sullivan (Dolby)]

*JVET-AH0118 also relates to the mandate to discuss JVET-AG2027, JVET-AG2032, and JVET-AG2034*

[JVET-AH0197](https://jvet-experts.org/doc_end_user/current_document.php?id=14096) AHG9: Showcase on multiplane image SEI message [A. Harinkhede, V. G. R., A. Sarate, J. R. Arumugam, J. Shingala (Ittiam), W. Husak, D. Y. Lee, S. McCarthy, S. Oh, G.-M. Su, G. J. Sullivan (Dolby)]

*JVET-AH0197 also relates to the mandate to discuss JVET-AG2027, JVET-AG2032, and JVET-AG2034 and to the mandate to coordinate with WG 4 and AG 5 to evaluate MPI visual quality*

[JVET-AH0239](https://jvet-experts.org/doc_end_user/current_document.php?id=14138) AHG9/AHG16: Software Implementation of Generative Face Video SEI Message [B. Chen, J. Chen, R. Zou, Y. Ye, R.-L. Liao (Alibaba), S. Wang (CityU)]

*JVET-AH0239 also relates to the mandate to discuss JVET-AG2027, JVET-AG2032, and JVET-AG2034*

***Coordinate with WG 4 and AG 5 to evaluate MPI visual quality***

[JVET-AH0045](https://jvet-experts.org/doc_end_user/current_document.php?id=13927) AHG9: Report on the joint AG 5, WG 4, and WG 5 (AHG9) conference call on preparations to evaluate video quality in the context of MPI [S. McCarthy, J.-R. Ohm, M. Wien, B. Kroon]

[JVET-AH0197](https://jvet-experts.org/doc_end_user/current_document.php?id=14096) AHG9: Showcase on multiplane image SEI message [A. Harinkhede, V. G. R., A. Sarate, J. R. Arumugam, J. Shingala (Ittiam), W. Husak, D. Y. Lee, S. McCarthy, S. Oh, G.-M. Su, G. J. Sullivan (Dolby)]

*JVET-AH0118 also relates to the mandate to discuss JVET-AG2027, JVET-AG2032, and JVET-AG2034 and to the mandate to collect software and showcase information*

[JVET-AH0290](https://jvet-experts.org/doc_end_user/current_document.php?id=14189) AHG9: real-time demonstration of MPI (V3C) [R. Gendrot, F. Galpin, C. Guede, B. Chupeau, B. Leroy, G. Martin-Cocher (Interdigital)]

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

[JVET-AH0052](https://jvet-experts.org/doc_end_user/current_document.php?id=13934) AHG9: Text Description Information SEI Message

*JVET-AH0052 also relates to the mandate to discuss JVET-AG2027, JVET-AG2032, and JVET-AG2034*

[JVET-AH0112](https://jvet-experts.org/doc_end_user/current_document.php?id=13994) AHG9: Signalling video usage for AI-driven processes in SEI message (LGE) [C. Kim, Hendry, J. Lim, S. Kim (LGE)]

*JVET-AH0112 also relates to the mandate to discuss JVET-AG2027, JVET-AG2032, and JVET-AG2034*

[JVET-AH0161](https://jvet-experts.org/doc_end_user/current_document.php?id=14060) AHG9: Region packing information SEI [J. Boyce, M. M. Hannuksela, H. Zhang (Nokia)]

[JVET-AH0162](https://jvet-experts.org/doc_end_user/current_document.php?id=14061) AHG9: Constituent rectangles SEI [J. Boyce, M. M. Hannuksela (Nokia)]

[JVET-AH0172](https://jvet-experts.org/doc_end_user/current_document.php?id=14071) AHG9: Text comment SEI message [P. de Lagrange, D. Doyen, E. François, F. Urban, C. Salmon-Legagneur (InterDigital)]

[JVET-AH0173](https://jvet-experts.org/doc_end_user/current_document.php?id=14072) AHG9: SEI message for International Color Consortium (ICC) profiles [Arianne Hinds, Stephan Wenger, Gilles Teniou]

*JVET-AH0173 also relates to the mandate to discuss JVET-AG2027, JVET-AG2032, and JVET-AG2034*

[JVET-AH0198](https://jvet-experts.org/doc_end_user/current_document.php?id=14097) AHG9: No display and no display purpose SEI messages [S. McCarthy, G. J. Sullivan, P. Yin (Dolby)]

[JVET-AH0204](https://jvet-experts.org/doc_end_user/current_document.php?id=14103) AHG9: Lens Optical Correction SEI message [G. Teniou, S. Wenger]

**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. Several emails with [AHG9] were exchanged relating to planning for a joint meeting of AG5, WG4, and AHG9 of JVET on preparing to evaluate video quality in the context of MPI. No other emails with [AHG9] were exchanged.

**Recommendations**

The AHG recommends to:

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

[JVET-AH0010](https://jvet-experts.org/doc_end_user/current_document.php?id=14046) JVET AHG report: Encoding algorithm optimization (AHG10) [P. de Lagrange, A. Duenas, R. Sjöberg, A. Tourapis (AHG chairs)]

**Related contributions**

Seven contributions, not including cross-checks, were identified relating to AHG10, and summarized in the following sections.

***Adaptive resolution***

**JVET-AH0130 - AHG8: RPR for machine consumption**

This contribution proposes to reduce resolution by 1.25x for chunks of 32 pictures, with a decision driven by object detection loss in reduced resolution. Gains are reported for machine tasks.

**JVET-AH0171 - AHG10/AHG12 GOP-based RPR encoder control results on UHD test data**

This contribution is a follow-up of JVET-AF0058 and JVET-AG0116, measuring the performance of GOP-based RPR encoding (using the “GOPBasedRPR” configuration parameter) with VTM-23.0 and ECM-12.0, on UHD sequences considered for ECM visual performance assessment (see JVET-AH0041).

BD-rate differences around -3.0% (Y-PSNR) and -6.6% (Y-MSSIM) are reported for the VTM, and respectively around -0.15% and -3.4% for the ECM. Visual quality improvement is also reported. It is suggested to also include the GOP-based RPR feature into VTM11\_ANC for consistency.

**JVET-AH0249 - AHG8: An adaptive spatial resampling method for machine vision**

This contribution proposes adaptive 2x reduced resolution coding for machine tasks, with downscaling and upscaling performed by CNN models (3 and 20 layers respectively). Performance improvements were observed.

***Local QP optimization***

**JVET-AH0078 – AhG10: Distortion Propagation Factor for VVC Low-Delay Configuration**

This contribution is a follow-up of JVET-AF0089 and JVET-AG0055, that proposes a method that tries to give more quality weight to local areas that are likely to be reused in other pictures (through temporal prediction). It does so by estimating a “distortion propagation factor” with a fast 1st inter pass.

During the 33rd JVET meeting, progress was acknowledged, and it was suggested to further investigate about the non-homogeneous behaviour of the scheme over different sequences.

In this follow-up version, a propagation length was introduced to differentiate quality propagation from key and non-key frames. BD-rate difference around -4.1% is reported for VVC low-delay configurations (class B and below). Speed optimization (1st pass only for key frames) reduces BD-rate performance to around -3.8% while reducing the additional encoder time by more than 2 times.

Compared to JVET-AG0055, per-sequence performance differences have been reduced, with around 1% BD-rate change for sequences with losses.

As a reminder, the gains of BIM (comparable technique, but single-pass relying on MCTF) are around 2.3% in the low-delay test conditions.

***Residual spatial weighting***

**JVET-AH0248 – Reduced residual encoding in VVC for machine consumption**

This contribution is a follow-up of JVET-AG0217 where a residual spatial weighting was proposed. The residuals are scaled by 70% in the center of a coding block -when larger than 4 in either dimension- but preserving DC). Compared to the previous contribution, the combination with Region of Interest was tested. BD-rate (PSNR) loss is around 0.5% but the method can bring gains for machine tasks.

***Low latency and low complexity***

**JVET-AH0180 – AHG12: Modified CTC for encoding time reduction under low-delay configuration**

This contribution is a follow-up of JVET-AE0163 and proposes further encoder configuration changes (MTT depth reduction for some temporal layer at low QP) in low-delay B common test conditions to reduce the worst case encoding time of ECM-12 (+2 days compared to ECM-11). Minor losses with significant reduction of encoding times are reported (including a plot showing several trade-offs and comparison with ECM-11).

**JVET-AH0199 – On the requirements and use cases of new-generation video coding standard**

This contribution advocates for more focus on low-delay and low-complexity in the study of next-generation coding, based on market forecast of related applications. It is suggested to include updated HDR and low-delay test material (gaming, user generated, remote screens) in the CTCs, and potentially include complexity constraints for low-delay. Comparison with both HEVC and VVC is also suggested.

**Recommendation**

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

[JVET-AH0011](https://jvet-experts.org/doc_end_user/current_document.php?id=14047) JVET AHG report: Neural network-based video coding (AHG11) [E. Alshina, F. Galpin, S. Liu, A. Segall (co-chairs), J. Li, R.-L. Liao, D. Rusanovskyy, M. Santamaria, T. Shao, M. Wien, P. Wu (vice chairs)]

**Activities**

The AHG used the main JVET reflector, jvet@lists.rwth-aachen.de, for email.

**Anchor Encoding**

Anchor for the NN-based video coding activity made available on the Git repository used for the AHG activity: <https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/nnvc-ctc/-/master/Anchor%20performance/NNVC-current_Reporting_Template-with-anchor-data.xlsm?ref_type=heads> also distributed by AhG14.

***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-AH0023 | EE1: Summary report of exploration experiment on neural network-based video coding | E. Alshina, F. Galpin, Y. Li, D. Rusanovskyy, M. Santamaria, J. Ström, R. Chang, Z. Xie (EE coordinators) |

***Teleconferences***

The AHG conducted 2 joint teleconferences with AHG14 and EE1 during the interim period:

First teleconference on 13.02.24

* up-dates on NNVC SW
  + Potential viewing preparation
* LOP NNLF filter training strategy (EE1-1.0)
* Adaptive resolution coding with RPR filter (EE1-4.1)

Second teleconference on 28.02.24

* Final settings for EE1 tests
* up-dates on NNVC SW

Re-trained LOP model with better compression performance (EE1-1.0) was decided.

***Performance Evaluation***

The performance of the NNVC-8.0 anchor compared to VTM anchor is reported in AhG14 and EE1 summary reports. By default, NN-Intra and Low Operation Point (LOP.2) filter are enabled in NNVC-8.0.

Compression performance of some tools and their combinations available in NNVC SW or from EE1 tests on two complexity metrics (kMAC/pxl and total member for parameters) is shown in the plots below.

|  |  |
| --- | --- |
|  |  |

By available NNVC tool combination for High Operation Point 13-14% gain (for all color components) over VVC (RA configuration) is possible to achieve with ×2-3 Encoder and around ×1000 Decoder run time increment (relatively to VTM).

For Low Operation Point 7% (Luma) and 14% (Chroma) gain over VVC (RA configuration) is possible to achieve with ×1.3 Encoder and around ×40 decoding run time increment (relatively to VTM).

It should be noticed that all run time data reported with SADL which is used for transparency of the process, and far not yet as optimized as other AI platforms.

Major trends in EE1 tests are

* New HOP architecture studies (component separation, depth/block balance, attention/transformer use)
* New LOP architecture and training changes (transformed inputs, very low complexity, rebalance wide/depth)
* Content adaptive filtering based on LOP
* NN-Inter complexity (both kMAC/pxl and run time) significantly improved, training cross-check has been completed,
* Two operation points for NN-based super resolution (20 kMAC/pxl and 469 kMAC/pxl)

**Input contributions**

There are 37 input contributions related to the AHG mandates. The list of input contributions is provided below.

***EE and Related Input Contributions***

15 documents, including EE1 summary report

|  |  |  |  |
| --- | --- | --- | --- |
| Reporting | | | |
| JVET-AH0023 | EE1: Summary report of exploration experiment on neural network-based video coding | E. Alshina,F. Galpin,Y. Li,D. Rusanovskyy,M. Santamaria,J. Ström,R. Chang,Z. Xie |
| JVET-AH0042 | EE1-1.0: Report on joint LOP2 training | D. Rusanovskyy,Y. Li,M. Karczewicz (Qualcomm),T. Shao,P. Yin,S. McCarthy (Dolby),J. N. Shingala,A. Shyam,A. Suneja,S. P. Badya (Ittiam) |
| JVET-AH0043 | [AHG11] [AHG14] AHG meeting report on NNVC | E. Alshina,F. Galpin |

|  |  |  |
| --- | --- | --- |
| EE1 | | |
| JVET-AH0050 | EE1-1.1: LOP candidate with Low Complexity TB and new BB structure | T. Shao,P. Yin,S. McCarthy (Dolby),J. N. Shingala,A. Shyam,A. Suneja,S. P. Badya (Ittiam),D. Rusanovskyy,Y. Li,M. Karczewicz (Qualcomm), |
| JVET-AH0051 | EE1-5: Study of the NN architecture at Very Low Operational Point | D. Rusanovskyy,Y. Li,M. Karczewicz (Qualcomm),J. Li,Y. Li,C. Lin,K. Zhang,L. Zhang (Bytedance),Z. Xie,Y. Yu,H. Yu,D. Wang (OPPO), |
| JVET-AH0080 | EE1-1.2: Joint LOP model with inputs transformed | D. Liu,J. Ström,M. Damghanian,P. Wennersten (Ericsson),D. Rusanovskyy,Y. Li,M. Karczewicz (Qualcomm),T. Shao,P. Yin,S. McCarthy (Dolby),J. N. Shingala,A. Shyam,A. Suneja,S. P. Badya (Ittiam), |
| JVET-AH0081 | EE1-1.3: Training from scratch for the joint LOP model with inputs transformed | D. Liu,J. Ström,M. Damghanian,P. Wennersten (Ericsson),D. Rusanovskyy,Y. Li,M. Karczewicz (Qualcomm),T. Shao,P. Yin,S. McCarthy (Dolby),J. N. Shingala,A. Shyam,A. Suneja,S. P. Badya (Ittiam), |
| JVET-AH0096 | EE1-1.4: Content-adaptive loop-filter | M.Santamaria,R. Yang,F. Cricri,M. M. Hannuksela,D. Bugdayci Sansli,A. Hallapuro,H. R. Tavakoli,J. Lainema,H. Zhang (Nokia) |
| JVET-AH0099 | EE1-4.1: Adaptive resolution coding for NNVC-8.0 with RPR | C. Lin,Y. Li,J. Li,K. Zhang,L. Zhang (Bytedance),Z. Lv,chuan.zhou |
| JVET-AH0104 | EE1-4.2: Adaptive resolution coding for NNVC-8 | chuan.zhou,Z. Lv (vivo) |
| JVET-AH0107 | EE1-3.1: Deep Reference Frame Generation for Inter Prediction Enhancement | W. Bao,N. Fu,X. Chen,J. Jia,Z. Chen (Wuhan Univ.),Z. Liu,X. Xu,S. Liu (Tencent) |
| JVET-AH0133 | EE1-4.3: RPR new input for super-resolution | Jiedong Ye,Xu li,Yiqing Zhu,Qiong Liu (HUST),Chuan Zhou,M. Rafie,Zhuoyi Lv (vivo) |
| JVET-AH0188 | EE1-2.1: HOP separate models | Y. Li,C. Lin,J. Li,K. Zhang,L. Zhang (Bytedance),F. Galpin (InterDigital),D. Rusanovskyy (Qualcomm),R. Chang (Tencent) |
| JVET-AH0189 | EE1-2.2: Wide activation HOP model | Y. Li,J. Li,C. Lin,K. Zhang,L. Zhang (Bytedance) |
| JVET-AH0205 | EE1-2.3: Integer implementation of HOP In-loop filter with Transformer blocks and Attention blocks | Y. Li,D. Rusanovskyy,M. Karczewicz (Qualcomm), |

***Non-EE Input Contributions***

12 contributions, including ablation study, training strategy study, response to the call for training materials and further improvements of NNV technologies.

|  |  |  |
| --- | --- | --- |
| Related and non-EE | | |
| JVET-AH0077 | AHG11: A Low-Complexity Neural Network Loop Filter based on Partial Convolution and Over-Parameterization | A. Li,C. Zhu,L. Luo (UESTC),Y. Huo,Y. Liu (Transsion) |
| JVET-AH0087 | AhG11: LOP/HOP training strategy study | F. Galpin,T. Dumas,P. Bordes(InterDigital) |
| JVET-AH0100 | EE1-related: Multiple scaling ratios coding for NNVC with NNSR | Z. Lv,chuan.zhou |
| JVET-AH0120 | AHG11 Response to Call for training materials JVET-AG2036 | F. Galpin,R. Gendrot,E. Francois,V. Allie (InterDigital) |
| JVET-AH0139 | AhG11: LOP/HOP ablation study | F. Galpin,T. Dumas,P. Bordes(InterDigital) |
| JVET-AH0165 | AHG11: combination of the neural network-based intra prediction mode and ISP | T. Dumas,F. Galpin,P. Bordes (Interdigital) |
| JVET-AH0195 | EE1-related: Complexity reduction of NN in-loop filters through early cropping | J. Ström,M. Damghanian,D. Liu,P. Wennersten (Ericsson) |
| JVET-AH0196 | [AhG11] On Low Complexity Operational Point for In-Loop Filtering | T. Ryder,S. Eadie,Y. Li,D. Rusanovskyy,M. Karczewicz (Qualcomm) |
| JVET-AH0206 | [EE1 related]: Additional inference test for EE1-2.3 to adjust luma-chroma balance | Y. Li,D. Rusanovskyy,M. Karczewicz (Qualcomm) |
| JVET-AH0207 | EE1 related: LOP input adjustment with trainable input transform | Y. Li,D. Rusanovskyy,M. Karczewicz (Qualcomm), |
| JVET-0298 | AHG11: Response to Call for training materials JVET-AG2036 | S. Puri, C. Bonnineau, I. Marzuki, R. Utida, F. Galpin (InterDigital) |
| JVET-AH0312 | EE1-4 related: On training data of super resolution | C. Lin, Y. Li, J. Li, K. Zhang, L. Zhang (Bytedance) |

***Crosschecks***

10 documents

|  |  |  |
| --- | --- | --- |
| Crosscheck | | |
| JVET-AH0241 | Crosscheck of JVET-AH0096 (EE1-1.4: Content-adaptive loop-filter) | D. Liu (Ericsson) |
| JVET-AH0250 | Crosscheck of JVET-AH0081 (EE1-1.3: Training from scratch for the joint LOP model with inputs transformed) | M. Santamaria (Nokia) |
| JVET-AH0263 | Crosscheck of JVET-AH0099 (EE1-4.1: Adaptive resolution coding for NNVC-8.0 with RPR s=1.5) | C. Lin (Bytedance) |
| JVET-AH0264 | Crosscheck of JVET-AH0100 (EE1-related: Multiple scaling ratios coding for NNVC with NNSR) | C. Lin (Bytedance) |
| JVET-AH0265 | Crosscheck of JVET-AH0104 (EE1-4.2: Adaptive resolution coding for NNVC-8) | C. Lin (Bytedance) |
| JVET-AH0266 | Crosscheck of JVET-AH0099 (EE1-4.1: Adaptive resolution coding for NNVC-8.0 with RPR s=2.0) | Z. Lv (vivo) |
| JVET-AH0277 | Crosscheck of JVET-AH0080 (EE1-1.2: Joint LOP model with inputs transformed) | R. Chang (Tencent) |
| JVET-AH0278 | Crosscheck of JVET-AH0205 (EE1-2.3: Integer implementation of HOP In-loop filter with Transformer blocks and Attention blocks) | R. Chang (Tencent) |
| JVET-AH0280 | crosscheck of JVET-AH0107 (EE1-3.1: Deep Reference Frame Generation for Inter Prediction Enhancement) | Z. Xie (OPPO) |
| JVET-AH0281 | Crosscheck of JVET-AH0189 (EE1-2.2: Wide activation HOP model) | F. Galpin (Interdigital) |

**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.

[JVET-AH0012](https://jvet-experts.org/doc_end_user/current_document.php?id=14048) JVET AHG report: Enhanced compression beyond VVC capability (AHG12) [M. Karczewicz, Y. Ye, L. Zhang (co-chairs), B. Bross, R. Chernyak, X. Li, K. Naser, Y. Yu (vice-chairs)]

**Activities**

The primary activity of the AHG was the “Exploration experiment on enhanced compression beyond VVC capability” (JVET-AG2024). The combined improvements of the ECM-12.0 over VTM-11.0ecm12.0 anchorfor AI, RA and LB configurations are:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | All Intra Main10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -11.49% | -23.82% | -31.29% | 974.2% | 461.4% |
| Class A2 | -17.87% | -30.14% | -33.45% | 971.5% | 477.6% |
| Class B | -12.19% | -28.03% | -26.89% | 886.8% | 469.7% |
| Class C | -12.19% | -18.16% | -19.27% | 904.0% | 433.4% |
| Class E | -16.00% | -26.76% | -24.38% | 1115.2% | 773.6% |
| Overall | **-13.66%** | **-25.28%** | **-26.60%** | **954.3%** | **501.3%** |
| Class D | -10.16% | -15.74% | -16.30% | 902.9% | 469.7% |
| Class F | -27.76% | -37.20% | -37.31% | 640.3% | 509.9% |
| Class TGM | -40.85% | -48.69% | -47.92% | 529.9% | 537.3% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Random Access Main 10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -23.81% | -29.45% | -38.33% | 1043.8% | 886.0% |
| Class A2 | -27.31% | -37.48% | -41.49% | 963.3% | 1047.8% |
| Class B | -22.31% | -36.57% | -34.80% | 847.1% | 890.3% |
| Class C | -23.79% | -28.57% | -29.15% | 863.0% | 904.4% |
| Class E |  |  |  |  |  |
| Overall | **-24.01%** | **-33.20%** | **-35.34%** | **910.7%** | **922.8%** |
| Class D | -24.62% | -29.48% | -30.46% | 849.7% | 1013.5% |
| Class F | -30.29% | -39.15% | -39.87% | 691.2% | 554.5% |
| Class TGM | -38.31% | -45.25% | -45.36% | 667.0% | 497.8% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Low Delay B Main 10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -18.68% | -41.71% | -39.50% | 884.5% | 750.4% |
| Class C | -20.33% | -32.55% | -33.40% | 775.5% | 848.1% |
| Class E | -17.84% | -33.16% | -31.46% | 724.5% | 526.3% |
| Overall | **-19.02%** | **-36.52%** | **-35.46%** | **805.3%** | **715.3%** |
| Class D | -22.12% | -35.14% | -34.68% | 749.7% | 881.7% |
| Class F | -26.41% | -40.45% | -40.19% | 657.3% | 577.2% |
| Class TGM | -36.79% | -46.01% | -46.24% | 632.4% | 505.1% |

The rate reduction for natural sequences over VTM in RA configuration for {Y, U, V} increased from ECM-11.0’s {-22.56%, -31.91%, -33.67%} to ECM-12.0’s {-24.01%, -33.20%, -35.34%}. For SCC sequences (class TGM) the rate reduction for RA configuration increased from ECM-11.0’s { -36.82%, -43.33%, -43.43%} to ECM-12.0’s { -38.31%, -45.25%, -45.36%}.

**Contributions**

In addition to 35 EE2 contributions, 51 (comparing to 43 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-AH0058, “Non-EE2: derived MIP modes with fusion”, Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AH0072, “AHG12: Eliminating division operations in DIMD and TIMD”, Z. Fan, T. Chujoh, T. Ikai (Sharp)

JVET-AH0082, “Non-EE2: GPM with CCCM for intra chroma prediction”, Y. Huo, Y. Liu (Transsion)

JVET-AH0083, “AHG12: Additional TIMD mode with different cost metric”, D. Bugdayci Sansli, S. Blasi, J. Lainema (Nokia)

JVET-AH0095, “AHG12: Regularized EIP”, Hongdong Qin, Jacek Konieczny, Keqin Ding, Zhuowei Xu (TCL)

JVET-AH0105, “AHG12: Multiple Reference Area Decoder-side Intra Mode Derive”, J. Fan, J. Huo, Z. Zhang, Y. Ma, F. Yang (Xidian Univ.), M. Li (OPPO)

JVET-AH0210, “Non-EE2: Modifications to Matrix-Based Intra Prediction”, H. Wang, B. Ray, V. Seregin, M. Karczewicz, P. Garus, S. Eadie (Qualcomm)

JVET-AH0211, “Non-EE2: Intra merge mode”, Y.-J. Chang, V. Seregin, M. Karczewicz (Qualcomm)

JVET-AH0274, "EE2 related: TIMD Merge Mode with Enhanced Block Vector Deployment", K. Naser, Y. Chen, F. Le Léannec, M. Radosavljević, K. Reuzé (InterDigital)

***IntraTMP and IntraBC (6)***

JVET-AH0059, “AHG12: Temporal BV for IBC merge list construction”, L. Xu, Y. Yu, H. Yu, D. Wang (OPPO), [N. Zhang](mailto:zhangna.cynthia@bytedance.com), [K. Zhang](mailto:zhangkai.video@bytedance.com), [L. Zhang (Bytedance)](mailto:lizhang.idm@bytedance.com)

JVET-AH0071, “EE2-related: IntraTMP extension to TIMD”, J. Fu, Z. Li, J. Zhang, C. Jia, S. Ma (PKU), Y. Gao, C. Huang (ZTE)

JVET-AH0131, “AhG12: Fix on BV Filtering for IntraTMP Fusion”, S. Kim, D. Jun (Dong-A University)

JVET-AH0151, “EE2-related: IntraTMP merge candidates clustering based on refinement window”, D. Ruiz Coll, J.-K. Lee, (Ofinno)

JVET-AH0156, “AHG12: Neural Network-based Intra Prediction”, F. Urban, T. Dumas, F. Galpin (Interdigital)

JVET-AH0203, “Non-EE2: On BVG-CCCM”, K. Zhang, Z. Deng, L. Zhang (Bytedance)

***Inter (14)***

JVET-AH0091, “Non-EE2: Geometry partitioning mode with inter prediction and intra block copy”, Y. Wang, K. Zhang, L. Zhang (Bytedance)

JVET-AH0116, “EE2-3.1/2 related: Additional chained motion vector prediction candidates”, N. Zhang, K. Zhang, L. Zhang (Bytedance)

JVET-AH0141, “AHG12: Sharp motion compensation filter for bi-prediction”, J. Samuelsson-Allendes (Sharp)

JVET-AH0144, “AHG12: Hierarchical Subblock based DMVR”, K. Andersson, C. Hollmann (Ericsson)

JVET-AH0145, “AHG12: Follow up on normative DMVR fix for ECM as in JVET-AG0125 (Parallel friendly use of boundary distortion for DMVR)”, K. Andersson (Ericsson)

JVET-AH0168, “Template Matching Picture Boundary Padding”, Nicolas Neumann, Mathias Wien

JVET-AH0178, “Non-EE2: High Accuracy Sample Based Bi-Directional Optical Flow”, M. Salehifar, Y. He, K. Zhang, L. Zhang (Bytedance)

JVET-AH0178, “Non-EE2: High Accuracy Sample Based Bi-Directional Optical Flow”, M. Salehifar, Y. He, K. Zhang, L. Zhang (Bytedance)

JVET-AH0193, “EE2-related: Chroma LIC derivation with template costs”, TM. Bae S. Deshpande

JVET-AH0202, “EE2 related: Adaptive weighting for Inter CCP merge mode with zero luma CBF”, X. Li (Google), Z. Deng, K. Zhang, L. Zhang (Bytedance)

JVET-AH0208, “Non-EE2: affine candidates derived from temporal collocated picture”, C. Ma, X. Xiu, C.-W. Kuo, W. Chen, X. Wang (Kwai)

JVET-AH0213, “Non-EE2: MVP extension”, Z. Zhang, J.-L Lin, H. Huang, V. Seregin, M. Karczewicz (Qualcomm)

JVET-AH0215, “Non-EE2: Adaptive Cost Function Selection in Merge Mode”, K. Cui, Z. Zhang, Y. Zhang, H. Huang, V. Seregin, M. Karczewicz (Qualcomm)

JVET-AH0222, “Non-EE2: GPM-Affine with MMVD and TM”, Y. Wang, K. Zhang, L. Zhang (Bytedance)

***In Loop Filters (6)***

JVET-AH0060, “Non-EE2: On residual adjustments for adaptive loop filters”, Z. Dai, N. Song, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AH0061, “Non-EE2: CCALF with Chroma SAO input”, Z. Dai, N. Song, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AH0062, “Non-EE2: CCALF with Chroma Fixed Filter Input”, N. Song, Z. Dai, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AH0163, “AHG12: ALF syntax modification”, F. Galpin, G. Boisson, P. Bordes, F. Lefebvre, I. Marzuki (InterDigital)

JVET-AH0170, “Non-EE2: ALF residuals scaling”, P. Bordes, F. Galpin, G. Boisson (InterDigital)

JVET-AH0275, "Non-EE2: CCALF with chroma ALF outputs", N. Hu, M. Karczewicz, V. Seregin (Qualcomm)

***Transform (8)***

JVET-AH0103, “Non-EE2: Low-delay configurations for LFNST/NSPT”, M. Koo, Y. Ahn, J. Nam, J. Zhao, J. Lim, S. Kim (LGE)

JVET-AH0181, “AHG12: Adaptation of intra/inter LFNST/NSPT for low-delay configuration”, C. Bonnineau, F. Le Leannec, K. Naser, S. Puri, I. Marzuki, R. Utida (InterDigital)

JVET-AH0182, “Non-EE2: On intra and inter LFNST/NSPT for low delay configuration”, Y. Kidani, H. Kato, K. Kawamura (KDDI)

JVET-AH0184, “EE2-4.1 related: On Multiple Transform Set Selection for LFNST/NSPT”, C. Bonnineau, S. Puri, K. Naser, F. Le Leannec (InterDigital)

JVET-AH0218, “EE2-4.1 related: Alternative intra mode derivation for LFNST/NSPT”, L. Zhao, K. Zhang, L. Zhang (Bytedance)

JVET-AH0219, “Non-EE2: Improvements on Inter LFNST/NSPT”, L. Zhao, K. Zhang, L. Zhang (Bytedance)

JVET-AH0237, “EE2-4.1 related: Alternative intra mode derivation for LFNST/NSPT kernel selection”, M. Coban, M. Karczewicz, V. Seregin

JVET-AH0307, "AHG12: Multiple Transform Set Selection for Intra MTS", C. Bonnineau, K. Naser, S. Puri, F. Le Léannec

***Coefficients and Entropy Coding (3)***

JVET-AH0089, “AhG12: On entropy models training”, F. Galpin, F. Lo Bianco, C. Salmon-Legagneur (InterDigital)

JVET-AH0153, “EE2-6.3 related: Combination of EE2-6.1 and EE2-6.2 on entropy coding extension – retraining”, F. Galpin, F. Lo Bianco, C. Salmon-Legagneur, M. Balcilar (InterDigital), R.-L. Liao, Yan Ye, Jie Chen, Xinwei Li (Alibaba), P. Nikitin, M. Karczewicz (Qualcomm)

JVET-AH0223, “AHG12: Context retraining for ECM-12.0”, V. Seregin, M. Coban, M. Karczewicz (Qualcomm)

***Partitioning (2)***

JVET-AH0152, “Ahg12: adaptive dual-tree coding in B slices”, F. Le Leannec, K. Naser, T. Dumas, T. Poirier, F. Urban, E. Francois (InterDigital)

JVET-AH0155, “AHG12: Restricting BT CUs to apply QT-like partitioning structure”, W. Ahmad, P. Wennersten, K. Andersson (Ericsson)

***Quantization (2)***

JVET-AH0063, “AHG12: On Shifting Quantization Center”, Y. Yu, H. Yu, L. Xu, J. Gan, F. Wang, Z. Xie, D. Wang (OPPO)

JVET-AH0117, “AHG12: Modification of chroma QP mapping table for ECM”, Y. Wang, K. Zhang, L. Zhang (Bytedance), J. Chen, R.-L. Liao, Y. Ye (Alibaba), V. Seregin, M. Karczewicz (Qualcomm)

***Other (1)***

JVET- AH0180, " AHG12: Modified CTC for encoding time reduction under low-delay configuration ", R. Utida, S. Puri, I. Marzuki, C. Bonnineau (InterDigital)

Recommendations

The AHG recommends to:

* To review all the related contributions.

[JVET-AH0013](https://jvet-experts.org/doc_end_user/current_document.php?id=14049) JVET AHG report: Film grain technologies (AHG13) [W. Husak, P. de Lagrange (co-chairs), A. Duenas, D. Grois, Y. He, X. Meng, M. Radosavljević, A. Segall, G. Teniou, A. Tourapis (vice-chairs)]

**Discussion**

In this AHG period, there were several topics of conversation. ISO/IEC 23002-9 DTR was edited and finally distributed for ballot. The group also discussed presentations given during the MHV2024 and the DVB Film Grain workshop. Finally, the group discussed potential future topics for the discussion and for the potential inclusion in a future version of the Technical Report.

Additional editing of the DTR included porting errors, printing bugs, and organizational style. The editors reached agreement with the group and the document was updated to reflect the suggestions. The DTR was then circulated for ballot.

The MHV2024 (Mile High Video 2024) conference featured a session on film grain technologies. Topics ranged from film grain activities within several groups to potential tools for future use. The DVB Film Grain Study Mission also arranged a workshop for the expressed reason of determining potential commercial requirements. The DVB workshop included presentations on the activities of several standards groups, discussions from content creators, and groups working on tools and metrics.

The following items were enumerated for further discussion. These items began as topics for a second version of the technical report; however, it was agreed that the items are wide ranging and may result in different actions and/or activities. The list is as follows:

* Update on available tools for film grain
* List of content available for testing and development of film grain processes and technologies
* Metrics – discussion and/or survey of available techniques or metrics for film grain
* Engineering Guidelines and/or Recommended Practices for film grain
* Conformance – SEI and/or as a tool in the coder
* Analysis – preprocessing analysis (parameter estimation)
* Future parameters and signaling as an SEI or in the codec (like AOM)

**Related contributions**

Six contributions related to AHG13 were identified as of 04/16/2024.

* One contribution was the AHG report:
  + JVET-AG0013 JVET AHG report: Film grain technologies (AHG13)
* Five other contributions were uploaded at the time of the report drafting:
  + JVET-AH0166 Improvements to the film grain regions characteristics SEI message
  + JVET-AH0212 Updates on the implementation of film grain regions characteristics SEI message
  + JVET-AH0216 Performance of denoisers on the Film Grain ground truth test set
  + JVET-AH0301 Input for subjective quality testing of the FGC SEI message
  + JVET-AH0311 Demonstration of FGC SEI editing, and live VVC web-player with grain synthesis

***Contributions***

There were five contributions uploaded other than the AHG report.

**JVET-AH0166 Improvements to the film grain regions characteristics SEI message**

In the last meeting, the film grain regions characteristics SEI message was adopted into the TuC for future extensions of the VSEI (version 3) specification. In order to improve the adaptability of this SEI message, two comments about region adaptive film grain model application are proposed, wherein:

* Allowing separate “fgr\_model\_id” to be applied in different regions, instead of restricting only one single “fgr\_model\_id” in the whole SEI message.
* Allowing separate “fgr\_blending\_mode\_id” to be applied in different regions, instead of restricting only one single “fgr\_blending\_mode\_id” in the whole SEI message.

**JVET-AH0212 Updates on the implementation of film grain regions characteristics SEI message**

[Not uploaded]

**JVET-AH0216 Performance of denoisers on the Film Grain ground truth test set**

[Not uploaded]

**JVET-AH0301 Input for subjective quality testing of the FGC SEI message**

[Not uploaded]

**JVET-AH0311 Demonstration of FGC SEI editing, and live VVC web-player with grain synthesis**

[Not uploaded]

**Recommendations**

The AHG recommends:

* the related input contributions are reviewed;
* any liaisons are reviewed;
* testing of FGC be discussed;
* continued conformance discussion;
* future extensions to the Technical Report;
* SEI message extensions;
* topics for an EG/RP; and
* continue the study of film grain technologies in JVET.

It was suggested by one expert also potentially considering the interaction with newly investigated coding tools. It was commented by other experts that the focus of AHG13 is meant to be different.

[JVET-AH0014](https://jvet-experts.org/doc_end_user/current_document.php?id=13925) JVET AHG report: NNVC software development (AHG14) [F. Galpin (chair), Y. Li, Y. Li, J. N. Shingala, L. Wang, Z. Xie (vice-chairs)]

**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, and enabling deblocking in the RDO.

NNVC-8.0 anchor at <https://vcgit.hhi.fraunhofer.de/jvet-ahg-nnvc/nnvc-ctc/-/blob/master/Anchor%20performance/NNVC-current_Reporting_Template-with-anchor-data.xlsm?ref_type=heads> is used for NNVC performance evaluation.

***Software changes***

NNVC***-8.0***

Several commits were merged in the NNVC repository.

The following changes were integrated:

* JVET-AG0109 JVET-AG0219 sadl v8
* JVET-AF0172: scaling cleanup
* JVET-AG0174: HOP3
* JVET- AG0130: unified SR filter

The following fixes and clean-up were perfomed:

* MR185: simd build option clean-up
* MR187: HOP2 float version
* MR186: fix opset version of ONNX to 10

***NNVC-8.1***

* MR197: support for Y4M
* MR198: unified model names
* MR200: fix build for ARM
* Other fixes (remaining debug code, json files correction etc.)
* MRxxx: fix memory padding issue

***Software version***

NNVC-8.1 was tagged xxx

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).

**CTC performance**

See configurations section for naming convention.

***Comparison to VTM***

**NNVC-7.1 VTM vs NNVC-8.0 VTM**

NNVC-8.0 in VTM mode performance are the same as the ones in NNVC-5.0/NNVC-6.0/NNVC-7.1.

**NNVC-8.0 VTM vs NNVC-8.0 anchor**

The NNVC-8.0 anchor includes LOP.2 filter and Intra Prediction tools activated.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -7.91% | -10.13% | -10.58% | -8.57% | -11.31% | -10.56% | 122% | 7629% |
| Class A2 | -6.80% | -12.67% | -9.74% | -6.92% | -11.64% | -7.52% | 114% | 7025% |
| Class B | -6.58% | -13.91% | -12.69% | -6.81% | -13.14% | -12.07% | 121% | 7467% |
| Class C | -6.59% | -14.87% | -14.44% | -7.10% | -13.23% | -13.00% | 121% | 7162% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -6.89% | -13.16% | -12.14% | -7.26% | -12.50% | -11.11% | 120% | 7326% |
| Class D | -7.16% | -14.79% | -14.97% | -6.54% | -13.04% | -13.02% | 117% | 7268% |
| Class F | -3.74% | -9.48% | -9.43% | -4.46% | -10.49% | -10.21% | 129% | 3275% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -5.31% | -13.68% | -13.36% | -6.23% | -15.19% | -17.25% | 113% | 7591% |
| Class C | -5.53% | -13.89% | -15.13% | -7.37% | -15.85% | -17.20% | 110% | 7143% |
| Class E | -6.17% | -8.64% | -11.92% | -7.97% | -10.13% | -13.32% | 119% | 7827% |
| **Overall** | -5.60% | -12.49% | -13.59% | -7.04% | -14.15% | -16.25% | 113% | 7496% |
| Class D | -6.49% | -13.14% | -15.10% | -7.37% | -14.18% | -18.02% | 110% | 7026% |
| Class F | -3.09% | -8.64% | -9.08% | -4.53% | -10.17% | -13.90% | 121% | 3871% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -8.62% | -12.69% | -12.29% | -9.00% | -14.91% | -12.55% | 168% | 5248% |
| Class A2 | -7.15% | -12.70% | -11.26% | -7.43% | -12.12% | -9.31% | 160% | 4409% |
| Class B | -7.35% | -13.02% | -13.55% | -7.46% | -13.33% | -13.40% | 167% | 4381% |
| Class C | -7.53% | -13.81% | -14.47% | -7.95% | -14.33% | -14.57% | 165% | 3524% |
| Class E | -10.71% | -14.15% | -15.12% | -10.89% | -13.52% | -14.18% | 168% | 5078% |
| **Overall** | -8.13% | -13.28% | -13.42% | -8.39% | -13.65% | -12.97% | 166% | 4414% |
| Class D | -7.65% | -12.72% | -15.05% | -7.45% | -13.57% | -15.41% | 157% | 3460% |
| Class F | -5.27% | -10.79% | -10.39% | -5.15% | -11.24% | -11.54% | 133% | 3832% |

Note: Results from Interdigital, crosschecked by Oppo.

**NNVC-8.0 VTM mode vs NNVC-8.0 HOP.3**

The NNVC-8.0 where LOP.2 filter is replaced by HOP.3 and Intra Prediction tools activated.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -15.25% | -10.18% | -18.82% | -16.35% | -14.10% | -20.86% | 268% | 110495% |
| Class A2 | -14.77% | -13.58% | -9.89% | -14.32% | -12.33% | -6.47% | 243% | 109442% |
| Class B | -12.48% | -13.53% | -12.81% | -11.77% | -12.85% | -12.47% | 260% | 115443% |
| Class C | -13.41% | -17.35% | -16.77% | -12.53% | -13.32% | -13.55% | 219% | 100974% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -13.74% | -13.89% | -14.49% | -13.40% | -13.12% | -13.23% | 247% | 109249% |
| Class D | -14.56% | -16.75% | -17.13% | -11.42% | -12.52% | -12.35% | 214% | 96985% |
| Class F | -8.59% | -12.88% | -10.90% | -9.08% | -12.97% | -11.81% | 351% | 56200% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -10.97% | -8.91% | -5.85% | -11.11% | -10.68% | -10.37% | 251% | 113144% |
| Class C | -12.22% | -14.10% | -12.34% | -12.29% | -12.03% | -11.74% | 208% | 107881% |
| Class E | -12.68% | -10.72% | -7.64% | -13.14% | -9.85% | -13.53% | 432% | 144336% |
| **Overall** | -11.82% | -11.09% | -8.46% | -12.01% | -10.93% | -11.62% | 270% | 118351% |
| Class D | -13.68% | -15.24% | -10.44% | -12.43% | -11.39% | -10.84% | 193% | 93836% |
| Class F | -8.87% | -11.99% | -9.35% | -10.14% | -11.83% | -16.40% | 349% | 65056% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -12.87% | -9.06% | -16.12% | -14.41% | -13.68% | -18.00% | 315% | 75281% |
| Class A2 | -12.52% | -10.73% | -8.40% | -13.38% | -10.32% | -6.11% | 233% | 59516% |
| Class B | -11.16% | -10.20% | -10.84% | -11.13% | -11.27% | -11.73% | 236% | 56660% |
| Class C | -12.29% | -13.10% | -15.34% | -11.95% | -12.65% | -14.52% | 195% | 37894% |
| Class E | -15.82% | -15.48% | -15.22% | -15.99% | -14.06% | -15.46% | 254% | 63142% |
| **Overall** | -12.70% | -11.62% | -13.05% | -13.05% | -12.29% | -13.08% | 240% | 55773% |
| Class D | -11.83% | -11.97% | -15.59% | -10.93% | -11.96% | -13.53% | 189% | 38033% |
| Class F | -8.87% | -11.73% | -10.21% | -8.55% | -12.04% | -11.72% | 161% | 47748% |

Note: Results from InterDigital, crosschecked by Oppo.

**NNVC-8.0 VTM mode vs NNVC-8.0 VTM mode + LOP.2**

The results reflect LOP only performance.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -5.92% | -8.83% | -9.08% | -6.68% | -10.46% | -9.36% | 114% | 7917% |
| Class A2 | -5.58% | -12.14% | -8.92% | -5.75% | -11.47% | -6.97% | 110% | 7549% |
| Class B | -4.99% | -13.20% | -12.06% | -5.26% | -12.71% | -12.06% | 111% | 7525% |
| Class C | -5.12% | -13.75% | -13.25% | -5.62% | -12.69% | -12.47% | 107% | 7272% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -5.33% | -12.26% | -11.15% | -5.74% | -12.01% | -10.61% | 110% | 7538% |
| Class D | -6.02% | -14.05% | -13.96% | -5.34% | -12.54% | -12.29% | 105% | 6861% |
| Class F | -2.77% | -8.94% | -8.89% | -3.37% | -10.21% | -10.25% | 115% | 3210% |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -4.89% | -13.49% | -12.77% | -5.82% | -15.07% | -16.97% | 114% | 7987% |
| Class C | -5.26% | -13.41% | -14.60% | -7.03% | -15.43% | -17.27% | 105% | 7276% |
| Class E | -6.05% | -8.54% | -12.83% | -7.82% | -10.33% | -13.69% | 118% | 8011% |
| **Overall** | -5.30% | -12.23% | -13.40% | -6.72% | -14.00% | -16.25% | 112% | 7749% |
| Class D | -6.36% | -13.10% | -14.24% | -7.39% | -14.87% | -17.08% | 105% | 6949% |
| Class F | -2.94% | -8.15% | -8.23% | -4.54% | -9.55% | -13.42% | 121% | 3936% |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -4.64% | -9.01% | -8.52% | -4.78% | -11.21% | -8.98% | 115% | 5097% |
| Class A2 | -4.48% | -10.12% | -8.62% | -4.75% | -9.96% | -6.96% | 106% | 4156% |
| Class B | -4.39% | -10.32% | -10.64% | -4.56% | -10.93% | -11.08% | 107% | 4077% |
| Class C | -4.64% | -11.11% | -11.70% | -4.93% | -12.02% | -12.27% | 102% | 2808% |
| Class E | -6.42% | -9.58% | -11.35% | -6.53% | -9.32% | -11.20% | 105% | 4571% |
| **Overall** | -4.84% | -10.12% | -10.31% | -5.04% | -10.79% | -10.33% | 107% | 3983% |
| Class D | -5.00% | -10.10% | -12.34% | -4.77% | -11.51% | -13.09% | 100% | 2707% |
| Class F | -3.21% | -9.07% | -8.61% | -3.02% | -9.83% | -9.96% | 101% | 3387% |

Note: Results from InterDigital, crosschecked by XX.

**NNVC-8.0 VTM mode vs NNVC-8.0 VTM mode + HOP.3**

The results reflect HOP only performance.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -13.55% | -9.39% | -17.87% | -14.76% | -13.62% | -20.30% | 257% | 116262% |
| Class A2 | -13.68% | -12.97% | -9.03% | -13.22% | -12.02% | -6.00% | 238% | 115050% |
| Class B | -11.10% | -12.81% | -11.89% | -10.49% | -12.51% | -12.31% | 248% | 119588% |
| Class C | -12.15% | -16.49% | -15.36% | -11.25% | -12.81% | -12.54% | 201% | 104150% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -12.39% | -13.14% | -13.44% | -12.09% | -12.71% | -12.71% | 234% | 113729% |
| Class D | -13.43% | -16.07% | -16.36% | -10.26% | -12.25% | -12.39% | 200% | 100674% |
| Class F | -7.74% | -11.87% | -10.25% | -7.98% | -11.89% | -11.60% | 325% | 54035% |

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|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -10.60% | -8.57% | -5.76% | -10.80% | -10.94% | -10.38% | 247% | 119531% |
| Class C | -12.01% | -14.17% | -12.04% | -12.14% | -12.38% | -12.00% | 211% | 109479% |
| Class E | -12.51% | -11.12% | -6.05% | -12.85% | -10.42% | -13.01% | 436% | 150792% |
| **Overall** | -11.55% | -11.07% | -7.93% | -11.76% | -11.29% | -11.58% | 271% | 123024% |
| Class D | -13.32% | -14.87% | -9.83% | -11.84% | -11.32% | -9.83% | 205% | 101113% |
| Class F | -8.79% | -11.21% | -9.45% | -10.22% | -10.76% | -15.92% | 345% | 66146% |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -9.39% | -5.38% | -12.55% | -10.81% | -10.02% | -14.67% | 245% | 72718% |
| Class A2 | -10.14% | -8.22% | -6.33% | -11.12% | -8.10% | -4.24% | 174% | 60217% |
| Class B | -8.53% | -6.91% | -7.58% | -8.58% | -8.64% | -9.15% | 169% | 55114% |
| Class C | -9.75% | -9.89% | -12.10% | -9.35% | -9.93% | -11.40% | 133% | 37919% |
| Class E | -12.07% | -11.04% | -11.12% | -12.41% | -10.06% | -12.30% | 179% | 65344% |
| **Overall** | -9.80% | -8.22% | -9.79% | -10.18% | -9.30% | -10.28% | 173% | 55459% |
| Class D | -9.42% | -9.42% | -12.58% | -8.43% | -10.42% | -11.51% | 126% | 36624% |
| Class F | -7.03% | -9.86% | -8.30% | -6.67% | -10.37% | -9.78% | 129% | 48234% |

Note: Results from InterDigital, crosschecked by xxxx.

**NNVC-8.0 VTM vs NNVC-8.0 NNSR**

The results show the performance of NNVC with all tools on (LOP) vs VTM.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC 8 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -11.13% | -9.37% | -8.88% |  |  |  |  |  |
| Class A2 | -7.92% | -6.25% | -2.78% |  |  |  |  |  |
| Class B | -6.58% | -13.91% | -12.69% |  |  |  |  |  |
| Class C | -6.59% | -14.87% | -14.44% |  |  |  |  |  |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -7.76% | -11.73% | -10.41% |  |  |  |  |  |
| Class D | -7.16% | -14.79% | -14.97% |  |  |  |  |  |
| Class F | -3.74% | -9.48% | -9.43% |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC 8 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -9.60% | -8.49% | -7.53% |  |  |  |  |  |
| Class A2 | -9.07% | -7.80% | -3.33% |  |  |  |  |  |
| Class B | -7.35% | -13.02% | -13.55% |  |  |  |  |  |
| Class C | -7.53% | -13.81% | -14.47% |  |  |  |  |  |
| Class E | -10.71% | -14.15% | -15.12% |  |  |  |  |  |
| **Overall** | -8.61% | -11.76% | -11.31% |  |  |  |  |  |
| Class D | -7.65% | -12.72% | -15.05% |  |  |  |  |  |
| Class F | -5.27% | -10.79% | -10.39% |  |  |  |  |  |

Note: Results from Oppo crosscheck by InterDigital,

***Comparison to previous NNVC anchor***

**NNVC-7.1 anchor vs NNVC-8.0 anchor**

The results reflect LOP/nnvc progress between NNVC 7.1 (as anchor) and NNVC 8.0 (as test).

The scaling clean-up affects only RA/LDB configuration. Update to SADL v8 speed-up both encoding and decoding.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | 0.00% | -0.05% | 0.03% | 0.00% | 0.01% | 0.04% | 75% | 65% |
| Class A2 | -0.01% | 0.01% | 0.00% | -0.01% | 0.01% | -0.01% | 75% | 64% |
| Class B | -0.01% | 0.03% | 0.01% | 0.00% | 0.03% | -0.02% | 74% | 60% |
| Class C | -0.01% | 0.00% | -0.01% | 0.00% | 0.00% | -0.04% | 79% | 64% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -0.01% | 0.00% | 0.01% | 0.00% | 0.01% | -0.01% | 76% | 63% |
| Class D | 0.00% | 0.05% | 0.03% | 0.00% | 0.06% | 0.09% | 80% | 67% |
| Class F | -0.03% | 0.01% | -0.02% | -0.03% | 0.02% | -0.03% | 79% | 62% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -0.02% | -0.35% | -0.15% | -0.06% | -0.50% | 0.24% | 79% | 66% |
| Class C | 0.00% | -0.19% | -0.28% | 0.01% | -0.41% | -0.24% | 79% | 66% |
| Class E | -0.04% | 0.25% | 0.19% | -0.08% | 0.39% | 0.33% | 74% | 61% |
| **Overall** | -0.02% | -0.15% | -0.11% | -0.04% | -0.24% | 0.11% | 77% | 65% |
| Class D | 0.05% | -0.05% | 0.38% | 0.00% | 0.12% | -0.09% | 82% | 66% |
| Class F | 0.06% | 0.08% | -0.45% | 0.05% | -0.16% | -0.68% | 79% | 66% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 66% | 61% |
| Class A2 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 64% | 58% |
| Class B | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 66% | 58% |
| Class C | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 71% | 58% |
| Class E | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 68% | 59% |
| **Overall** | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 67% | 59% |
| Class D | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 71% | 56% |
| Class F | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 79% | 60% |

Note: Results from InterDigital, crosschecked by xxxx.

Comparison ***to NNVC-8.0 anchor***

**NNVC-8.0 anchor vs NNVC-8.0 HOP.3**

Official results for HOP.

The results below reflect LOP/HOP performance differences (LOP set as anchor, HOP as test).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -7.96% | -0.24% | -9.22% | -8.51% | -3.49% | -11.65% | 219% | 1448% |
| Class A2 | -8.53% | -1.20% | -0.31% | -7.90% | -0.99% | 1.03% | 213% | 1558% |
| Class B | -6.33% | 0.50% | -0.15% | -5.30% | 0.39% | -0.49% | 215% | 1546% |
| Class C | -7.32% | -2.94% | -2.77% | -5.82% | -0.19% | -0.77% | 181% | 1410% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -7.36% | -0.91% | -2.69% | -6.60% | -0.82% | -2.49% | 206% | 1491% |
| Class D | -7.98% | -2.35% | -2.76% | -5.20% | 0.60% | 0.35% | 183% | 1334% |
| Class F | -5.13% | -3.97% | -1.72% | -4.90% | -3.09% | -1.88% | 272% | 1716% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -6.00% | 5.88% | 8.70% | -5.22% | 5.79% | 8.60% | 222% | 1490% |
| Class C | -7.09% | -0.03% | 3.22% | -5.30% | 4.96% | 6.66% | 190% | 1510% |
| Class E | -6.92% | -2.08% | 4.80% | -5.54% | 0.45% | -0.18% | 362% | 1844% |
| **Overall** | -6.59% | 1.92% | 5.90% | -5.33% | 4.18% | 5.76% | 238% | 1579% |
| Class D | -7.69% | -2.26% | 5.41% | -5.46% | 3.92% | 9.46% | 176% | 1335% |
| Class F | -6.03% | -3.70% | -0.20% | -5.94% | -1.71% | -3.03% | 289% | 1681% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -4.64% | 4.09% | -4.26% | -5.92% | 1.33% | -6.29% | 188% | 1434% |
| Class A2 | -5.80% | 2.38% | 3.18% | -6.39% | 2.06% | 3.54% | 145% | 1350% |
| Class B | -4.14% | 3.60% | 3.24% | -3.94% | 2.58% | 2.00% | 141% | 1293% |
| Class C | -5.20% | 0.88% | -1.01% | -4.33% | 1.85% | -0.06% | 118% | 1075% |
| Class E | -5.74% | -1.61% | -0.16% | -5.62% | -0.68% | -1.57% | 151% | 1243% |
| **Overall** | -5.00% | 2.01% | 0.47% | -5.04% | 1.58% | -0.18% | 145% | 1264% |
| Class D | -4.55% | 0.94% | -0.81% | -3.77% | 2.02% | 1.86% | 120% | 1099% |
| Class F | -3.88% | -1.04% | 0.22% | -3.58% | -0.93% | -0.15% | 121% | 1246% |

Note: Results from InterDigital, crosschecked by xxxx.

**NNVC-8.0 vs NNVC RPR**

From JVET-AH0099

For scaling x2 (crosschecked by Interdigital):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **BD-rate Over NNVC-8.0 anchor** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -3.06% | 1.25% | 2.77% |  |  |  |  |  |
| Class A2 | 0.09% | 10.28% | 9.82% |  |  |  |  |  |
| Class B | 0.00% | 0.00% | 0.00% |  |  |  |  |  |
| Class C | 0.00% | 0.00% | 0.00% |  |  |  |  |  |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -0.59% | 2.31% | 2.52% |  |  |  |  |  |
| Class D | 0.00% | 0.00% | 0.00% |  |  |  |  |  |
| Class F | 0.00% | 0.00% | 0.00% |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0 anchor** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -1.48% | 3.38% | 4.33% |  |  |  |  |  |
| Class A2 | -0.85% | 9.15% | 11.64% |  |  |  |  |  |
| Class B | 0.00% | 0.00% | 0.00% |  |  |  |  |  |
| Class C | 0.00% | 0.00% | 0.00% |  |  |  |  |  |
| Class E | 0.00% | 0.00% | 0.00% |  |  |  |  |  |
| **Overall** | -0.39% | 2.09% | 2.66% |  |  |  |  |  |
| Class D | 0.00% | 0.00% | 0.00% |  |  |  |  |  |
| Class F | 0.00% | 0.00% | 0.00% |  |  |  |  |  |

For scaling x1.5

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0 (NN-Intra LOP2)** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -2.72% | 0.02% | 0.74% |  |  |  |  |  |
| Class A2 | -1.19% | 6.95% | 6.65% |  |  |  |  |  |
| Class B | 0.00% | 0.00% | 0.00% |  |  |  |  |  |
| Class C | 0.00% | 0.00% | 0.00% |  |  |  |  |  |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -0.78% | 1.39% | 1.48% |  |  |  |  |  |
| Class D | 0.00% | 0.00% | 0.00% |  |  |  |  |  |
| Class F | 0.00% | 0.00% | 0.00% |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-8.0 (NN-Intra LOP2)** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -1.27% | 0.19% | 1.28% |  |  |  |  |  |
| Class A2 | -2.65% | 7.00% | 7.92% |  |  |  |  |  |
| Class B | 0.00% | 0.00% | 0.00% |  |  |  |  |  |
| Class C | 0.00% | 0.00% | 0.00% |  |  |  |  |  |
| Class E | 0.00% | 0.00% | 0.00% |  |  |  |  |  |
| **Overall** | -0.65% | 1.20% | 1.53% |  |  |  |  |  |
| Class D | 0.00% | 0.00% | 0.00% |  |  |  |  |  |
| Class F | 0.00% | 0.00% | 0.00% |  |  |  |  |  |

**NNVC-8.0 anchor vs NNVC-8.0 NRSR unified**

Official results for NNSR.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over nnvc** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -3.20% | 0.60% | 1.79% | -6.14% | -0.69% | -0.98% | 76% | 56% |
| Class A2 | -1.00% | 6.51% | 7.00% | -5.64% | 7.96% | 7.02% | 78% | 65% |
| Class B | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 96% | 95% |
| Class C | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 94% | 95% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -0.84% | 1.42% | 1.76% | -2.36% | 1.45% | 1.21% | 88% | 79% |
| Class D | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 97% | 102% |
| Class F | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 93% | 92% |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over nnvc** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -1.08% | 4.37% | 4.92% | -3.29% | 4.55% | 5.81% | 111% | 116% |
| Class A2 | -2.07% | 5.11% | 8.48% | -8.26% | 4.31% | 8.41% | 84% | 120% |
| Class B | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 92% | 99% |
| Class C | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 90% | 98% |
| Class E | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 94% | 100% |
| **Overall** | -0.53% | 1.58% | 2.23% | -1.93% | 1.48% | 2.37% | 93% | 105% |
| Class D | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 89% | 91% |
| Class F | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 93% | 100% |

Note: Results from Oppo checked by Interdigital.

***Other tools***

Other results remain the same as tools were not changed.

**Contributions**

We have 3 contributions for AhG14.

|  |  |  |
| --- | --- | --- |
| [JVET-AH0064](https://jvet-experts.org/doc_end_user/current_document.php?id=13946) | AHG14: Port VTM Temporal Filter Fixes to NNVC software and Enable Temporal Filter in NNVC LD CTC | [X. Li (Google)](mailto:xlxiangli@google.com) |
| [JVET-AH0088](https://jvet-experts.org/doc_end_user/current_document.php?id=13970) | AhG14: SADL update | [F. Galpin](mailto:franck.galpin@interdigital.com), T. Dumas, P. Bordes, E. Francois (InterDigital) |
| [JVET-AH0106](https://jvet-experts.org/doc_end_user/current_document.php?id=13988) | AHG14: The extension of SADL library | [N. Fu](mailto:nianxiangfu@whu.edu.cn), [W. Bao](mailto:baoweijie@whu.edu.cn), [Z. Chen (Wuhan Univ.)](mailto:zzchen@whu.edu.cn) |

**Configurations**

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

The column “tested” is read as follow:

* Y: the configuration has been tested using the new NNVC-7.1 software
* P: the results are the ones from previous NNVC software basis
* N: not tested.

The column “xcheck” is read as follow:

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Tools | Configuration | Tested | Xcheck |
| NNVC VTM mode | none | encoder\_xxx\_vtm.cfg | P |  |
| NNVC Anchor/EE1 | Intra Pred + LOP.2 filterset | encoder\_xxx\_nnvc.cfg | Y | Y |
| NNVC. HOP | Intra Pred + HOP.3 | encoder\_xxx\_nnvc.cfg + nn-based/HOP.cfg | Y | Y |
| HOP only | HOP | encoder\_xxx\_vtm.cfg + nn-based/HOP.cfg | Y | Y |
| Intra lower complexity | NN Intra lower complexity | nn-based/intra2.cfg | Y | Y |
| Sr | Super-resolution | nn-based/nnsr.cfg + nn-based/nnsr\_classAx.cfg | P |  |
| Pf | Adaptive post-filters | nn-based/nnpf/nnpf\_xxx.cfg | P |  |

Deprecated options:

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

**Recommendations**

The AHG recommends to:

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

[JVET-AH0015](https://jvet-experts.org/doc_end_user/current_document.php?id=14050) JVET AHG report: Gaming content compression (AHG15) [S. Puri, J. Sauer (co-chairs), R. Chernyak, A. Duenas, L. Wang (vice chairs)]

**Simulations on gaming content sequences**

Note: This information has now been repeated with minor modificaitons several times in AhG and BoG reports. Should we produce a testing condition output document to which we can refer instead?

***Used testing conditions***

Anchor:

* VTM-11.0-ECM12.0 (<https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/tree/VTM-11.0ecm12.0>)

Test:

* ECM-12.0 (<https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/tree/ECM-12.0>)

Testing conditions

* QPs 22, 27, 32, 37, 42
* AI/RA/LDB/LDP
  + No testing of 4K sequences for low-delay.
* No per-class configs, no SCC config
* Simulations were split throughout the group.
* Excel template adapted from AhG11, supports 5 QPs.
* Classes:
  + Class G1: sequences with auxiliary data
  + Class G2: sequences without auxiliary data
* A 5s segment was used for each sequence

***List of tested sequences***

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Class** | **Sequence name** | **Frame count** | **Frame rate** | **Bit depth** | **Start frame** | **End frame** | **Intra** | **Random access** | **Low-delay** |
| G1 | Level1 | 600 | 60 | 10 | 0 | 299 | M | M | M |
| G1 | Darktree | 600 | 60 | 10 | 300 | 599 | M | M | M |
| G1 | ARPG | 600 | 60 | 8 | 100 | 399 | M | M | M |
| G1 | DesertTown1 | 600 | 60 | 8 | 200 | 499 | M | M | M |
| G1 | DesertTown2 | 600 | 60 | 8 | 150 | 449 | M | M | M |
| G1 | Sun\_Temple1 | 600 | 60 | 8 | 40 | 339 | M | M | M |
| G1 | Sun\_Temple2 | 600 | 60 | 8 | 50 | 349 | M | M | M |
| G2 | ArenaOfValor | 600 | 60 | 8 | 0 | 299 | M | M | M |
| G2 | CSGO | 3600 | 60 | 8 | 1100 | 1399 | M | M | M |
| G2 | DOTA2 | 3600 | 60 | 8 | 1734 | 2033 | M | M | M |
| G2 | EuroTruckSimulator2 | 3600 | 60 | 8 | 1000 | 1299 | M | M | M |
| G2 | Fallout4 | 3600 | 60 | 8 | 600 | 899 | M | M | M |
| G2 | GTAV | 3600 | 60 | 8 | 300 | 599 | M | M | M |
| G2 | Hearthstone | 3600 | 60 | 8 | 3099 | 3398 | M | M | M |
| G2 | Minecraft | 3600 | 60 | 8 | 600 | 899 | M | M | M |
| G2 | Rust | 3600 | 60 | 8 | 3000 | 3299 | M | M | M |
| G2 | Starcraft | 3600 | 60 | 8 | 2900 | 3199 | M | M | M |
| G2 | Witcher3 | 3600 | 60 | 8 | 1300 | 1599 | M | M | M |
| G2 | Baolei-Man | 600 | 60 | 8 | 300 | 599 | M | M | M |
| G2 | Baolei-Balloon 4K | 600 | 60 | 8 | 300 | 599 | M | M |  |
| G2 | Baolei-Yard 4K | 600 | 60 | 8 | 60 | 359 | M | M |  |
| G2 | Baolei-Woman | 600 | 60 | 8 | 120 | 419 | M | M | M |
| G2 | Jianling-Temple | 600 | 60 | 8 | 0 | 299 | M | M | M |
| G2 | Jianling-Beach | 600 | 60 | 8 | 0 | 299 | M | M | M |
| G2 | Heroes of the Storm part 1 | 300 | 30 | 8 | 150 | 299 | M | M | M |
| G2 | Project CARS | 300 | 30 | 8 | 0 | 149 | M | M | M |
| G2 | WoW part 2 | 300 | 30 | 8 | 150 | 299 | M | M | M |

***Coding performance results***

**ECM-12.0 vs VTM11.0ecm12.0**

**AI**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **BD-rate 5 QPs (piecewise cubic)** | | |
| **Class** | **Sequence** | Y-PSNR | U-PSNR | V-PSNR |
| G1 | Level1 | -7.29% | -22.17% | -18.52% |
|  | Darktree | -8.06% | -30.10% | -34.05% |
|  | ARPG | -9.86% | -23.77% | -16.88% |
|  | DesertTown1 | -10.96% | -41.41% | -25.27% |
|  | DesertTown2 | -11.26% | -41.28% | -29.26% |
|  | Sun\_Temple1 | -13.97% | -37.17% | -30.44% |
|  | Sun\_Temple2 | -13.81% | -38.69% | -31.76% |
|  | Average (G1) | -10.74% | -33.51% | -26.60% |
| G2 | ArenaOfValor | #VALUE! | #VALUE! | #VALUE! |
|  | CSGO | -12.21% | -26.47% | -34.36% |
|  | DOTA2 | -9.95% | -16.43% | -16.43% |
|  | EuroTruckSimulator2 | -11.79% | -27.71% | -27.48% |
|  | Fallout4 | -10.54% | -22.51% | -20.63% |
|  | GTAV | -10.25% | -27.13% | -39.94% |
|  | Hearthstone | -11.25% | -19.04% | -19.37% |
|  | Minecraft | -32.30% | -44.01% | -44.38% |
|  | Rust | -10.36% | -39.06% | -39.82% |
|  | Starcraft | -18.41% | -28.92% | -31.72% |
|  | Witcher3 | -10.09% | -29.56% | -24.57% |
|  | Baolei-Man | -11.61% | -24.57% | -21.59% |
|  | Baolei-Balloon | -14.24% | -19.43% | -20.01% |
|  | Baolei-Yard | -14.98% | -22.65% | -24.84% |
|  | Baolei-Woman | -14.15% | -22.80% | -21.86% |
|  | Jianling-Temple | -10.46% | -18.33% | -21.83% |
|  | Jianling-Beach | -19.18% | -29.23% | -30.22% |
|  | Heroes of the Storm part 1 | -16.31% | -23.60% | -24.36% |
|  | Project CARS | -16.55% | -32.42% | -28.50% |
|  | WoW part 2 | -21.51% | -33.27% | -32.47% |
|  | Average (G2)\* | -14.53% | -26.69% | -27.60% |

\*ignoring AoV

**RA**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **BD-rate 5 QPs (piecewise cubic)** | | |
| **Class** | **Sequence** | Y-PSNR | U-PSNR | V-PSNR |
| G1 | Level1 | -20.44% | -45.38% | -37.92% |
|  | Darktree | -24.84% | -45.05% | -50.35% |
|  | ARPG | -25.44% | -39.68% | -31.01% |
|  | DesertTown1 | -26.87% | -50.67% | -35.65% |
|  | DesertTown2 | -25.40% | -49.67% | -36.89% |
|  | Sun\_Temple1 | -29.77% | -47.63% | -44.09% |
|  | Sun\_Temple2 | -28.47% | -49.36% | -43.68% |
|  | Average (G1) | -25.89% | -46.78% | -39.94% |
| G2 | ArenaOfValor | #VALUE! | #VALUE! | #VALUE! |
|  | CSGO | -24.65% | -37.70% | -40.58% |
|  | DOTA2 | -14.06% | -21.06% | -20.61% |
|  | EuroTruckSimulator2 | -19.61% | -34.76% | -30.77% |
|  | Fallout4 | -25.48% | -34.76% | -33.21% |
|  | GTAV | -24.75% | -48.19% | -52.15% |
|  | Hearthstone | -18.26% | -29.44% | -28.53% |
|  | Minecraft | -24.66% | -47.25% | -47.91% |
|  | Rust | -22.17% | -54.76% | -55.36% |
|  | Starcraft | -19.18% | -33.88% | -37.59% |
|  | Witcher3 | -16.32% | -40.18% | -44.78% |
|  | Baolei-Man | -17.36% | -34.53% | -29.62% |
|  | Baolei-Balloon | -26.47% | -31.78% | -31.74% |
|  | Baolei-Yard | #VALUE! | #VALUE! | #VALUE! |
|  | Baolei-Woman | -22.59% | -31.32% | -31.19% |
|  | Jianling-Temple | -16.52% | -32.01% | -32.84% |
|  | Jianling-Beach | -15.59% | -32.96% | -30.85% |
|  | Heroes of the Storm part 1 | -16.64% | -27.13% | -26.61% |
|  | Project CARS | -20.42% | -37.74% | -33.53% |
|  | WoW part 2 | -22.59% | -38.67% | -36.48% |
|  | Average (G2) | #VALUE! | #VALUE! | #VALUE! |

**LDB**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **BD-rate 5 QPs (piecewise cubic)** | | |
| **Class** | **Sequence** | Y-PSNR | U-PSNR | V-PSNR |
| G1 | Level1 | -15.05% | -48.47% | -37.87% |
|  | Darktree | -16.71% | -60.54% | -65.30% |
|  | ARPG | -17.22% | -57.55% | -42.69% |
|  | DesertTown1 | -17.36% | -65.55% | -46.77% |
|  | DesertTown2 | -16.95% | -66.82% | -53.25% |
|  | Sun\_Temple1 | -21.19% | -53.81% | -49.13% |
|  | Sun\_Temple2 | -21.22% | -57.73% | -52.20% |
|  | Average (G1) | -17.96% | -58.64% | -49.60% |
| G2 | ArenaOfValor | #VALUE! | #VALUE! | #VALUE! |
|  | CSGO | -17.56% | -44.99% | -50.27% |
|  | DOTA2 | -13.16% | -27.14% | -25.85% |
|  | EuroTruckSimulator2 | -13.85% | -43.49% | -36.79% |
|  | Fallout4 | #VALUE! | #VALUE! | #VALUE! |
|  | GTAV | -15.71% | -60.24% | -60.57% |
|  | Hearthstone | -20.24% | -36.83% | -35.73% |
|  | Minecraft | #VALUE! | #VALUE! | #VALUE! |
|  | Rust | #VALUE! | #VALUE! | #VALUE! |
|  | Starcraft | -16.62% | -38.81% | -41.99% |
|  | Witcher3 | #VALUE! | #VALUE! | #VALUE! |
|  | Baolei-Man | -15.05% | -42.76% | -33.46% |
|  |  |  |  |  |
|  |  |  |  |  |
|  | Baolei-Woman | -19.62% | -32.13% | -32.44% |
|  | Jianling-Temple | #VALUE! | #VALUE! | #VALUE! |
|  | Jianling-Beach | -13.60% | -39.68% | -36.76% |
|  | Heroes of the Storm part 1 | -15.12% | -32.75% | -32.21% |
|  | Project CARS | -17.45% | -42.30% | -35.85% |
|  | WoW part 2 | -18.88% | -44.07% | -39.65% |
|  | Average (G2) | #VALUE! | #VALUE! | #VALUE! |

**LDP**

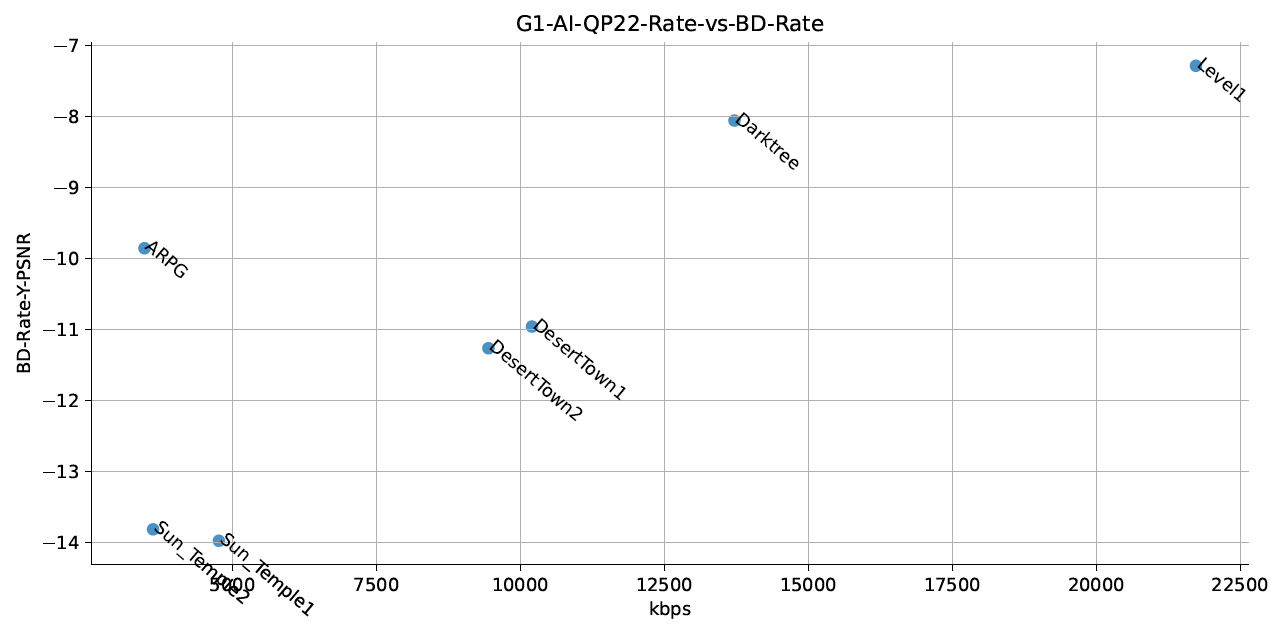
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **BD-rate 5 QPs (piecewise cubic)** | | |
| **Class** | **Sequence** | Y-PSNR | U-PSNR | V-PSNR |
| G1 | Level1 | #VALUE! | #VALUE! | #VALUE! |
|  | Darktree | #VALUE! | #VALUE! | #VALUE! |
|  | ARPG | -16.31% | -56.63% | -41.88% |
|  | DesertTown1 | -16.32% | -64.67% | -45.33% |
|  | DesertTown2 | -15.93% | -66.20% | -52.73% |
|  | Sun\_Temple1 | -20.33% | -53.18% | -48.42% |
|  | Sun\_Temple2 | -20.56% | -57.18% | -51.66% |
|  | Average (G1) | #VALUE! | #VALUE! | #VALUE! |
| G2 | ArenaOfValor | #VALUE! | #VALUE! | #VALUE! |
|  | CSGO | -16.58% | -44.37% | -49.87% |
|  | DOTA2 | -11.90% | -25.39% | -24.56% |
|  | EuroTruckSimulator2 | -13.50% | -41.63% | -34.42% |
|  | Fallout4 | -13.78% | -37.25% | -34.26% |
|  | GTAV | -15.05% | -60.03% | -60.60% |
|  | Hearthstone | -17.33% | -35.87% | -34.35% |
|  | Minecraft | #VALUE! | #VALUE! | #VALUE! |
|  | Rust | -14.94% | -70.59% | -71.80% |
|  | Starcraft | -14.76% | -37.77% | -41.05% |
|  | Witcher3 | #VALUE! | #VALUE! | #VALUE! |
|  | Baolei-Man | #VALUE! | #VALUE! | #VALUE! |
|  |  |  |  |  |
|  |  |  |  |  |
|  | Baolei-Woman | -18.08% | -31.11% | -31.24% |
|  | Jianling-Temple | #VALUE! | #VALUE! | #VALUE! |
|  | Jianling-Beach | -12.22% | -38.00% | -34.91% |
|  | Heroes of the Storm part 1 | -13.49% | -31.69% | -31.37% |
|  | Project CARS | -16.52% | -39.65% | -34.28% |
|  | WoW part 2 | -17.23% | -42.83% | -38.38% |
|  | Average (G2) | #VALUE! | #VALUE! | #VALUE! |

**Visualizations**

Plotted QP 22 rate saving for luma over rate.

**Class G1**

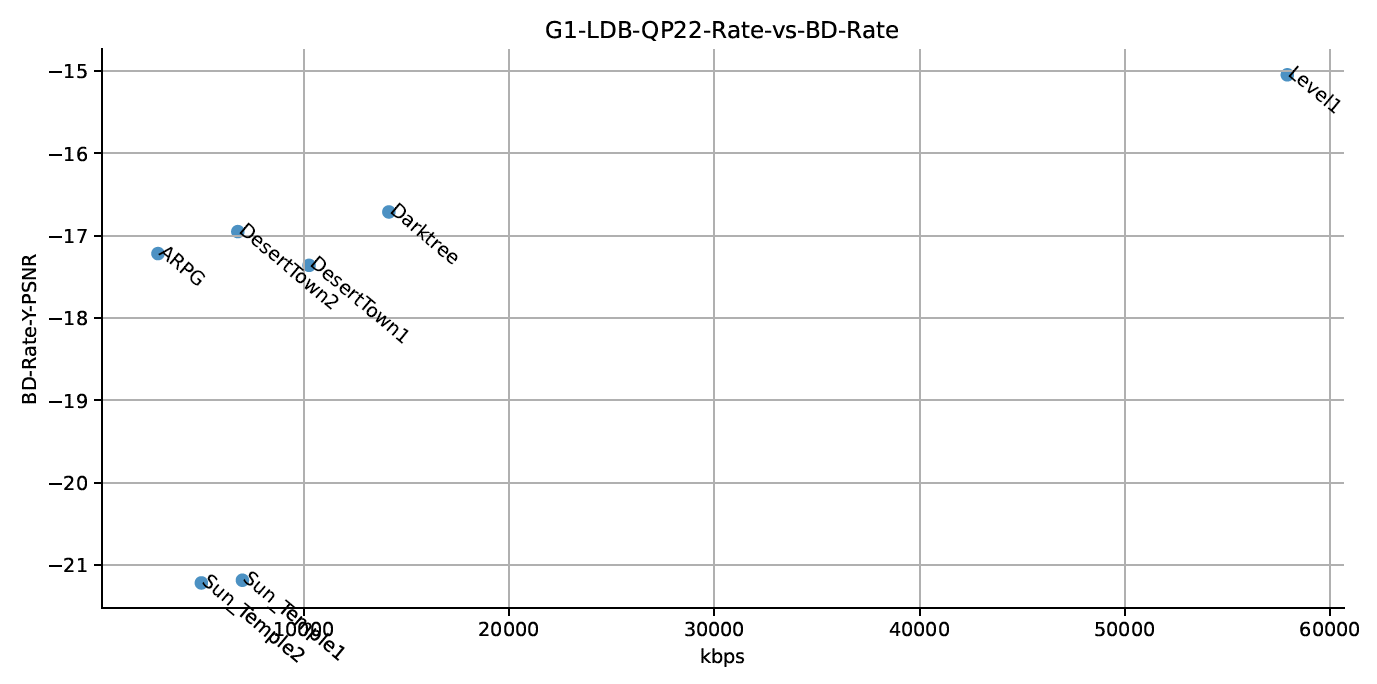
***AI***



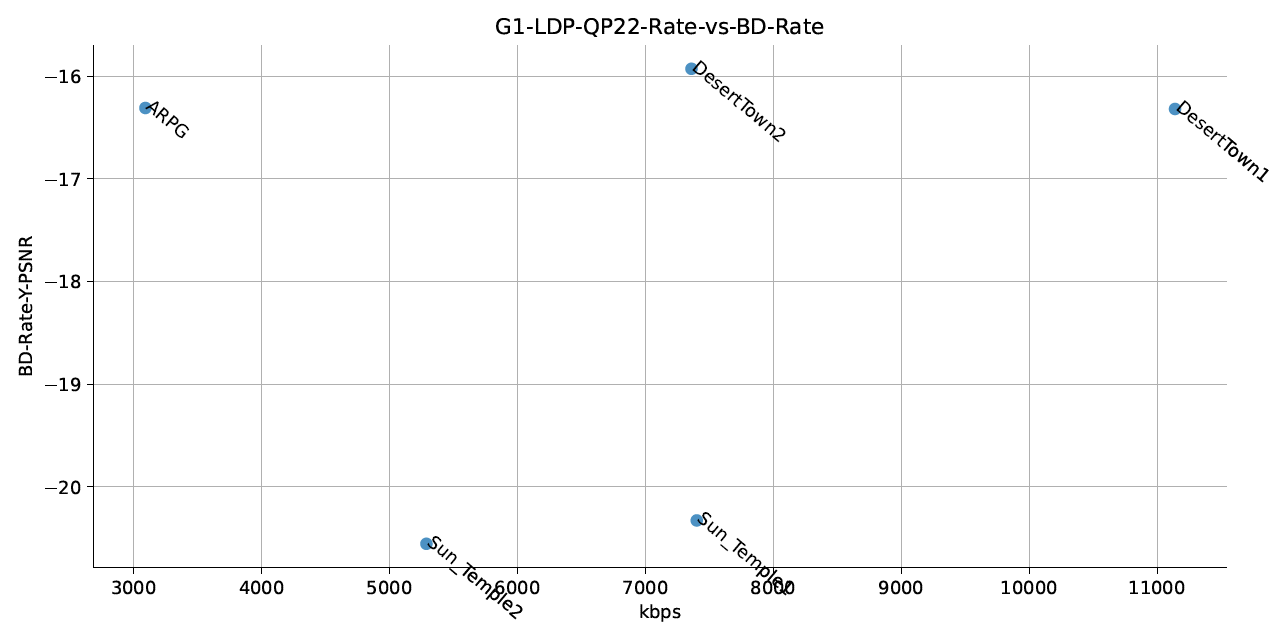
***RA***



***LDB***

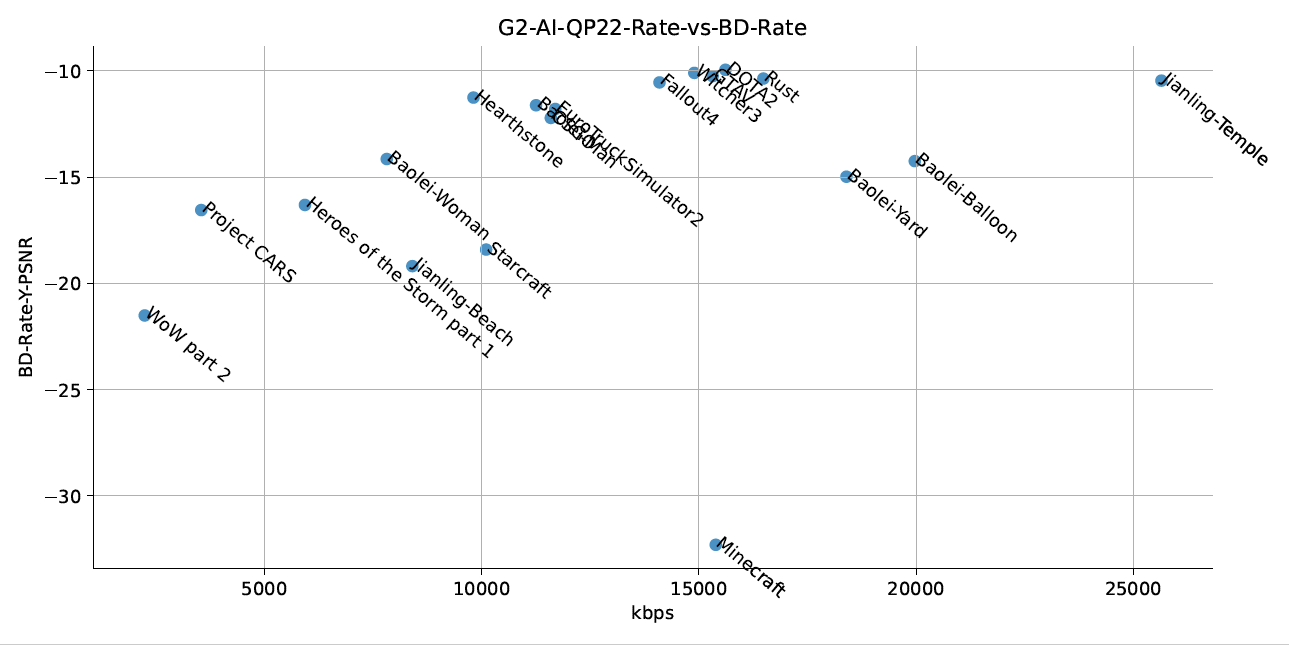


***LDP***

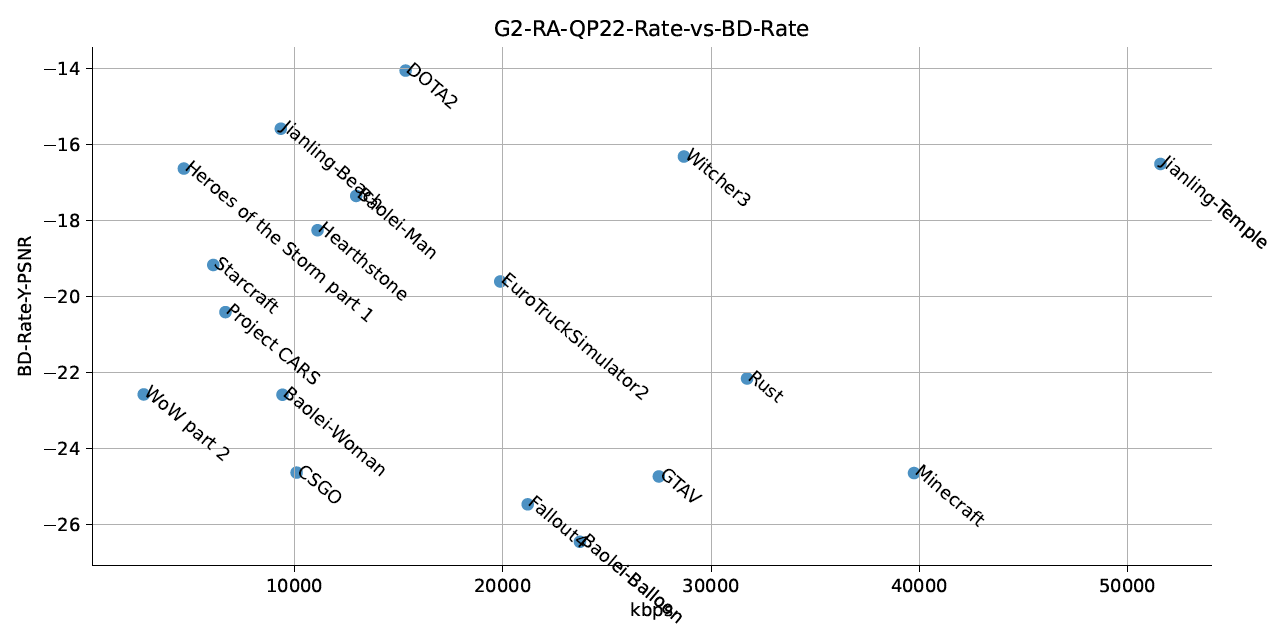


**Class G2**

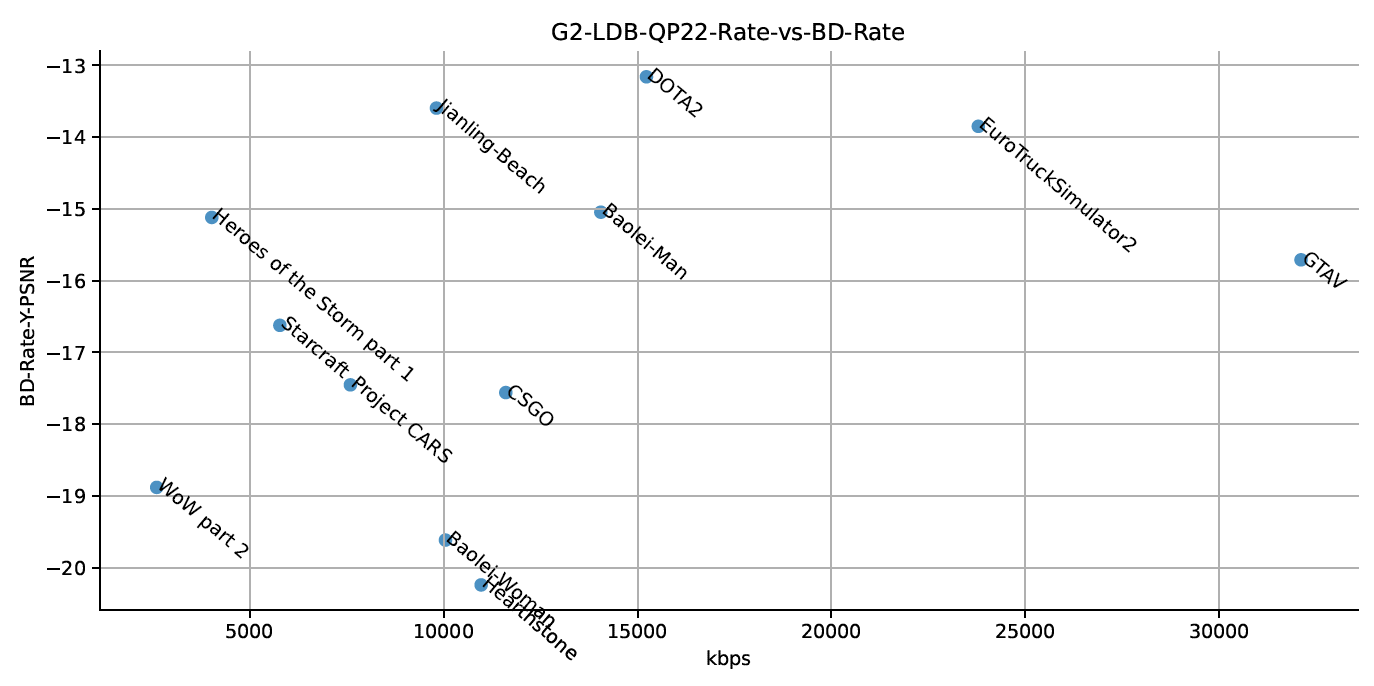
***AI***



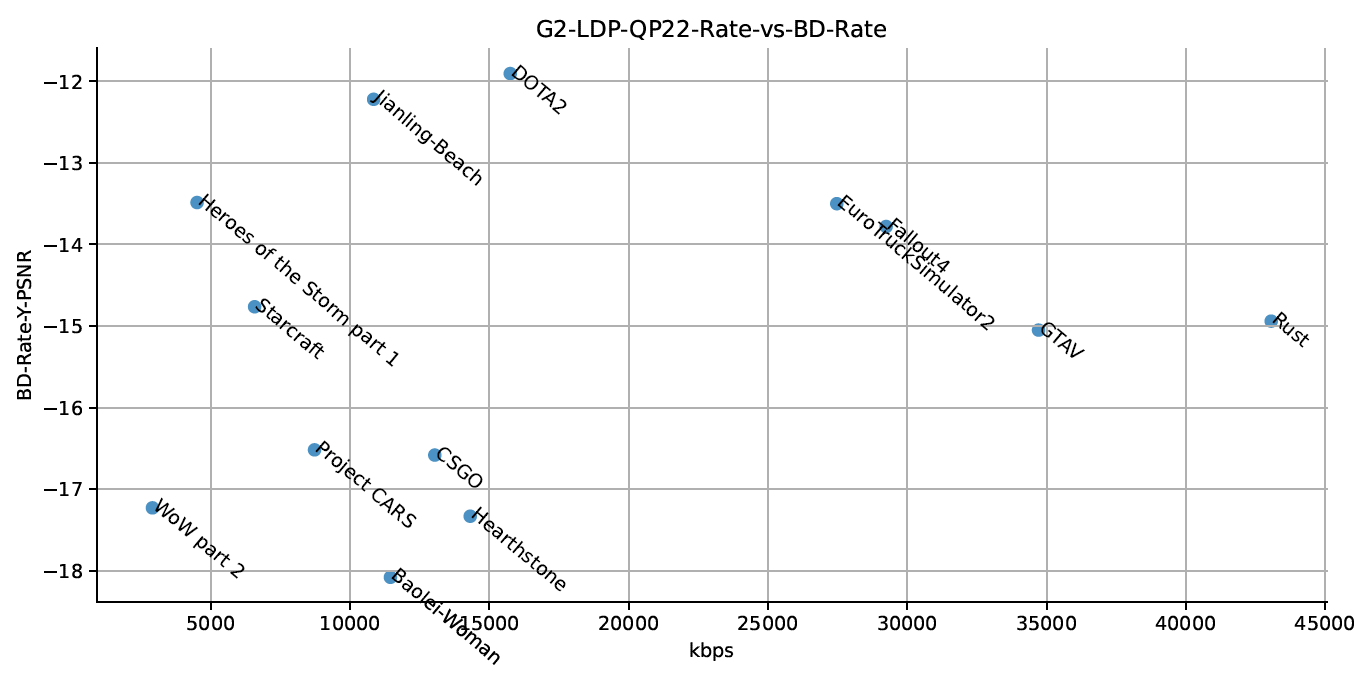
***RA***



***LDB***



***LDP***



**Input documents**

Tool ***assessment / sequence selection***

* JVET-AH0067: AHG15: ECM-12.0 Tool assessment on class G candidate sequences

Auxiliary ***data format***

* JVET-AH0147: AHG15: Description of the auxiliary information for the gaming content sequences proposed by Huawei
* JVET-AH0179: AHG15: On auxiliary information for the Unity Gaming sequences proposed by InterDigital

***New test sequences***

* JVET-AH0149: AHG15: Description of the auxiliary information for the gaming content sequences proposed by Huawei

***Testing conditions***

* JVET-AH0220: AHG15: Configurations for gaming sequences

**Recommendations**

The AHG recommends to:

* Review input documents on gaming content compression
* Review testing conditions and refine them, if necessary
* Review gaming content testset (classes G1 and G2) and shorten them, if necessary
* Identify if/how auxiliary information can be used for coding of gaming content
* Create a output document describing gaming content testset and test conditions

It was commented by the AG 5 chair that some of the sequences have artifacts that may be annoying for users (see email that had been sent bv him). It should be avoided to include such sequences.

Target a BoG (J. Sauer) to make a proposal of sequences

[JVET-AH0016](https://jvet-experts.org/doc_end_user/current_document.php?id=14051) JVET AHG report: Generative face video compression (AHG16) [Y. Ye (chair), H.-B. Teo, Z. Lyu, S. McCarthy, S. Wang (vice chairs)]

**AHG activities**

Regarding the output document JVET-AG2035 “Test conditions and evaluation procedures for generative face video coding” (including the associated GFVC performance reporting template), v1 of the document was uploaded on 23 February 2024, and v2 and v3 were uploaded on 17 March and 22 March, respectively. The revisions included ftp information for test sequences, improvements to the reporting template, and other editorial improvements.

Regarding the AHG16 GFVC software tool, a GIT repository was created for AHG16 and the software package has been made available at <https://vcgit.hhi.fraunhofer.de/jvet-ahg-gfvc>. The AHG16 software tool integrates three GFVC methods (FOMM, FV2V and CFTE) and four generative models (FOMM, FV2V, CFTE and lightweight CFTE). It also provides usage instructions and exemplar configurations for experimentation. A new input contribution (JVET-AH0114) proposes further improvements to the GFVC software package.

Regarding GFVC performance, two input contributions (JVET-AH0110 and JVET-AH0114) propose algorithms to extend GFVC’s bitrate range coverage from ultra-low bitrates to mid-to-high bitrate ranges. In addition, input contribution JVET-AH0113 proposes to extend GFVC to code higher resolution face video sequences.

Regarding the coordination with AHG9 to develop the GFV SEI message, a number of input contributions (JVET-AH0053, JVET-AH0054, JVET-AH0127, JVET-AH0138 and JVET-AH0148) propose various refinements and/or modifications to the GFV SEI message in JVET-AG2032 “Technologies under consideration for future extensions of VSEI (version 3)”, and JVET-AH0118 provides a showcase for the picture fusion function in GFV SEI. Further, input contribution JVET-AH0239 proposes a software implementation of the GFV SEI message on top of VTM that supports all GFVC methods in the AHG16 GFVC software.

**Related contributions**

The following list of input contributions to this meeting are identified as being related to the activities of AHG16:

1. [JVET-AH005](https://jvet-experts.org/doc_end_user/current_document.php?id=13935)3 AHG9: Comments on Generative Face Video SEI [S. Deshpande (Sharp)]
2. [JVET-AH0054](https://jvet-experts.org/doc_end_user/current_document.php?id=13936) AHG16: On the generative face video SEI message [H.-B. Teo, J.-Y. Thong, K. Abe, C.-S. Lim, K. Jayashree (Panasonic)]
3. [JVET-AH0109](https://jvet-experts.org/doc_end_user/current_document.php?id=13991) AHG16: Removal of the analysis model on the decoder side and lightweight design [R. Zou, R.-L. Liao, B. Chen, Y. Ye, J. Chen (Alibaba)]
4. [JVET-A](https://jvet-experts.org/doc_end_user/current_document.php?id=13992)[H011](https://jvet-experts.org/doc_end_user/current_document.php?id=13595)0 AHG16: Scalable Representation and Layered Reconstruction for Generative Face Video Compression [B. Chen, Y. Ye, J. Chen, R.-L. Liao(Alibaba), S. Yin, S. Wang (CityU)]
5. [JVET-AH0113](https://jvet-experts.org/doc_end_user/current_document.php?id=13995) AHG16: Lightweight CFTE with Multi-Resolution support [R. Zou, B. Chen, R.-L. Liao, J. Chen, Y. Ye (Alibaba)]
6. [JVET-AH011](https://jvet-experts.org/doc_end_user/current_document.php?id=13996)4 AHG16: Updated Common Software Tools for Generative Face Video Compression [B. Chen, Y. Ye (Alibaba), G.Konuko, G. Valenzise (Centrale Supelec), S. Yin, S. Wang (CityU)]
7. [JVET-AH011](https://jvet-experts.org/doc_end_user/current_document.php?id=14000)8 AHG9/AHG16: Showcase for picture fusion for generative face video SEI message [S. Gehlot, G. Su, P. Yin, S. McCarthy, G. J. Sullivan (Dolby)]
8. [JVET-AH0127](https://jvet-experts.org/doc_end_user/current_document.php?id=14009) AHG9/AHG16: The SEI message design for scalable representation and layered reconstruction for generative face video compression [J. Chen, B. Chen, Y. Ye, R.-L. Liao (Alibaba), S. Yin, S. Wang (CityU)]
9. [JVET-AH0138](https://jvet-experts.org/doc_end_user/current_document.php?id=14020) AHG9/AHG16: Pupil position SEI message for Generative Face Video [A. Trioux, Y. Yao, F. Ma, F. Yang(Xidian Univ.), F. Xing, Z. Wang(Hisense)]
10. [JVET-AH0148](https://jvet-experts.org/doc_end_user/current_document.php?id=14030) AHG9/AHG16: On key point coordinates calculation for the generative face video SEI message [K. Yang (SJTU), Y.-K. Wang (Bytedance), Y. Xu, Y. Li (SJTU)]
11. [JVET-AH0239](https://jvet-experts.org/doc_end_user/current_document.php?id=14138) AHG9/AHG16: Software Implementation of Generative Face Video SEI Message [B. Chen, J. Chen, R. Zou, Y. Ye, R.-L. Liao (Alibaba), S. Wang (CityU)]

**Recommendations**

The AHG recommends to:

* Review related contributions.
* Continue to improve the GFVC software tool and its compression capability

# Project development (41)

## AHG1: Development, deployment and advertisement of standards (1)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0199](https://jvet-experts.org/doc_end_user/current_document.php?id=14098) On the requirements and use cases of new-generation video coding standard [Y. Zhao, X. Gu, Y. Zhao, W. Xu, X. Ma, K. Cai, J. Wang, J. Zhou, J. Sauer, E. Alshina (Huawei), S. Wenger (Tencent), F. Le Léannec, K. Naser, F. Galpin, S. Puri, E. François (InterDigital)]

## AHG2: Text development and errata reporting (4)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0046](https://jvet-experts.org/doc_end_user/current_document.php?id=13928) On MV-HEVC profiles [Y.-K. Wang, H. Liu, L. Zhang, S. Jiao, C. Hu, J. Cui (Bytedance), A. M. Tourapis, D. Podborski, S. Paluri (Apple)]

See section 4.14

[JVET-AH0154](https://jvet-experts.org/doc_end_user/current_document.php?id=14036) Carriage of depth and alpha maps as HEVC single-layer bitstreams [E. Thomas, E. Potetsianakis, E. Alexiou, R. Ghaznavi-Youvalari, M. Abdoli, A. Tissier, M.-L. Champel (Xiaomi), D. Podborski, W. Zia, A. Tourapis (Apple)]

[JVET-AH0169](https://jvet-experts.org/doc_end_user/current_document.php?id=14068) Video CICP problem reports and proposed actions [G. J. Sullivan (Dolby Labs)]

[JVET-AH0175](https://jvet-experts.org/doc_end_user/current_document.php?id=14074) [AHG9/CICP] On constraints and reference of MatrixCoefficients [J. Xu, Y.-K. Wang (Bytedance)]

[JVET-AH0217](https://jvet-experts.org/doc_end_user/current_document.php?id=14116) CICP enum for generic subsampling and sample location [L. Barnes, D. Podborski, A. Tourapis (Apple)]

## AHG3: Test conditions (0)

This section is kept as a template for future use.

## AHG3: Software development (0)

This section is kept as a template for future use.

## AHG4: Subjective quality testing and verification testing (2)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0041](https://jvet-experts.org/doc_end_user/current_document.php?id=13922) [AHG4] AHG meeting report on ECM expert viewing preparations [M. Wien]

[JVET-AH0301](https://jvet-experts.org/doc_end_user/current_document.php?id=14200) AHG4/AHG13: input for subjective quality testing of the FGC SEI message [P. de Lagrange (InterDigital)] [late] [miss]

## AHG4: Test and training material (4)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0120](https://jvet-experts.org/doc_end_user/current_document.php?id=14002) AHG11 Response to Call for training materials JVET-AG2036 [F. Galpin, R. Gendrot, E. François, V. Allie (InterDigital)] [late]

[JVET-AH0142](https://jvet-experts.org/doc_end_user/current_document.php?id=14024) AHG4: HDR 4K content for JVET CTCs [E. François, S. Puri, P. de Lagrange, D. Doyen (InterDigital)] [late]

[JVET-AH0298](https://jvet-experts.org/doc_end_user/current_document.php?id=14197) AHG11: Response to Call for training materials JVET-AG2036 [S. Puri, C. Bonnineau, I. Marzuki, R. Utida, F. Galpin (InterDigital)] [late]

[JVET-AH0299](https://jvet-experts.org/doc_end_user/current_document.php?id=14198) AHG4/AHG13: review of test material from JVET-AF0262 [P. de Lagrange (InterDigital)] [late] [miss]

## Codec performance with alternative test materials and under non-CTC conditions (2)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0048](https://jvet-experts.org/doc_end_user/current_document.php?id=13930) AHG4: ECM test results on some 8K HDR sequences [Y. Sun, Y. Zhao, E. Alshina (Huawei), Y. Li (CMG), Q. Zhang (ABP)]

[JVET-AH0067](https://jvet-experts.org/doc_end_user/current_document.php?id=13949) AHG15: ECM-12.0 Tool assessment on class G candidate sequences [S. Schwarz, M. M. Hannuksela (Nokia)]

See section 4.15

[JVET-AH0074](https://jvet-experts.org/doc_end_user/current_document.php?id=13956) Objective Results of VVC Multilayer Reference Implementation (VTM-21.0) on SDR UHD (4K) Content from JVET CTC [O. Chubach, C.-Y. Chen, T.-D. Chuang, Y.-W. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

## AHG5: Conformance test development (0)

This section is kept as a template for future use.

## AHG7: ECM tool assessment (1)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0227](https://jvet-experts.org/doc_end_user/current_document.php?id=14126) AHG7: Statistical analysis of luma and chroma intra tools in ECM versions [M. Abdoli, R. G. Youvalari, A. Tissier (Xiaomi), K. Naser, K. Reuzé, F. Le Léannec (InterDigital)] [late]

## AHG8: Optimization of encoders and receiving systems for machine analysis of coded video content (9)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0125](https://jvet-experts.org/doc_end_user/current_document.php?id=14007) AHG8/AHG9: Indication of NNPFs and processing chains for machine consumption [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

[JVET-AH0130](https://jvet-experts.org/doc_end_user/current_document.php?id=14012) AHG8: RPR for machine consumption [C. Hollmann, J. Ström, P. Wennersten, K. Andersson (Ericsson)]

[JVET-AH0253](https://jvet-experts.org/doc_end_user/current_document.php?id=14152) Crosscheck of JVET-AH0130 (AHG8: RPR for machine consumption) [D. Ding (Tencent)] [late] [miss]

[JVET-AH0143](https://jvet-experts.org/doc_end_user/current_document.php?id=14025) AHG8: Updates for technical report [C. Hollmann (Ericsson), S. Liu (Tencent), J. Chen (Alibaba)]

[JVET-AH0157](https://jvet-experts.org/doc_end_user/current_document.php?id=14056) AHG8: On combined pre-processing and post-processing for machine vision [S. Wang, B. Li, J. Chen, Y. Ye (Alibaba)]

[JVET-AH0187](https://jvet-experts.org/doc_end_user/current_document.php?id=14086) AHG8: Semantic segmentation task for VCM with PandaSet [H. Zhang, N. Le, J. Ahonen, F. Cricri, F. Pakdaman, A. Aminlou, M. M. Hannuksela (Nokia), K. Pham (Tampere University)]

[JVET-AH0254](https://jvet-experts.org/doc_end_user/current_document.php?id=14153) Crosscheck of JVET-AH0187 (AHG8: Semantic segmentation task for VCM with PandaSet) [D. Ding (Tencent)] [late] [miss]

[JVET-AH0247](https://jvet-experts.org/doc_end_user/current_document.php?id=14146) AHG8: Multi-layer VVC for hybrid machine-human consumption [J. Laitinen, T. Partanen, A. Mercat, J. Vanne (Tampere University), A. Aminlou, M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)] [late]

[JVET-AH0248](https://jvet-experts.org/doc_end_user/current_document.php?id=14147) AHG8: Reduced residual encoding in VVC for machine consumption [A. Aminlou, A. Hallapuro, H. Zhang (Nokia)] [late]

[JVET-AH0249](https://jvet-experts.org/doc_end_user/current_document.php?id=14148) AHG8: An adaptive spatial resampling method for machine vision [S. Wang, B. Li, J. Chen, Y. Ye (Alibaba)] [late]

[JVET-AH0322](https://jvet-experts.org/doc_end_user/current_document.php?id=14222) AHG8: Report of study of ground truth data [Steve Keating (Sony)] [late]

## AHG10: Encoding algorithm optimization (2)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0078](https://jvet-experts.org/doc_end_user/current_document.php?id=13960) AhG10: Distortion Propagation Factor for VVC Low-Delay Configuration [H. Guo, C. Zhu, J. Chen, L. Luo (UESTC), Y. Huo, Y. Liu (Transsion)]

[JVET-AH0320](https://jvet-experts.org/doc_end_user/current_document.php?id=14220) Crosscheck of JVET-AH0078 (AhG10: Distortion Propagation Factor for VVC Low-Delay Configuration) [J. Huo, Z. Zhang (Xidiyan Univ.)] [late] [miss]

[JVET-AH0171](https://jvet-experts.org/doc_end_user/current_document.php?id=14070) AHG10/AHG12 GOP-based RPR encoder control results on UHD test data [K. Andersson, J. Ström, P. Wennersten, W. Ahmad, C. Hollmann (Ericsson)]

## AHG13: Film grain synthesis (2+3)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0212](https://jvet-experts.org/doc_end_user/current_document.php?id=14111) AHG9/AHG13: Updates on the implementation of film grain regions characteristics SEI message [G. Teniou (Tencent), P. De Lagrange, E. François (InterDigital)] [late] [miss]

See section 6.2.3.

[JVET-AH0216](https://jvet-experts.org/doc_end_user/current_document.php?id=14115) [AHG13] Performance of denoisers on Film Grain ground truth test set [S. Paluri, D. Podborksi, A. M. Tourapis (Apple)] [late] [miss]

Also related to section 4.5/4.6?

[JVET-AH0299](https://jvet-experts.org/doc_end_user/current_document.php?id=14198) AHG4/AHG13: review of test material from JVET-AF0262 [P. de Lagrange (InterDigital)] [late] [miss]

See section 4.6.

[JVET-AH0301](https://jvet-experts.org/doc_end_user/current_document.php?id=14200) AHG4/AHG13: input for subjective quality testing of the FGC SEI message [P. de Lagrange (InterDigital)] [late] [miss]

See section 4.5.

[JVET-AH0311](https://jvet-experts.org/doc_end_user/current_document.php?id=14211) AHG13: demonstration of FGC SEI editing, and live VVC web-player with grain synthesis [P. de Lagrange (InterDigital)] [late] [miss]

## Implementation studies (0)

Section kept as a template for future use.

## Profile/tier/level specification (1)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0046](https://jvet-experts.org/doc_end_user/current_document.php?id=13928) On MV-HEVC profiles [Y.-K. Wang, H. Liu, L. Zhang, S. Jiao, C. Hu, J. Cui (Bytedance), A. M. Tourapis, D. Podborski, S. Paluri (Apple)]

## Gaming content compression (AHG15) (5)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0067](https://jvet-experts.org/doc_end_user/current_document.php?id=13949) AHG15: ECM-12.0 Tool assessment on class G candidate sequences [S. Schwarz, M. M. Hannuksela (Nokia)]

[JVET-AH0147](https://jvet-experts.org/doc_end_user/current_document.php?id=14029) AHG15: Description of the auxiliary information for the gaming content sequences proposed by Huawei [W. Chen, Z. Lin, Yu. Zhao, K. Cai, J. Sauer, E. Alshina, Yi. Zhao (Huawei)]

[JVET-AH0149](https://jvet-experts.org/doc_end_user/current_document.php?id=14031) AHG15: Description of the gaming content sequences proposed by Huawei [W. Chen, Z. Lin, Yu. Zhao, K. Cai, J. Sauer, E. Alshina, Yi. Zhao (Huawei)]

[JVET-AH0179](https://jvet-experts.org/doc_end_user/current_document.php?id=14078) AHG15: On auxiliary information for the Unity Gaming sequences proposed by InterDigital [S. Thiebaud, S. Puri, T. Poirier, F. Galpin (InterDigital)]

[JVET-AH0220](https://jvet-experts.org/doc_end_user/current_document.php?id=14119) AHG15: Configurations for gaming sequences [R. Utida, S. Puri, I. Marzuki, C. Bonnineau (InterDigital)]

## Generative face video (AHG16) (8+1)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0109](https://jvet-experts.org/doc_end_user/current_document.php?id=13991) AHG16: Removal of the analysis model on the decoder side and lightweight design [R. Zou, R.-L. Liao, B. Chen, Y. Ye, J. Chen (Alibaba)]

[JVET-AH0110](https://jvet-experts.org/doc_end_user/current_document.php?id=13992) AHG16: Scalable Representation and Layered Reconstruction for Generative Face Video Compression [B. Chen, Y. Ye, J. Chen, R.-L. Liao (Alibaba), S. Yin, S. Wang (CityU)]

[JVET-AH0113](https://jvet-experts.org/doc_end_user/current_document.php?id=13995) AHG16: Lightweight CFTE with Multi-Resolution support [R. Zou, B. Chen, R.-L. Liao, J. Chen, Y. Ye (Alibaba)]

[JVET-AH0114](https://jvet-experts.org/doc_end_user/current_document.php?id=13996) AHG16: Updated Common Software Tools for Generative Face Video Compression [B. Chen, Y. Ye (Alibaba), G. Konuko, G. Valenzise (CentraleSupelec), S. Yin, S. Wang (CityU)]

[JVET-AH0324](https://jvet-experts.org/doc_end_user/current_document.php?id=14224) Crosscheck of JVET-AH0114 (AHG 16: Updated Common Software Tools for Generative Face Video Compression) [P. Yin (Dolby)] [late] [miss]

[JVET-AH0118](https://jvet-experts.org/doc_end_user/current_document.php?id=14000) AHG9/AHG16: Showcase for picture fusion for generative face video SEI message [S. Gehlot, G. Su, P. Yin, S. McCarthy, G. J. Sullivan (Dolby)]

[JVET-AH0127](https://jvet-experts.org/doc_end_user/current_document.php?id=14009) AHG9/AHG16: The SEI message design for scalable representation and layered reconstruction for generative face video compression [J. Chen, B. Chen, Y. Ye, R.-L. Liao (Alibaba), S. Yin, S. Wang (CityU)]

[JVET-AH0138](https://jvet-experts.org/doc_end_user/current_document.php?id=14020) AHG9/AHG16: Pupil position SEI message for Generative Face Video [A. Trioux, Y. Yao, F. Ma, F. Yang (Xidian Univ.), F. Xing, Z. Wang (Hisense)]

[JVET-AH0148](https://jvet-experts.org/doc_end_user/current_document.php?id=14030) AHG9/AHG16: On key point coordinates calculation for the generative face video SEI message [K. Yang (SJTU), Y.-K. Wang (Bytedance), Y. Xu, Y. Li (SJTU)]

See section 6.2.1

[JVET-AH0239](https://jvet-experts.org/doc_end_user/current_document.php?id=14138) AHG9/AHG16: Software Implementation of Generative Face Video SEI Message [B. Chen, J. Chen, R. Zou, Y. Ye, R.-L. Liao (Alibaba), S. Wang (CityU)] [late]

# Low-level tool technology proposals (108)

## AHG11/AHG14: Neural network-based video coding (26+2)

### Summary, BoG reports, and information documents (2)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0023](https://jvet-experts.org/doc_end_user/current_document.php?id=14054) EE1: Summary report of exploration experiment on neural network-based video coding [E. Alshina, F. Galpin, Y. Li, D. Rusanovskyy, M. Santamaria, J. Ström, R. Chang, Z. Xie]

[JVET-AH0043](https://jvet-experts.org/doc_end_user/current_document.php?id=13924) [AHG11] [AHG14] AHG meeting report on NNVC [E. Alshina, F. Galpin]

### EE1 contributions: Neural network-based video coding (13)

Contributions in this area were discussed in the context of the EE summary report JVET-AH0023, unless noted otherwise.

[JVET-AH0042](https://jvet-experts.org/doc_end_user/current_document.php?id=13923) EE1-1.0: Report on joint LOP2 training [D. Rusanovskyy, Y. Li, M. Karczewicz (Qualcomm), T. Shao, P. Yin, S. McCarthy (Dolby), J. N. Shingala, A. Shyam, A. Suneja, S. P. Badya (Ittiam)]

[JVET-AH0050](https://jvet-experts.org/doc_end_user/current_document.php?id=13932) EE1-1.1: LOP candidate with Low Complexity TB and new BB structure [T. Shao, P. Yin, S. McCarthy (Dolby), J. N. Shingala, A. Shyam, A. Suneja, S. P. Badya (Ittiam), D. Rusanovskyy, Y. Li, M. Karczewicz (Qualcomm)]

[JVET-AH0051](https://jvet-experts.org/doc_end_user/current_document.php?id=13933) EE1-5: Study of the NN architecture at Very Low Operational Point [D. Rusanovskyy, Y. Li, M. Karczewicz (Qualcomm), J. Li, Y. Li, C. Lin, K. Zhang, L. Zhang (Bytedance), Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AH0080](https://jvet-experts.org/doc_end_user/current_document.php?id=13962) EE1-1.2: Joint LOP model with inputs transformed [D. Liu, J. Ström, M. Damghanian, P. Wennersten (Ericsson), D. Rusanovskyy, Y. Li, M. Karczewicz (Qualcomm), T. Shao, P. Yin, S. McCarthy (Dolby), J. N. Shingala, A. Shyam, A. Suneja, S. P. Badya (Ittiam)]

[JVET-AH0277](https://jvet-experts.org/doc_end_user/current_document.php?id=14176) Crosscheck of JVET-AH0080 (EE1-1.2: Joint LOP model with inputs transformed) [R. Chang (Tencent)] [late]

[JVET-AH0081](https://jvet-experts.org/doc_end_user/current_document.php?id=13963) EE1-1.3: Training from scratch for the joint LOP model with inputs transformed [D. Liu, J. Ström, M. Damghanian, P. Wennersten (Ericsson), D. Rusanovskyy, Y. Li, M. Karczewicz (Qualcomm), T. Shao, P. Yin, S. McCarthy (Dolby), J. N. Shingala, A. Shyam, A. Suneja, S. P. Badya (Ittiam)]

[JVET-AH0250](https://jvet-experts.org/doc_end_user/current_document.php?id=14149) Crosscheck of JVET-AH0081 (EE1-1.3: Training from scratch for the joint LOP model with inputs transformed) [M. Santamaria (Nokia)] [late]

[JVET-AH0096](https://jvet-experts.org/doc_end_user/current_document.php?id=13978) EE1-1.4: Content-adaptive loop-filter [M. Santamaria, R. Yang, F. Cricri, M. M. Hannuksela, D. Bugdayci Sansli, A. Hallapuro, H. R. Tavakoli, J. Lainema, H. Zhang (Nokia)]

[JVET-AH0241](https://jvet-experts.org/doc_end_user/current_document.php?id=14140) Crosscheck of JVET-AH0096 (EE1-1.4: Content-adaptive loop-filter) [D. Liu (Ericsson)] [late]

[JVET-AH0099](https://jvet-experts.org/doc_end_user/current_document.php?id=13981) EE1-4.1: Adaptive resolution coding for NNVC-8.0 with RPR [C. Lin, Y. Li, J. Li, K. Zhang, L. Zhang (Bytedance), Z. Lv, C. Zhou (vivo)]

[JVET-AH0263](https://jvet-experts.org/doc_end_user/current_document.php?id=14162) Crosscheck of JVET-AH0099 (EE1-4.1: Adaptive resolution coding for NNVC-8.0 with RPR s=1.5) [C. Lin (Bytedance)] [late]

[JVET-AH0266](https://jvet-experts.org/doc_end_user/current_document.php?id=14165) Crosscheck of JVET-AH0099 (EE1-4.1: Adaptive resolution coding for NNVC-8.0 with RPR s=2.0) [Z. Lv (vivo)] [late] [miss]

[JVET-AH0104](https://jvet-experts.org/doc_end_user/current_document.php?id=13986) EE1-4.2: Adaptive resolution coding for NNVC-8 [C. Zhou, Z. Lv (vivo)]

[JVET-AH0265](https://jvet-experts.org/doc_end_user/current_document.php?id=14164) Crosscheck of JVET-AH0104 (EE1-4.2: Adaptive resolution coding for NNVC-8) [C. Lin (Bytedance)] [late] [miss]

[JVET-AH0107](https://jvet-experts.org/doc_end_user/current_document.php?id=13989) EE1-3.1: Deep Reference Frame Generation for Inter Prediction Enhancement [W. Bao, N. Fu, X. Chen, J. Jia, Z. Chen (Wuhan Univ.), Z. Liu, X. Xu, S. Liu (Tencent)]

[JVET-AH0280](https://jvet-experts.org/doc_end_user/current_document.php?id=14179) crosscheck of JVET-AH0107 (EE1-3.1: Deep Reference Frame Generation for Inter Prediction Enhancement) [Z. Xie (OPPO)] [late] [miss]

[JVET-AH0133](https://jvet-experts.org/doc_end_user/current_document.php?id=14015) EE1-4.3: RPR new input for super-resolution [J. Ye, X. Li, Y. Zhu, Q. Liu (HUST), C. Zhou, M. Rafie, Z. Lv (vivo)]

[JVET-AH0303](https://jvet-experts.org/doc_end_user/current_document.php?id=14202) Crosscheck of AH0133 (EE1-4.3: RPR new input for super-resolution) [Y. Zhou, X. Zhang, J. Zhang (PKU/UCAS?)] [late] [miss]

[JVET-AH0188](https://jvet-experts.org/doc_end_user/current_document.php?id=14087) EE1-2.1: HOP separate models [Y. Li, C. Lin, J. Li, K. Zhang, L. Zhang (Bytedance), F. Galpin (InterDigital), D. Rusanovskyy (Qualcomm), R. Chang (Tencent)]

[JVET-AH0189](https://jvet-experts.org/doc_end_user/current_document.php?id=14088) EE1-2.2: Wide activation HOP model [[Y. Li](mailto:yue.li@bytedance.com), J. Li, C. Lin, K. Zhang, L. Zhang (Bytedance)]

[JVET-AH0281](https://jvet-experts.org/doc_end_user/current_document.php?id=14180) Crosscheck of JVET-AH0189 (EE1-2.2: Wide activation HOP model) [F. Galpin (InterDigital)] [late] [miss]

[JVET-AH0205](https://jvet-experts.org/doc_end_user/current_document.php?id=14104) EE1-2.3: Integer implementation of HOP In-loop filter with Transformer blocks and Attention blocks [Y. Li, D. Rusanovskyy, M. Karczewicz (Qualcomm)]

[JVET-AH0278](https://jvet-experts.org/doc_end_user/current_document.php?id=14177) Crosscheck of JVET-AH0205 (EE1-2.3: Integer implementation of HOP In-loop filter with Transformer blocks and Attention blocks) [R. Chang (Tencent)] [late]

### EE1 related contributions: Neural network-based video coding (5)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0100](https://jvet-experts.org/doc_end_user/current_document.php?id=13982) EE1-related: Multiple scaling ratios coding for NNVC with NNSR [Z. Lv, C. Zhou (vivo)]

[JVET-AH0264](https://jvet-experts.org/doc_end_user/current_document.php?id=14163) Crosscheck of JVET-AH0100 (EE1-related: Multiple scaling ratios coding for NNVC with NNSR) [C. Lin (Bytedance)] [late]

[JVET-AH0195](https://jvet-experts.org/doc_end_user/current_document.php?id=14094) EE1-related: Complexity reduction of NN in-loop filters through early cropping [J. Ström, M. Damghanian, D. Liu, P. Wennersten (Ericsson)]

[JVET-AH0206](https://jvet-experts.org/doc_end_user/current_document.php?id=14105) EE1 related: Additional inference test for EE1-2.3 to adjust luma-chroma balance [Y. Li, D. Rusanovskyy, M. Karczewicz (Qualcomm)]

[JVET-AH0207](https://jvet-experts.org/doc_end_user/current_document.php?id=14106) EE1 related: LOP input adjustment with trainable input transform [Y. Li, D. Rusanovskyy, M. Karczewicz (Qualcomm)]

[JVET-AH0312](https://jvet-experts.org/doc_end_user/current_document.php?id=14212) EE1-4 related: On training data of super resolution [C. Lin, Y. Li, J. Li, K. Zhang, L. Zhang (Bytedance)] [late]

### Improvements of NNVC beyond EE1 (5)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0077](https://jvet-experts.org/doc_end_user/current_document.php?id=13959) AHG11: A Low-Complexity Neural Network Loop Filter based on Partial Convolution and Over-Parameterization [A. Li, C. Zhu, L. Luo (UESTC), Y. Huo, Y. Liu (Transsion)]

[JVET-AH0087](https://jvet-experts.org/doc_end_user/current_document.php?id=13969) AhG11: LOP/HOP training strategy study [F. Galpin, T. Dumas, P. Bordes (InterDigital)]

[JVET-AH0120](https://jvet-experts.org/doc_end_user/current_document.php?id=14002) AHG11 Response to Call for training materials JVET-AG2036 [F. Galpin, R. Gendrot, E. François, V. Allie (InterDigital)] [late]

See also section 4.6

[JVET-AH0139](https://jvet-experts.org/doc_end_user/current_document.php?id=14021) AhG11: LOP/HOP ablation study [F. Galpin, T. Dumas, P. Bordes (InterDigital)]

[JVET-AH0165](https://jvet-experts.org/doc_end_user/current_document.php?id=14064) AHG11: Combination of the neural network-based intra prediction mode and ISP [T. Dumas, F. Galpin, P. Bordes (InterDigital)]

[JVET-AH0196](https://jvet-experts.org/doc_end_user/current_document.php?id=14095) [AhG11] On Low Complexity Operational Point for In-Loop Filtering [T. Ryder, S. Eadie, Y. Li, D. Rusanovskyy, M. Karczewicz (Qualcomm)]

[JVET-AH0298](https://jvet-experts.org/doc_end_user/current_document.php?id=14197) AHG11: Response to Call for training materials JVET-AG2036 [S. Puri, C. Bonnineau, I. Marzuki, R. Utida, F. Galpin (InterDigital)] [late]

See also section 4.6

### SADL and NNVC implementation (3)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0064](https://jvet-experts.org/doc_end_user/current_document.php?id=13946) AHG14: Port VTM Temporal Filter Fixes to NNVC software and Enable Temporal Filter in NNVC LD CTC [X. Li (Google)]

[JVET-AH0306](https://jvet-experts.org/doc_end_user/current_document.php?id=14205) Crosscheck of JVET0064 AHG14: Port VTM Temporal Filter Fixes to NNVC software and Enable Temporal Filter in NNVC LD CTC [F. Galpin (InterDigital)] [late] [miss]

[JVET-AH0088](https://jvet-experts.org/doc_end_user/current_document.php?id=13970) AhG14: SADL update [F. Galpin, T. Dumas, P. Bordes, E. François (InterDigital)]

[JVET-AH0106](https://jvet-experts.org/doc_end_user/current_document.php?id=13988) AHG14: The extension of SADL library [N. Fu, W. Bao, Z. Chen (Wuhan Univ.)]

## AHG6/AHG12: Enhanced compression beyond VVC capability (87+1)

### Summary and BoG reports (1)

Contributions in this area were discussed at 1400–XXXX on Wednesday 17 April 2024 (chaired by JRO).

[JVET-AH0024](https://jvet-experts.org/doc_end_user/current_document.php?id=14055) 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]

**List of tests**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Partitioning** | | | |
| 1.1a | Temporal prediction of split modes | G. Laroche  (Canon) | R. Utida  (InterDigital) |
| 1.1b | Test 1.1a + Maximum MTT depth adaptation | G. Laroche  (Canon) | R. Utida  (InterDigital) |
| 1.1c | Test 1.1b + Prediction of split syntax elements order | G. Laroche  (Canon) | R. Utida  (InterDigital)  H. Huang  (Qualcomm) |
| 1.1d | Test 1.1c - Maximum MTT depth adaptation decrease only | G. Laroche  (Canon) | H. Huang  (Qualcomm) |
| **2 Intra prediction** | | | |
| 2.1 | TIMD merge mode | R. Youvalari (Xiaomi) | I. Zupancic  (Nokia)  Y. Wang  (Bytedance) |
| 2.2 | Occurrence-based intra coding | R. Youvalari (Xiaomi) | P. Nikitin  (Qualcomm) |
| 2.3a | Intra prediction using merged histogram of gradients | S. Blasi  (Nokia) | K. Naser (Interdigital) |
| 2.3b | Intra prediction using merged histogram of gradients (without restrictions) | S. Blasi  (Nokia) | K. Naser (Interdigital) |
| 2.4 | DIMD merge list | M. Blestel  (Ofinno) | K. Reuzé  (InterDigital) |
| 2.5a | Test 2.3a + Test 2.4 | S. Blasi  (Nokia)  M. Blestel  (Ofinno) | C. Zhou (Vivo) |
| 2.5b | Test 2.3a + Test 2.4 + Test 2.2 | R. Youvalari (Xiaomi)  S. Blasi  (Nokia)  M. Blestel  (Ofinno) | K. Reuzé  (InterDigital) |
| 2.5c | Test 2.3a + Test 2.2 | R. Youvalari (Xiaomi)  S. Blasi  (Nokia) | M. Salehifar  (ByteDance) |
| 2.5d | Test 2.4 + Test 2.2 | R. Youvalari (Xiaomi)  M. Blestel  (Ofinno) | M. Salehifar  (ByteDance) |
| 2.6a | Adaptive MRL fusion with fixed weights | S. Blasi  (Nokia) | R. Youvalari (Xiaomi) |
| 2.6b | Adaptive MRL fusion with adaptive weights | S. Blasi  (Nokia) | R. Youvalari (Xiaomi) |
| 2.7 | Relaxing line buffer restriction | Z. Deng  (Bytedance) | H. Huang  (Qualcomm)  JVET-AH0282 |
| 2.8 | Test 2.6b + Test 2.7 | Z. Deng  (Bytedance)  S. Blasi  (Nokia) | H. Huang  (Qualcomm)  JVET-AH0283 |
| 2.9a | EIP with bias | J. Lainema (Nokia) | L. Xu (OPPO) |
| 2.9b | EIP with clipping | J. Lainema (Nokia) | L. Xu (OPPO) |
| 2.9c | EIP with bias and clipping | J. Lainema (Nokia) | K. Andersson (Ericsson) |
| 2.10a | SATD based IntraTMP BV search without signalling | W. Chen  (Kwai) | L.Zhao (Bytedance)  R.-L.Liao  (Alibaba) |
| 2.10b | SATD based IntraTMP BV search with signalling | K. Naser  (InterDigital) | withdrawn |
| 2.10c | MR-SAD based IntraTMP BV search with signalling | K. Naser  (InterDigital) | S. Blasi (Nokia) JVET-AH0294 |
| 2.10d | IntraTMP BV reordering | W. Chen  (Kwai) | L.Zhao (Bytedance)  R.-L.Liao  (Alibaba) |
| 2.10e | Test 2.10a + Test 2.10d | W. Chen  (Kwai) | not provided |
| 2.10f | Test 2.10a + Test 2.10c + Test 2.10d | K. Naser  (InterDigital)  W. Chen  (Kwai) | G. Verba  (Qualcomm)  JVET-AH0305 |
| 2.10g | Test 2.10d + Test 2.11c | W. Chen  (Kwai)  L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) | X. Li  (Google)  JVET-AH0229  C. Zhou  (vivo)  JVET-AH0297 |
| 2.10h | Test 2.10a + Test 2.10c + Test 2.10d + Test 2.11c | K. Naser  (InterDigital)  W. Chen  (Kwai)  L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) | G. Verba  (Qualcomm) |
| 2.11a | Auto-relocated BVP for IntraTMP merge candidates | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) | X. Li  (Alibaba)  JVET-AH0267 |
| 2.11b | Template matching based sorting of IntraTMP merge candidates with maximum list size of N | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) | X. Li  (Alibaba)  JVET-AH0267 |
| 2.11c | Test 2.11a + Test 2.11b | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) | X. Li  (Alibaba)  JVET-AH0267 |
| 2.11d | Test 2.11c + Restricting the BV range for IntraTMP merge candidates | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) | X. Li  (Alibaba)  JVET-AH0267 |
| 2.12a | Chroma mode reordering based on unextended list | X. Li  (Alibaba) | Z. Deng  (Bytedance)  L. Xu  (OPPO) |
| 2.12b | Chroma mode reordering based on extended list | X. Li  (Alibaba) | Z. Deng  (Bytedance)  L. Xu  (OPPO) |
| 2.13 | Matrix based intra prediction replacing conventional intra modes | B. Ray  (Qualcomm) | Y. Wang  (Bytedance)  JVET-AH0260 |
| 2.14a | Bilateral filtering for intra prediction (not applied to planar mode) | W. Yin  (Bytedance) | V. Shchukin  (Ericsson)  JVET-AH0240 |
| 2.14b | Bilateral filtering for intra prediction (applied to planar mode) | W. Yin  (Bytedance) | V. Shchukin  (Ericsson)  JVET-AH0240 |
| **3** **Inter prediction** | | | |
| 3.1a | Chained motion vector prediction | Y. Kidani (KDDI) | P.-H Lin (Qualcomm) |
| 3.1b | Test 3.1a + Restriction of only motion from collocated pictures | Y. Kidani (KDDI) | P.-H Lin  (Qualcomm) |
| 3.2a | Removing the one-CTU-row temporal buffer constraint for all relevant tools | Z. Deng  (Bytedance) | Y. Kidani (KDDI)  JVET-AH0236 |
| 3.2b | Imposing the one-CTU-row temporal buffer constraint on all relevant tools | Z. Deng  (Bytedance) | Y. Kidani (KDDI)  JVET-AH0236 |
| 3.2c | Test 3.2a + Test 3.1a | Z. Deng  (Bytedance)  Y. Kidani (KDDI) | D. Ruiz Coll (Ofinno)  JVET-AH0214 |
| 3.2d | Test 3.2b + Test 3.1a | Z. Deng  (Bytedance)  Y. Kidani (KDDI) | D. Ruiz Coll (Ofinno)  JVET-AH0214 |
| 3.3 | Inter CCP merge mode with zero luma CBF | Z. Deng  (Bytedance) | Z. Lv  (vivo)  JVET-AH0102 |
| 3.4 | Adaptive GPM blending | L. Zhao  (Bytedance) | Z. Zhang  (Qualcomm) |
| 3.5a | LIC model inheritance for GPM | C.-C. Chen  (Qualcomm) | L. Zhao  (Bytedance)  JVET-AH0291 |
| 3.5b | Test 3.5a + LIC model inheritance for merge modes at LIC flag swapping stage | C.-C. Chen  (Qualcomm) | L. Zhao  (Bytedance)  JVET-AH0291 |
| 3.5c | Test 3.5a + LIC model inheritance for merge modes at ARMC stage | C.-C. Chen  (Qualcomm) | L. Zhao  (Bytedance)  JVET-AH0291 |
| 3.5d | Test 3.4 + Test 3.5c | C.-C. Chen  (Qualcomm)  L. Zhao  (Bytedance) | H.-J. Jhu  (Kwai) |
| 3.6a | Reference filtering for inter-prediction (with reference sample classification into 2 groups) | V. Rufitskiy (Ofinno) | Y. Kidani  (KDDI) |
| 3.6b | Reference filtering for inter-prediction (with reference sample classification into the extended number of groups) | V. Rufitskiy (Ofinno) | Y. Kidani  (KDDI) |
| 3.7a | TM-based motion refinement with more candidates for SbTMVP | J. Chen  (Alibaba) | L. Zhao  (Bytedance)  JVET-AH0257 |
| 3.7b | TM-based motion refinement for affine candidates | J. Chen  (Alibaba) | L. Zhao  (Bytedance)  JVET-AH0257 |
| 3.7c | Test 3.7a + Test 3.7b | J. Chen (Alibaba) | L. Zhao  (Bytedance)  JVET-AH0257  Z. Lv  (vivo)  JVET-AH0268 |
| **4 Transform and coefficients coding** | | | |
| 4.1 | Multiple transform set selection for LFNST/NSPT | F. Wang  (OPPO) | M. Koo  (LGE)  JVET-AH0252 |
| 4.2 | Fix on LFNST/NSPT index signalling for inter coding | M. Koo  (LGE) |  |
| 4.3 | 16 states TCQ | M. Balcilar  (InterDigital) | M. Coban  (Qualcomm) |
| **5 In-loop filtering** | | | |
| 5.1a | Adaptive precision for CCALF coefficients | N. Hu  (Qualcomm)  N. Song  (OPPO) | W. Yin  (Bytedance)  JVET-AH0269 |
| 5.1b | Adaptive precision for CCALF coefficients with precision used for luma ALF coefficients | N. Hu  (Qualcomm)  N. Song  (OPPO) | W. Yin  (Bytedance)  JVET-AH0269 |
| 5.1c | Removal of power of 2 constrain for CCALF coefficients | N. Hu  (Qualcomm)  N. Song  (OPPO) | W. Yin  (Bytedance)  JVET-AH0269 |
| 5.1d | Test 5.1a + Test 5.1c | N. Hu  (Qualcomm)  N. Song  (OPPO) | W. Yin  (Bytedance)  JVET-AH0269 |
| 5.1e | Test 5.1b + Test 5.1c | N. Hu  (Qualcomm)  N. Song  (OPPO) | W. Yin  (Bytedance)  JVET-AH0269 |
| 5.2a | Coding information based classification for ALF (with partitioning info only) | W. Yin  (Bytedance)  N. Hu  (Qualcomm) | N. Song  (OPPO)  JVET-AH0313 |
| 5.2b | Coding information based classification for ALF (with prediction info only) | W. Yin  (Bytedance)  N. Hu  (Qualcomm) | N. Song  (OPPO)  JVET-AH0313 |
| 5.2c | Test 5.2a + Test 5.2b | W. Yin  (Bytedance)  N. Hu  (Qualcomm) | N. Song  (OPPO)  JVET-AH0313 |
| **6 Entropy coding** | | | |
| 6.1a | Switching of context initialization for B-slice at slice level | R.-L. Liao  (Alibaba) | Z. Deng  (Bytedance)  JVET-AH0238 |
| 6.1b | Switching of context initialization for B-slice at sequence level | R.-L. Liao  (Alibaba) | Z. Deng  (Bytedance)  JVET-AH0238 |
| 6.2a | Extended entropy coding with non equiprobable coding | F. Galpin (InterDigital) | M. Abdoli  (Xiaomi)  M. Blestel  (Ofinno)  [M. Coban](mailto:mcoban@qti.qualcomm.com)  (Qualcomm) |
| 6.2b | Test 6.2a but trained on another dataset | F. Galpin (InterDigital) | M. Abdoli  (Xiaomi)  M. Blestel  (Ofinno)  [M. Coban](mailto:mcoban@qti.qualcomm.com)  (Qualcomm) |
| 6.3 | Test 6.1 + Test 6.2 | F. Galpin (InterDigital)  R.-L. Liao  (Alibaba) | H.-J. Jhu  (Kwai)  JVET-AH0251 |

***Partitioning***

**Test 1.1: Temporal partitioning prediction ([JVET-AH0135](https://jvet-experts.org/doc_end_user/current_document.php?id=14017))**

In this method, temporal prediction of partitioning is utilized:

* Temporal prediction of split modes

For each block, the allowances of split modes (QT, BT, TT) are predicted according to the minimum QT split and the average QT split obtained from a temporal area, and whether TT split is elected in a parent node.

* Temporal prediction of maximum MTT depth

The maximum MTT depth can be increased or decreased based on whether a reference picture is inter or intra picture, temporal ID, POC distance, and based on the current QT and MTT depths comparing to the ones of the reference picture.

* Temporal prediction of split syntax elements

split\_qt\_flag is signalled first before split\_cu\_flag if QT depth is smaller than the average temporal QT depth, otherwise it is signalled after split\_cu\_flag as it is currently in ECM.

Test 1.1a: Temporal prediction of split modes

Test 1.1b: Test 1.1a with temporal prediction of maximum MTT depth

Test 1.1c: Test 1.1b with temporal prediction of split syntax elements

Test 1.1d: Test 1.1c but the maximum MTT depth can be only decreased in the adaptation process

(not applicable for AI)



Why is decoding runtime increased? May be due to preference for smaller partitions, according to proponents. Cannot be explained by additional processing.

Tests c and d would give advantage either in coding efficiency (c), or reduction of encoding time (d). It is noted that the decoding process is different in c and d. In terms of tradeoff, d is asserted to provide better tradeoff encoder runtime vs. complexity. It was asked if d could be built as an encoder optimization of c, but according to proponents this is not the case (or would have higher losses).

Decision: Adopt JVET-AH0135 tests c and d, configurable by SPS flag, test d in CTC.

***Intra prediction***

**Test 2.1: TIMD merge mode ([JVET-AH0075](https://jvet-experts.org/doc_end_user/current_document.php?id=13957))**

In ECM, TIMD prediction is derived by a fusion of up to 3 intra modes with the smallest SATD cost with the weights corresponding to the template cost.

In the test, TIMD merge list of size 5 is constructed by adding TIMD information (prediction modes, fusion flag, fusion weights and wide-angle conditions of TIMD modes, MTS transform types) from adjacent and non-adjacent neighbouring blocks shown in the next figure.



TIMD candidates are sorted in the list based on SAD template cost.

The TIMD merge mode is applied to only luma blocks and is disabled for 4x4 block sizes. A flag is signalled in TIMD branch to indicate the mode usage and if more than one candidate is used, a syntax element is signalled to indicate the selected candidate.

Test 2.1a: TIMD merge mode with the best candidate selected from the list.

Test 2.1b: TIMD merge mode with the two best candidates selected from the list.

**Test 2.2: Occurrence-based intra coding ([JVET-AH0076](https://jvet-experts.org/doc_end_user/current_document.php?id=13958))**

In DIMD, up to 5 intra modes are derived using histogram of gradients to be combined with Planar mode or BV predictor.

In the test, a new prediction mode is evaluated, where up to 5 intra modes are derived based on sample-wise occurrence of the intra modes in the adjacent and non-adjacent neighboring blocks. Instead of histogram of gradient, the histogram of occurrence consisting of the intra modes and their sample-wise occurrences is used. The occurrence values are calculated based on the number of samples that are coded in a certain intra prediction mode in that neighborhood. For example, if a uiWidth × uiHeight block is coded with an IPM mode, the occurrence of the mode in that particular block is calculated as:

HoC[IPM] += uiWidth \* uiHeight;

Where uiWidth and uiHeight are the width and height of a neighboring block.

The occurrences of the existing modes from the spatial neighborhood blocks are accumulated into the histogram.

Some neighbouring blocks may use more than one intra mode for prediction, for example coded with coded with DIMD, TIMD, or SGPM. In such cases, all the intra modes of such blocks are selected and used when creating the histogram of occurrence. MIP, IntraTMP, IBC, and EIP blocks are considered only in inter slices.

The blending weights are calculated similar to the DIMD mode, but instead of using gradient values from the template, the occurrence values are used in the test.

Moreover, the mode is disabled for blocks that have less than 64 samples.

**Test 2.3: Intra-prediction using merged histogram of gradients ([JVET-AH0092](https://jvet-experts.org/doc_end_user/current_document.php?id=13974))**

In this method, a new intra prediction mode similar to DIMD is added based on the computation of a merged histogram of gradient, which is computed based on the information extracted from neighbouring blocks, including both DIMD and non-DIMD neighbours.

For DIMD neighbours, the histogram of gradients of those blocks are directly considered and is scaled depending on the block size.

For non-DIMD neighbours, the histogram of gradients is derived from the intra prediction mode used in those blocks.

Test 2.3a: Merged histogram of gradients with restrictions. The mode is restricted to only be used if the current block has an area larger or equal than 64 samples, and only if there is at least one neighbouring block coded with DIMD.

Test 2.3b: Merged histogram of gradients without restrictions.

**Test 2.4: DIMD merge list ([JVET-AH0090](https://jvet-experts.org/doc_end_user/current_document.php?id=13972))**

In this method, DIMD merge list is derived from neighbouring adjacent and non-adjacent blocks’ DIMD information. DIMD merge candidate is added to the DIMD merge list when the associated DIMD information is different from every information from DIMD merge candidates already present in the list and the current block DIMD information.

A mode flag and mode index are signalled in a bitstream. DIMD merge is used, and flag is signaled only if the current block has at least one neighbour coded with DIMD or DIMD merge modes.

**Test 2.5: Combination of DIMD related tests ([JVET-AH0128](https://jvet-experts.org/doc_end_user/current_document.php?id=14010))**

In the combination, a merge list is built as in Test 2.4.

Test 2.5a: Test 2.3a + Test 2.4, DIMD parameters are derived as in Test 2.3a.

Test 2.5b: Test 2.2 + Test 2.3a + Test 2.4, DIMD parameters are derived as in Test 2.3a and Test 2.2.

Test 2.5c: Test 2.2 + Test 2.3aTest 2.5d: Test 2.2 + Test 2.4

**Test 2.6: Adaptive MRL fusion ([JVET-AH0093](https://jvet-experts.org/doc_end_user/current_document.php?id=13975))**

In this test, adaptive MRL fusion is tested, where the MRL index is used to derive the two predictors. When the current MRL index *i* = 0, then MRL indexes 1 and 2 are used to compute the two additional predictors. Conversely, when the current MRL index is *i > 0*, then the MRL indexes *i*+ 1 and *i* – 1 are used to compute the two additional predictors.

The final prediction is then obtained as a weighted average of the two additional predictors P1 and P2 and the main predictor Pmain:

P = Wmain x Pmain + W1 x P1 + W2 x P2

In Test 2.6a, fixed weights equal to 5/8, 2/8 and 1/8 are used to blend the predictors.

In Test 2.6b, the fusion weights are determined adaptively for each block using a template-based search, where MRL index line is used to perform intra prediction for the template resulting in the template cost.

**Test 2.7: Relaxing line buffer restriction ([JVET-AH0065](https://jvet-experts.org/doc_end_user/current_document.php?id=13947))**

In ECM, several intra tools follow the above one-line CTU buffer constraint, while many other intra tools do not follow the constraint. In the test, the above one CTU line constraint is removed for the remaining intra tools: extended MRL, template based MRL, and intra luma fusion.

**Test 2.8: Combination of Test 2.6b and Test 2.7 ([JVET-AH0094](https://jvet-experts.org/doc_end_user/current_document.php?id=13976))**

**Test 2.9: EIP with bias and clipping ([JVET-AH0086](https://jvet-experts.org/doc_end_user/current_document.php?id=13968))**

In the test, bias term 2bitdepth-1 and a clipping of the predicted sample to be in the range for the reference samples rather the full sample value range are applied.

Test 2.9a: EIP with bias

Test 2.9b: EIP with clipping

Test 2.9c: Test 2.9a + Test 2.9b

**Test 2.10ad: SATD based IntraTMP BV search without signalling and BV reordering ([JVET-AH0200](https://jvet-experts.org/doc_end_user/current_document.php?id=14099))**

In the current IntraTMP, the best prediction block is determined by matching the L-shaped reconstructed neighbouring samples of the CU (based on the SAD cost) in a predefined search range. In the initial search, the IntraTMP search regions are subsampled by a factor of 3. After finding the best match, a refinement process is further applied by refining the BV around the best match within a reduced range.

Sub-pel precision is also enabled for IntraTMP, which includes three sub-pel positions (1/2-pel, 1/4-pel and 3/4-pel). For each sub-pel position, eight directions are supported, the selected sub-pel BV is explicitly signalled in bitstream, which takes up to 6-bit signalling overhead.

In Test 2.10a, SATD cost function is used instead of SAD for the integer BV refinement process then the initial BV is determined based on the subsampled template matching using SAD. SATD is always enabled at the refinement stage without any control signalling.

In Test 2.10d, reordering of the candidate list consisting of the results of integer BV search and 16 sub-pel BVs (1/2-, 1/4-pel with eight directions) amount the selected inter BV is performed. The list is sorted based on the SAD cost between the template samples of the current CU and their corresponding prediction samples. After the reordering, the first two candidates are allowed to be selected with one single flag being signalled from encoder to decoder.

**Test 2.10c: MR-SAD based IntraTMP BV search with signalling ([JVET-AH0244](https://jvet-experts.org/doc_end_user/current_document.php?id=14143))**

In the test, a CU-level signalling is signalled to alternate between SAD and MR-SAD cost functions for IntraTMP. The encoder performs two template searches to generate two BV candidate lists (SAD- and MR-SAD based), while the decoder performs SAD or MR-SAD template search depending on the CU flag.

To reduce redundancies between the two lists, starting point for MR-SAD template search is shifted by half of the subsampling factor that is used for the sparce search.

**Test 2.10ef: Combination tests for IntraTMP cost functions**

Test 2.10e: Test 2.10a + Test 2.10d (not provided)

Test 2.10f: Test 2.10a + Test 2.10d + Test 2.10c ([JVET-AH0245](https://jvet-experts.org/doc_end_user/current_document.php?id=14144))

**Test 2.11: Auto-relocated BVP for IntraTMP merge candidates ([JVET-AH0055](https://jvet-experts.org/doc_end_user/current_document.php?id=13937))**

In the current IntraTMP, adjacent and non-adjacent blocks are checked to construct a merge list of candidates, up to 10 merge candidates are kept for further refinement.

In Test 2.11a, additional auto-relocated BVP are introduced, where 10 merge candidates derived in IntraTMP are sued as a guiding BVs to construct auto-relocated BVPs by adding the BVs of the reference blocks. Up to 20 auto relocated BVPs are constructed and there would be up to 30 merge candidates in total. If an auto relocated BVP candidate is selected for refinement, it would have a refinement range of 3x3.

In Test 2.11b, the template matching based sorting process for IntraTMP merge candidates is introduced. Up to 50 merge candidates are derived from the neighbouring PUs. Then the best 10 candidates are kept by ranking the template matching cost instead of prioritizing candidates outside the IntraTMP search range. SAD or MR-SAD is used for calculating the cost depending on the tmpLicFlag.

Test 2.11c: Test 2.11a + Test 2.11b

Test 2.11d: Test 2.11c with the restriction for reference block and template to be within the IBC search range.

**Test 2.10gh: Combination of IntraTMP tests**

Test 2.10g: Test 2.10d + Test 2.11c ([JVET-AH0201](https://jvet-experts.org/doc_end_user/current_document.php?id=14100))

Test 2.10h: Test 2.10a + Test 2.10d + Test 2.10c + Test 2.11c ([JVET-AH0246](https://jvet-experts.org/doc_end_user/current_document.php?id=14145))

**Test 2.12: Chroma intra prediction mode reordering ([JVET-AH0136](https://jvet-experts.org/doc_end_user/current_document.php?id=14018))**

In ECM-12.0, there are 7 non-CCP chroma intra prediction modes: chroma DBV mode, DM mode, chroma DIMD mode, and four default modes (i.e. planar mode, vertical mode, horizontal mode and DC mode). A fixed order is used to parse the non-CCP modes.

In the test, a non-CCP chroma intra prediction mode list is reordered.

In Test 2.12a, the list was constructed by adding the existing 7 non-CCP intra prediction modes as in ECM. In Test 2.12b, this list is further extended by adding the collocated luma modes, adjacent chroma modes, and collocated luma BVs as shown in the next figure.



Then, the non-CCP chroma intra prediction modes in the list are used to predict the collocated luma block and the template of the current chroma block. This template includes one top row and one left column of the current chroma block. The modes in the list are reordered based on a combined SATD cost, calculated as follows:



Only the first N modes in the list can be allowed for the current chroma block. If at least one of the luma blocks in the five collocated locations is coded with IBC or IntraTMP mode, N is equal to 7, otherwise, N is equal to 6.

**Test 2.13: Matrix based intra prediction replacing conventional intra modes ([JVET-AH0209](https://jvet-experts.org/doc_end_user/current_document.php?id=14108))**

In this test, a matrix of weights, which are defined for a block shape and intra mode, is introduced, those weights are multiplied by the neighbour reference template to derive the prediction samples replacing conventional intra prediction. The weights are applied to the reference samples of the L shaped causal neighborhood template as shown in the next figure.

A blue rectangular object with arrows

Description automatically generated

The reference samples in the causal neighborhood are denoted as r, and F(x,y) is the matrix of weights. Then the prediction P(x,y) can be derived as

P(x,y) = ∑k F(x,y,k)\*r(k),

where k denotes the index of the reference sample in the template.

In the test, this prediction is used for block size with both width and height up to 32 (except for 4x32,32x4, 8x32 and 32x8). The template size is 2 for blocks with both width and height up to 16 and it is only used for mode 0, 1, and (2+2\*k). For other blocks, template size is set to 1; is used for mode 0, 1, and (2+4\*k); prediction is only performed for 16x16 positions, and the rest of the samples are generated by bilinear interpolation. For all block sizes, block shape and mode-based symmetry is used. Reference length is set to W and H for modes greater than 18 and less than 50 and set to 2\*W and 2\*H otherwise.

The filters are trained with BVI sequences composing of 800 sequences with diverse resolutions.

MAC for per block shapes for reference length 2\*W and 2\*H are provided in the below table. MAC numbers for reference length W and H are roughly half of those. Total number of coefficients is 1.84M with 3.68MB memory.

|  |  |
| --- | --- |
| **Block shape** | **MAC/sample** |
| 4x4 | 36 |
| 4x8/8x4 | 52 |
| 8x8 | 68 |
| 4x16/16x4 | 84 |
| 8x16/16x8 | 100 |
| 16x16 | 132 |
| 32x16/16x32 | 97 |
| 32x32 | 129 |

**Test 2.14: Bilateral filtering for intra prediction ([JVET-AH0097](https://jvet-experts.org/doc_end_user/current_document.php?id=13979))**

In the test, intra prediction samples are further filtered by bilateral filtering, which follows the design of the bilateral filter used in the loop-filtering stage. The filter length is kept as 2.

Test 2.14a: Bilateral filtering for intra prediction (not applied to planar mode).

Test 2.14b: Bilateral filtering for intra prediction (applied to planar mode).

(LB results all incomplete by time of review)



Combination tests 2.5x use 2.3a.

No combination available with 2.1x.

Combination tests of 2.2…2.4 show that gains are not additive, and from overall tradeoffs reported are not attractive.

Overall, 2.2 shows best tradeoff standalone. Its adoption is supported also by non-proponents. Further, 2.1a is supported by one non-proponent and one cross-checker, said to be conceptually straightforward. Other experts asked how it would perform in combination with 2.2. Further study on this in next EE.

Decision: Adopt JVET-AH0076 test 2.2.

2.6 is not attractive in terms of tradeoff.

2.7 has small gain, and giving up the line buffer restriction could simplify in the context of an exploration. The combination with 2.6 does not show additional benefit of the latter.

Decision: Adopt JVET-AH0065 test 2.7.

Test 2.9 are straightforward changes of EIP according to cross-checkers. Tradeoff (small gain with runtime reduction) is attractive.

Decision: Adopt JVET-AH0086 test 2.9c.

In 2.10/2.11, 2.10d and 2.11a provide good tradeoffs standalone, whereas the 2.11b standalone gain is minor also in combination 2.11c, and 50 candidates seem not to be trivial.

The combination 2.10g (2.10d plus 2.11c) shows additive gain of 2.10 and 2.11, and the influence of 2.11b should be minor.

Decision: Adopt JVET-AH0200 test 2.10d.

Decision: Adopt JVET-AH0055 test 2.11a.

2.12 has small gain, but also impact in runtime is small (mainly additional processing at decoder). Crosscheckers confirm that implementation is straightforward.

Decision: Adopt JVET-AH0136 test 2.12b.

Test 2.13: It is commented that conventional intra modes are not fully replaced (not for all block sizes, and half of modes is retained in an interleaving fashion). It was also pointed out that the table size for storing the weights is significantly larger than for MIP, and number of MAC is also higher for some block sizes. It was however pointed out that other elements of ECM use comparable table sizes and comparable number of MAC/pix. Is asserted interesting for its impact on compression Tradeoff compression vs. runtime is attractive in the context of this exploration.

Decision: Adopt JVET-AH0209 test 2.13.

Test 2.14 has worse tradeoff compression vs. encoder runtime than other proposal adopted in this category. Some support was expressed, but also concern about practicality in implementation. No consensus for adoption.

Inter prediction

**Test 3.1: Chained motion vector prediction ([JVET-AH0069](https://jvet-experts.org/doc_end_user/current_document.php?id=13951))**

In this test, chained motion vector prediction (CMVP) is introduced as a new inter merge candidate list construction. As shown in the next figure Figure 1, CMVP candidates can be derived as the accumulation of the recursively traced motion vectors (MVs) and block vectors (BVs) based on the pre-derived MVs.

A black and white image of a graph

Description automatically generated

**Figure 1 An example of derivation of CMVP candidate.**

When deriving MVk(m), all five-positions shown in Figure 2 including the center, top-left, top-right, bottom-left, and bottom-right of the current block, are checked to find traced MVs or BVs.

A black and white image of a square

Description automatically generated

**Figure 2 Operation of referencing source and destination of tracing MVs in CMVP.**

CMVP candidates are derived for each merge index, each reference picture list, and each trace depth, and they are inserted after HMVP candidates for the regular merge and TM merge. The number of traced depths to derive CMVPs is restricted to one. The traceable reference pictures are only within the reference picture list.

Test 3.1a: Chained motion vector prediction.

Test 3.1b: Test 3.1a with temporal buffer constraint limiting the motion trace of CMVP to only come from the collocated pictures.

**Test 3.2: Alignment of temporal buffer usage ([JVET-AH0068](https://jvet-experts.org/doc_end_user/current_document.php?id=13950))**

In ECM-12.0, different temporal motion tools use different temporal buffer restrictions in the collocated pictures, some tools (e.g., TMVP candidate derivation in inter merge, BM merge, affine merge, etc.) use a one-CTU-row buffer, and other tools (e.g., temporal CCP candidate derivation process in intra CCP merge and inter CCP merge modes) can use the entire collocated picture.

In Test 3.2a, the one-CTU-row temporal buffer constraint is removed for all relevant tools in ECM-12.0.

In Test 3.2b, the one-CTU-row temporal buffer constraint is imposed for all relevant tools in ECM-12.0.

Test 3.2c: Test 3.1a + Test 3.2a

Test 3.2d: Test 3.1a + Test 3.2b

**Test 3.3: Inter CCP merge mode with zero luma CBF ([JVET-AH0066](https://jvet-experts.org/doc_end_user/current_document.php?id=13948))**

The inter CCP merge mode in ECM-12.0 blends the inter motion-compensated chroma prediction with a CCP model estimated chroma prediction, and the CCP model can be either calculated from adjacent neighbouring samples or inherited from a previous CCP coded block. The inter CCP merge mode follows the same restriction of inter CCCM mode that requires the luma CBF to be non-zero.

In this test, the inter CCP merge mode is extended to CUs with zero luma CBFs.

If the root CBF is equal to 0, a CU level flag is signalled to indicate the usage of inter CCP merge mode. Otherwise, a TU level flag is signalled as in ECM-12.0.

Whether to allow this method for inter AMVP or merge coded blocks with W×H less than 16 or greater than 1024 is determined based on the selection ratio of the blocks coded in the inter CCP merge mode in the previous coded picture.

**Test 3.4: Adaptive GPM blending ([JVET-AH0073](https://jvet-experts.org/doc_end_user/current_document.php?id=13955))**

In ECM-12.0, the prediction samples within a certain region along the GPM split boundary are generated by blending the two prediction signals. The blending width is determined from a predefined set with five fixed candidates, *i.e.*, {*τ*/4, *τ*/2, *τ*, 2*τ*, 4*τ*}, and up to 8 samples on each side of the boundary are blended by a weighted sum. A CU level index is signaled to specify the blending width index.

In the test, an adaptive GPM blending method with two alternative blending width candidate lists is investigated. In particular, list #0 ({*τ*/4, *τ*/2, *τ*, 2*τ*, 4*τ*}) comprises the same blending candidates as in ECM-12.0, and list #1 ({*τ*/2, *τ*, 2*τ*, 4*τ,* 8*τ*}) is designed for larger blocks, where at most 16 samples are blended on each side of the split boundary. The selection of the candidate list is adaptively determined based on the block size. If min(width, height) < 32, list #0 is used. Otherwise list #1 is used.

**Test 3.5: LIC model inheritance for merge modes ([JVET-AH0186](https://jvet-experts.org/doc_end_user/current_document.php?id=14085))**

In the merge candidate list construction process of ECM, LIC flag may be inferred from neighbouring blocks’ motion information stored in the motion field. If inferred, the stored LIC model parameters are utilized, which is used in OBMC process.

In Test 3.5a, similarly LIC model parameters are extended to be inherited during the construction process of GPM merge candidate list. Accordingly, LIC can be enabled for GPM without the model parameter derivation in motion compensation.

In Test 3.5b, on top of Test 3.5a, candidates with LIC model parameters inheritance are introduced to the regular merge modes, so there can be candidates with LIC off, LIC on, LIC inheritance.

In Test 3.5c, on top of Test 3.5a, candidates with LIC model parameters inheritance are introduced to the regular merge modes and are included together with other candidates in the reordering ARMC stage.

Test 3.5d: Test 3.4 + Test 3.5c ([JVET-AH0314](https://jvet-experts.org/doc_end_user/current_document.php?id=14214))

**Test 3.6: Reference filtering for inter-prediction ([JVET-AH0122](https://jvet-experts.org/doc_end_user/current_document.php?id=14004))**

In this test, a linear filter is applied to interpolated reference area to obtain predicted samples. Linear filter parameters are derived from template areas of current and reference blocks using spatially collocated samples (as shown in the figure below).

A diagram of a square and square area

Description automatically generated

The method is applied to uni-predicted blocks that are predicted in AMVP or regular merge modes. Several filters with different parameter sets could be applied within the reference area. Selection of filter is performed based on classification that is performed for the template areas of reference and current blocks. The decision on whether reference filtering is applied is taken based on the value of LIC flag, SAD costs and difference of Histograms of Gradients obtained for reference block and current block templates.

**Test 3.7: Subblock merge mode improvements ([JVET-AH0119](https://jvet-experts.org/doc_end_user/current_document.php?id=14001))**

In this method, TM based motion refinement is applied to subblock merge mode.

In Test 3.7a, TM-based motion refinement is applied to the SbTMVP candidates to refine the subblock MVs of SbTMVP candidates and more candidates for which the reference picture indices of all subblocks are equal to 0 are added. During the refinement, one top row and one left column are used as the template and all the subblock MVs share the same MV offset.

In Test 3.7b, TM-based motion refinement is extended to the bi-predicted affine candidates and a non-translation parameter refinement process is added after the current base MV refinement process for uni-predicted affine candidate. The non-translation parameter refinement scheme is the same as that of affine DMVR in ECM-12.0 but with bilateral matching being replaced by template matching.

Test 3.7c: Test 3.7a + Test 3.7b.

(Results RA/LB)



3.1 has attractive gain. It was asked why the runtime increase is higher in LB? Proponents explain it is more frequently used in that case. It was commented that 3.1b might be more practical in a real-world implementation, but 3.1a is more attractive in this exploration.

Decision: Adopt JVET-AH0069 test 3.1a.

3.2a removes the temporal buffer constraint (imposed on some tools only), and gives some gain while increasing consistency and simplifying software implementation.

Decision: Adopt JVET-AH0068 test 3.2a.

Test 3.3 is only beneficial for class TGM. It is asserted by proponents and crosscheckers that zero luma CBF is more frequently used in that class (over all sequences). It is straightforward, just omitting a condition check, and does not harm performance in other classes.

Decision: Adopt JVET-AH0066

Test 3.5 investigates LIC model inheritance, avoiding to compute the parameters again if already available from neighbored block. This gives a small compression benefit for GPM (test 5.5a), whereas for other merge cases it is not conclusive yet whether the variant of 3.5b or 3.5c is better (one for LB, the other for RA).

Test 3.4 investigates GPM boundary blending done different for small and large block sizes.

The combination 3.4 and 3.5c reported in 3.5d gives a reasonable benefit/tradeoff in both RA and LB. Changes are straightforward.

Decision: Adopt JVET-AH0314 test 3.5d

Test 3.6 does not have a reasonable tradeoff compression performance vs. encoder runtime. Further study (EE) to decrease encoding time without losing compression benefit.

Test 3.7b extends the TM based refinement for affine subblocks to bi prediction (currently in ECM only for uni prediction). Test 3.7a introduces TM based refinement for both uni and bi prediction also in SbTMVP subblocks. Test 3.7c is combination of both. Tradeoff compression vs. runtime increase is attractive.

Decision: Adopt JVET-AH0119 test 3.7c.

***Transform and coefficient coding***

**Test 4.1 Multiple transform set selection for LFNST/NSPT ([JVET-AH0056](https://jvet-experts.org/doc_end_user/current_document.php?id=13938))**

In the test, blocks coded with DIMD, TIMD, SGPM, MIP, EIP, and IntraTMP modes to select one LFNST/NSPT transform set out of 2 candidate sets. A flag is signalled for those modes to indicate whether set 1 or 2 is utilized.

The 1st candidate transform set remains the same as the current ECM.

To derive the 2nd candidate:

For TIMD, if fusion is applied, the 2nd TIMD IPM is first considered;

For SGPM, the 2 IPMs that SGPM uses are first considered;

For MIP and EIP, PLANAR is first considered;

The 1st and 2nd candidate should be different transform sets. If the 2nd candidate is not derived by the above process, it is derived by the HoG of neighbouring reconstructed pixels.

The method is applied to CUs with the area equal or larger than the threshold.

Test 4.1a: Multiple transform set selection for LFNST/NSPT without retractions

Test 4.1b: Test 4.1a with the threshold set to 256 for AI configuration.

Test 4.1c: Test 4.1a with the threshold set to 256 for all configurations.

**Test 4.2 Fix on LFNST/NSPT index signalling for inter coding ([JVET-AH0101](https://jvet-experts.org/doc_end_user/current_document.php?id=13983))**

LFNST/NSPT for inter coding is applied to only luma component and an LFNST/NSPT index is signalled only when a set of DC condition (i.e., last non-zero coefficient of each of relevant components is not at DC position) is met.

However, in the current ECM, DC condition checking process considers both luma and chroma for inter-LFNST/NSPT. As a result, an LFNST/NSPT index, which is set as 0, can be signalled unnecessarily, even when last non-zero coefficient of luma component is in DC position.

In the test, last non-zero position is checked using luma component only.

**Test 4.3 16 states TCQ with state exchange ([JVET-AH0079](https://jvet-experts.org/doc_end_user/current_document.php?id=13961))**

TCQ maps transform coefficients to reconstruction points to two predefined scalar quantizers while taking RD cost into account. The selection of the scalar quantizer used for current transform coefficient depends on the current state. Currently 8 states TCQ is used.

In the test, 16 states are used and following state to state transition table where default scalar quantizers are . The transition depends on the current state and the parity of the quantization index to be either even or odd shown by or respectively.

|  |  |  |  |
| --- | --- | --- | --- |
| state | quantizer used | next state | |
|  |  |
| 0 |  | 0 | 2 |
| 1 |  | 5 | 7 |
| 2 |  | 1 | 3 |
| 3 |  | 6 | 4 |
| 4 |  | 10 | 8 |
| 5 |  | 12 | 14 |
| 6 |  | 11 | 9 |
| 7 |  | 15 | 13 |
| 8 |  | 8 | 10 |
| 9 |  | 13 | 15 |
| 10 |  | 9 | 11 |
| 11 |  | 14 | 12 |
| 12 |  | 2 | 0 |
| 13 |  | 4 | 6 |
| 14 |  | 3 | 1 |
| 15 |  | 7 | 5 |

16 states TCQ is enabled for RA and LDB configurations.



For 4.1, it was asked if this adds more transform kernels. It was confirmed that this is not the case. Results were confirmed by crosscheckers, but they cannot provide reliable runtime (encoder runtimes they report for tests b and c were around 2%). Other experts report they also found higher encoder runtimes than given in the table above, except for test a. It is also mentioned that most gain comes from classes A, and also runtime was higher for those classes.

The compression/runtime tradeoff reported in particular for 4.1b might still be acceptable; it was however pointed out that the normative restriction necessary for 4.1b might be undesirable.

Given the concerns raised, no consensus is reached for taking action.

For 4.2, it had basically already in the last meeting that this was a useful change, but results were still incomplete; therefore it was put into the EE.

Decision: Adopt JVET-AH0101.

For 4.3, the tradeoff compression vs. runtime is not attractive in particular for RA (and according to proponents would be even worse for AI). According to crosscheckers, there might be some headroom for improving the software, but they see the problem that the encoder runtime is highly QP dependent (more significant increase for low QP). Further study is recommended in EE. Also parameters such as threshold could be varied, or frequency depency variations to reduce number of choices.

***In-loop filtering***

**Test 5.1: Adaptive precision for CCALF coefficients ([JVET-AH0057](https://jvet-experts.org/doc_end_user/current_document.php?id=13939))**

This test investigates the impact of using an adaptive number of bits to represent the fractional part of a CCALF coefficient and removing the constraint power of 2 for a CCALF coefficient.

In Test 5.1a, the number of bits used to represent the fractional part of a CCALF coefficient is adaptively selected from the range of 7 to 10, inclusively.

In Test 5.1b, the number of bits used to represent the fractional part of a CCALF coefficient is adaptively selected from the range of 5 to 8, inclusively.

In Test 5.1c, the power of 2 constraint is removed.

Test 5.1d: Test 5.1a + Test 5.1c

Test 5.1e: Test 5.1b + Test 5.1c

**Test 5.2: Coding information based classification for ALF ([JVET-AH0098](https://jvet-experts.org/doc_end_user/current_document.php?id=13980))**

In ECM-12.0, 3 classifiers which are texture-based, band-based and residual-based classifiers are used in luma ALF. The encoder collects corresponding statistical data for each classifier and selects the most suitable classifier for each CTU.

In the test, coding information such as the partitioning and prediction information are additionally considered to classify a block into 2 noise levels. For each classification unit (2x2), it would be classified into noise level 1 if it is located at a block boundary position or coded by intra mode. Otherwise, the unit would be classified into noise level 0.

Then the generated noise levels are further combined with the existing classifiers to output the final classification results. The class number of existing classifiers is reduced to 12 from 25. For the band and residual classifier, the range of 0 to 2bitdepth – 1 are quantized into 12 classes. For the texture classifier, a LUT is used to map 25 classes to 12 classes. The 12 classes are further combined with the 2 noise levels. Finally, for each classifier, the number of classes is 12 x 2 = 24.

In Test 5.2a, only the boundary information is utilized.

In Test 5.2b, only the prediction information is utilized.

In Test 5.2c, both boundary and prediction information are utilized.



Test 5.1 is not a simplification, but rather alignment with the method already used in luma ALF (which uses something equivalent to 5.1b), which is here applied the same way for CCALF. Gain is relatively small, but no runtime increase, tradeoff is OK for 5.1a.

Decision: Adopt JVET.AH0057 test 5.1a

5.2 is using information from coding in the classification stage of ALF. Using the coding mode (5.2b) shows almost no benefit, using partitioning information (5.2a) is assessed providing some compression gain, while not having significant impact on complexity – no runtime increase, small storage for partition boundary, classification straightforward.

It was pointed out that results on 5.2a were still incomplete in RA and LB. Revisit when results are complete.

As of 22:00, discussion was chaired by M. Zhou as J. Ohm had connection issues and Y. Ye had a conflict of interest with test 6.1. Notes of the discussion were taken by Y. Ye and shared throughout the discussion.

Entropy coding:



For test 6.1a/b, it was asked how big is the table for the LDB context initialization table. This would be the same as other types (I/B/P) of context initialization tables, and estimated to be around 1500 contexts per type.

For test 6.2a, it was asked if the conversion to non-equal-probablity (NEP) state was pre-determined, or decided on the fly. The answer was that this converstion was pre-determined (i.e. fixed). One cross checker of test 6.2a commented that 681 additional contexts were needed in test 6.2a, this was due to the need to store different NEP’s for different bins (as opposed to the case of equal probability where all bins have 0.5/0.5 probability). Also, it was reported that the design for the sign coding bin of transform skip residual was different from the design for other bins, without sufficient justification. Another cross checker of tests 6.2a and 6.2b confirmed the results and supported test 6.2a due to the favorable performance vs. runtime tradeoff. A third cross checker of test 6.2a confirmed the results and supported including it in the next version of ECM.

Several cross checkers (of test 6.1, test 6.2a and combination test 6.3) confirmed the results reported by the proponents, and commented that the combination was straightforward. Test 6.3 was commented to be more favorable as it provided higher performance of test 6.3\*.

Another expert suggested that test 6.2a\* (which doesn’t change the way context coded bins are handled in ECM-12) provides a safer solution than test 6.2. Test 6.2a\* only converts bypass coded bins to NEP. For test 6.2a, it additionally retrains the context initialization values for context coded bins.

It was commented that decision should be made based on individual tests rather than the combination test.

Several experts supported test 6.1a based on the gain it provides to LDB config.

Decision: Adopt JVET-AH0176 test 6.1a. For test 6.2a\*, it included a change to sign coding bin of transform skip residual. The necessity of this change was questioned. It was requested for the proponent to bring results after this aspect was removed. The proponent mentioned that JVET-AH0153 is an EE related contribution that provides results after this aspect is removed.

Discuss test 6.2a\* again in the context of JVET-AH0153, see notes under JVET-AH0153.

[JVET-AH0041](https://jvet-experts.org/doc_end_user/current_document.php?id=13922) [AHG4] AHG meeting report on ECM expert viewing preparations [M. Wien]

See section 4.5

### EE2 contributions: Enhanced compression beyond VVC capability (33)

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-AH0055](https://jvet-experts.org/doc_end_user/current_document.php?id=13937) EE2-2.11: Auto-relocated BVP for IntraTMP merge candidates [N. Qiu, J. Huo, Y. Ma, F. Yang (Xidian University), L. Zhang, Y. Yu, F. Wang, H. Yu, D. Wang (OPPO)]

[JVET-AH0267](https://jvet-experts.org/doc_end_user/current_document.php?id=14166) Crosscheck of JVET-AH0055 (EE2-2.11: Auto-relocated BVP for IntraTMP merge candidates) [X. Li (Alibaba)] [late] [miss]

[JVET-AH0056](https://jvet-experts.org/doc_end_user/current_document.php?id=13938) EE2-4.1: Multiple Transform Set Selection for LFNST/NSPT [F. Wang, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AH0252](https://jvet-experts.org/doc_end_user/current_document.php?id=14151) Crosscheck of JVET-AH0056 (EE2-4.1: Multiple Transform Set Selection for LFNST/NSPT) [M. Koo (LGE)] [late] [miss]

[JVET-AH0057](https://jvet-experts.org/doc_end_user/current_document.php?id=13939) EE2-5.1: Adaptive precision for CCALF coefficients [N. Song, Y. Yu, H. Yu, D. Wang (OPPO), N. Hu, M. Karczewicz, V. Seregin, H. Wang (Qualcomm)]

[JVET-AH0242](https://jvet-experts.org/doc_end_user/current_document.php?id=14141) Crosscheck of JVET-AH0057 (EE2-5.1: Adaptive precision for CCALF coefficients) [C. Ma (Kwai)] [late] [miss]

[JVET-AH0269](https://jvet-experts.org/doc_end_user/current_document.php?id=14168) Crosscheck of JVET-AH0057 (EE2-5.1: Adaptive Precision for CCALF Coefficients) [W. Yin (Bytedance)] [late] [miss]

[JVET-AH0065](https://jvet-experts.org/doc_end_user/current_document.php?id=13947) EE2-2.7: Relaxing line buffer restriction [Z. Deng, K. Zhang, L. Zhang (Bytedance)]

[JVET-AH0282](https://jvet-experts.org/doc_end_user/current_document.php?id=14181) Crosscheck of JVET-AH0065 (EE2-2.7: Relaxing line buffer restriction) [H. Huang (Qualcomm)] [late]

[JVET-AH0066](https://jvet-experts.org/doc_end_user/current_document.php?id=13948) EE2-3.3: Inter CCP merge mode with zero luma CBF [Z. Deng, K. Zhang, L. Zhang (Bytedance)]

[JVET-AH0102](https://jvet-experts.org/doc_end_user/current_document.php?id=13984) Crosscheck of JVET-AH0066 (EE2-3.3: Inter CCP merge mode with zero luma CBF) [[Z. Lv (vivo)](mailto:zhuoyi.lv@vivo.com)] [late] [miss]

[JVET-AH0068](https://jvet-experts.org/doc_end_user/current_document.php?id=13950) EE2-3.2: Alignment of temporal buffer usage [Z. Deng, K. Zhang, L. Zhang (Bytedance), Y. Kidani, H. Kato, K. Kawamura (KDDI)]

[JVET-AH0214](https://jvet-experts.org/doc_end_user/current_document.php?id=14113) Crosscheck of JVET-AH0068 (EE2-3.2: Alignment of temporal buffer usage) [D. Ruiz Coll, J.-K. Lee (Ofinno)] [late] [miss]

[JVET-AH0236](https://jvet-experts.org/doc_end_user/current_document.php?id=14135) Crosscheck of EE2-Test 3.2a and 3.2b: Alignment of temporal buffer usage [Y. Kidani, K. Kawamura (KDDI)] [late] [miss]

[JVET-AH0069](https://jvet-experts.org/doc_end_user/current_document.php?id=13951) EE2-3.1: Chained motion vector prediction [Y. Kidani, H. Kato, K. Kawamura (KDDI)]

[JVET-AH0259](https://jvet-experts.org/doc_end_user/current_document.php?id=14158) Crosscheck of JVET-AH0069 (EE2-3.1: Chained motion vector prediction) [P.-H. Lin (Qualcomm)] [late] [miss]

[JVET-AH0073](https://jvet-experts.org/doc_end_user/current_document.php?id=13955) EE2-3.4: Adaptive GPM blending [L. Zhao, K. Zhang, L. Zhang (Bytedance)]

[JVET-AH0255](https://jvet-experts.org/doc_end_user/current_document.php?id=14154) Crosscheck of JVET-AH0073 (EE2-3.4: Adaptive GPM blending) [Z. Zhang (Qualcomm)] [late] [miss]

[JVET-AH0075](https://jvet-experts.org/doc_end_user/current_document.php?id=13957) EE2-2.1: TIMD merge mode [M. Abdoli, R. G. Youvalari, A. Tissier (Xiaomi)]

[JVET-AH0262](https://jvet-experts.org/doc_end_user/current_document.php?id=14161) Crosscheck of JVET-AH0075 (EE2-2.1: TIMD merge mode) [Y. Wang (Bytedance)] [late]

[JVET-AH0273](https://jvet-experts.org/doc_end_user/current_document.php?id=14172) Crosscheck of JVET-AH0075 (EE2-2.1: TIMD merge mode) [I. Zupancic (Nokia)] [late] [miss]

[JVET-AH0076](https://jvet-experts.org/doc_end_user/current_document.php?id=13958) EE2-2.2: Occurrence-based intra coding (OBIC) [R. G. Youvalari, M. Abdoli, A. Tissier (Xiaomi)]

[JVET-AH0270](https://jvet-experts.org/doc_end_user/current_document.php?id=14169) Crosscheck of JVET-AH0076 (EE2-2.2: Occurrence-based intra coding (OBIC)) [P. Nikitin (Qualcomm)] [late] [miss]

[JVET-AH0079](https://jvet-experts.org/doc_end_user/current_document.php?id=13961) EE2-4.3: 16 States TCQ with State Exchange [M. Balcilar, K. Naser, Y. Chen, F. Galpin, F. Le Léannec (InterDigital)]

[JVET-AH0191](https://jvet-experts.org/doc_end_user/current_document.php?id=14090) Crosscheck of JVET-AH0079 (EE2-4.3: 16 States TCQ with State Exchange) [M. Coban, M. Karczewicz (Qualcomm)] [late] [miss]

[JVET-AH0084](https://jvet-experts.org/doc_end_user/current_document.php?id=13966) EE2-6.3: Combination of EE2-6.1 and EE2-6.2 on entropy coding extension [F. Galpin, F. Lo Bianco, C. Salmon-Legagneur, M. Balcilar (InterDigital), R.-L. Liao, Yan Ye, Jie Chen, Xinwei Li (Alibaba)]

[JVET-AH0251](https://jvet-experts.org/doc_end_user/current_document.php?id=14150) Crosscheck of JVET-AH0084 (EE2-6.3: Combination of EE2-6.1 and EE2-6.2 on entropy coding extension) [H.-J. Jhu, X. Xiu (Kwai)] [late] [miss]

[JVET-AH0085](https://jvet-experts.org/doc_end_user/current_document.php?id=13967) EE2-6.2: Entropy coding extension [F. Galpin, F. Lo Bianco, C. Salmon-Legagneur, M. Balcilar (InterDigital)]

[JVET-AH0192](https://jvet-experts.org/doc_end_user/current_document.php?id=14091) Crosscheck of JVET-AH0085 (EE2-6.2: Entropy coding extension) [[M. Coban](mailto:mcoban@qti.qualcomm.com), V. Seregin, M. Karczewicz (Qualcomm)] [late] [miss]

[JVET-AH0228](https://jvet-experts.org/doc_end_user/current_document.php?id=14127) Crosscheck of JVET-AH0085 (EE2-6.2: Entropy coding extension) [M. Blestel (Ofinno)] [late] [miss]

[JVET-AH0243](https://jvet-experts.org/doc_end_user/current_document.php?id=14142) Crosscheck of JVET-AH0085 (EE2-6.2: Entropy coding extension) [M. Abdoli, R. G. Youvalari, A. Tissier (Xiaomi)] [late]

[JVET-AH0086](https://jvet-experts.org/doc_end_user/current_document.php?id=13968) EE2-2.9: EIP with bias and clipping [J. Lainema, P. Astola (Nokia)]

[JVET-AH0129](https://jvet-experts.org/doc_end_user/current_document.php?id=14011) Cross-check of EE2-2.9c (JVET-AH0086: EIP with bias and clipping) [K. Andersson (Ericsson)]

[JVET-AH0224](https://jvet-experts.org/doc_end_user/current_document.php?id=14123) Crosscheck of JVET-AH0086 (EE2-2.9: EIP with bias and clipping) [L. Xu (OPPO)]

[JVET-AH0090](https://jvet-experts.org/doc_end_user/current_document.php?id=13972) EE2-2.4: DIMD Merge List [M. Blestel, P. Andrivon, K. Suverov (Ofinno)]

[JVET-AH0293](https://jvet-experts.org/doc_end_user/current_document.php?id=14192) Crosscheck of JVET-AH0090 (EE2-2.4: DIMD Merge List) [K. Naser (InterDigital)] [late] [miss]

[JVET-AH0092](https://jvet-experts.org/doc_end_user/current_document.php?id=13974) EE2-2.3: Intra-prediction using Merged Histogram of Gradients [S. Blasi, I. Zupancic, P. Astola, J. Lainema (Nokia)]

[JVET-AH0292](https://jvet-experts.org/doc_end_user/current_document.php?id=14191) crosscheck of JVET-AH0092 (EE2-2.3: Intra-prediction using Merged Histogram of Gradients) [K. Naser (InterDigital)] [late] [miss]

[JVET-AH0093](https://jvet-experts.org/doc_end_user/current_document.php?id=13975) EE2-2.6: Adaptive MRL Fusion [S. Blasi, J. Lainema (Nokia)]

[JVET-AH0226](https://jvet-experts.org/doc_end_user/current_document.php?id=14125) Crosscheck of JVET-AH0093 (EE2-2.6: Adaptive MRL Fusion) [R. G. Youvalari, M. Abdoli, A. Tissier (Xiaomi)] [late] [miss]

[JVET-AH0094](https://jvet-experts.org/doc_end_user/current_document.php?id=13976) EE2-2.8: Combination of tests EE2-2.6b and EE2-2.7 [S. Blasi, J. Lainema (Nokia), Z. Deng, K. Zhang, L. Zhang (Bytedance)]

[JVET-AH0283](https://jvet-experts.org/doc_end_user/current_document.php?id=14182) Crosscheck of JVET-AH0094 (EE2-2.8: Combination of tests EE2-2.6b and EE2-2.7) [H. Huang (Qualcomm)] [late]

[JVET-AH0097](https://jvet-experts.org/doc_end_user/current_document.php?id=13979) EE2-2.14: Bilateral Filtering for Intra Prediction [W. Yin, K. Zhang, Y. Wang, Z. Deng, L. Zhang (Bytedance)]

[JVET-AH0240](https://jvet-experts.org/doc_end_user/current_document.php?id=14139) Crosscheck of JVET-AH0097 (EE2-2.14: Bilateral Filtering for Intra Prediction) [V. Shchukin (Ericsson)] [late] [miss]

[JVET-AH0098](https://jvet-experts.org/doc_end_user/current_document.php?id=13980) EE2-5.2: Coding Information based Classification for ALF [W. Yin, K. Zhang, Y. Wang, Z. Deng, L. Zhang (Bytedance), N. Hu, M. Karczewicz, V. Seregin (Qualcomm)]

[JVET-AH0313](https://jvet-experts.org/doc_end_user/current_document.php?id=14213) Crosscheck of JVET-AH0098 (EE2-5.2: Coding Information based Classification for ALF) [N. Song (OPPO)] [late] [miss]

[JVET-AH0101](https://jvet-experts.org/doc_end_user/current_document.php?id=13983) EE2-4.2: Fix on LFNST/NSPT index signalling for inter coding [M. Koo, J. Zhao, J. Lim, S. Kim (LGE)]

[JVET-AH0190](https://jvet-experts.org/doc_end_user/current_document.php?id=14089) Crosscheck of JVET-AH0101 (EE2-4.2: Fix on LFNST/NSPT index signaling for inter coding) [S. Puri, K. Naser (InterDigital)] [late]

[JVET-AH0119](https://jvet-experts.org/doc_end_user/current_document.php?id=14001) EE2-3.7: Subblock merge mode improvements [J. Chen, R.-L. Liao, Y. Zheng, X. Li, Y. Ye (Alibaba)]

[JVET-AH0257](https://jvet-experts.org/doc_end_user/current_document.php?id=14156) Crosscheck of JVET-AH0119 (EE2-3.7: Subblock merge mode improvements) [L. Zhao (Bytedance)] [late]

[JVET-AH0268](https://jvet-experts.org/doc_end_user/current_document.php?id=14167) Crosscheck of JVET-AH0119 (EE2-3.7c: Subblock merge mode improvements) [Z. Lv (vivo)] [late] [miss]

[JVET-AH0122](https://jvet-experts.org/doc_end_user/current_document.php?id=14004) EE2-3.6: Reference filtering for inter-prediction [A. Filippov, V. Rufitskiy (Ofinno)]

[JVET-AH0276](https://jvet-experts.org/doc_end_user/current_document.php?id=14175) Crosscheck of JVET-AH0122 (EE2-3.6: Reference filtering for inter-prediction) [Y. Kidani, K. Kawamura (KDDI)] [late] [miss]

[JVET-AH0128](https://jvet-experts.org/doc_end_user/current_document.php?id=14010) EE2-2.5: Combination of EE2-2.2, EE2-2.3, and EE2-2.4 [R. G. Youvalari (Xiaomi), S. Blasi (Nokia), M. Blestel, M. Abdoli, I. Zupancic, A. Tissier, P. Andrivon, K. Suverov (Ofinno)]

[JVET-AH0279](https://jvet-experts.org/doc_end_user/current_document.php?id=14178) Crosscheck of test EE2-2.5b in JVET-AH0128 (EE2-2.5: Combination of EE2-2.2, EE2-2.3, and EE2-2.4) [Kevin Reuzé (InterDigital)] [late]

[JVET-AH0285](https://jvet-experts.org/doc_end_user/current_document.php?id=14184) Crosscheck of JVET-AH0128, Tests EE2-2.5c and EE2-2.5d (EE2-2.5 Combination of EE2-2.2, EE2-2.3, and EE2-2.4) [M. Salehifar (Bytedance)] [late]

[JVET-AH0295](https://jvet-experts.org/doc_end_user/current_document.php?id=14194) Crosscheck of EE2-2.5d: JVET-AH0128: Combination of EE2-2.2, EE2-2.3, and EE2-2.4 [F. Galpin (InterDigital)] [late]

[JVET-AH0296](https://jvet-experts.org/doc_end_user/current_document.php?id=14195) Crosscheck of 2.5a in JVET-AH0128 (EE2-2.5: Combination of EE2-2.2, EE2-2.3, and EE2-2.4) [C. Zhou (vivo)] [late]

[JVET-AH0176](https://jvet-experts.org/doc_end_user/current_document.php?id=14075) EE2-6.1: Context initialization for B-slice [R.-L. Liao, Y. Ye, J. Chen, X. Li (Alibaba)]

[JVET-AH0238](https://jvet-experts.org/doc_end_user/current_document.php?id=14137) Crosscheck of JVET-AH0176 (EE2-6.1: Context initialization for B-slice) [Z. Deng (Bytedance)] [late]

[JVET-AH0186](https://jvet-experts.org/doc_end_user/current_document.php?id=14085) EE2-3.5: LIC model inheritance for merge modes [C.-C. Chen, H. Huang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AH0291](https://jvet-experts.org/doc_end_user/current_document.php?id=14190) Crosscheck of JVET-AH0186 (EE2-3.5: LIC model inheritance for merge modes) [L. Zhao (Bytedance)] [late] [miss]

[JVET-AH0200](https://jvet-experts.org/doc_end_user/current_document.php?id=14099) EE2-2.10a and 2.10d: SATD based IntraTMP BV search without signalling and BV reordering [W. Chen, X. Xiu, C. Ma, H.-J. Jhu, X. Wang (Kwai)]

[JVET-AH0256](https://jvet-experts.org/doc_end_user/current_document.php?id=14155) Crosscheck of JVET-AH0200 (EE2-2.10a and 2.10d: SATD based IntraTMP BV search without signalling and BV reordering) [L. Zhao (Bytedance)] [late]

[JVET-AH0272](https://jvet-experts.org/doc_end_user/current_document.php?id=14171) Crosscheck of JVET-AH0200 (EE2-2.10a and 2.10d: SATD based IntraTMP BV search without signalling and BV reordering) [R.-L. Liao (Alibaba)] [late]

[JVET-AH0201](https://jvet-experts.org/doc_end_user/current_document.php?id=14100) EE2-2.10g: combination test of EE2-2.10d and EE2-2.11c [W. Chen, X. Xiu, X. Wang (Kwai), N. Qiu, J. Huo, Y. Ma, F. Yang (Xidian University), L. Zhang, Y. Yu, F. Wang, H. Yu, D. Wang (OPPO)]

[JVET-AH0229](https://jvet-experts.org/doc_end_user/current_document.php?id=14128) Crosscheck of JVET-AH0201 EE2-2.10g: combination test of EE2-2.10d and EE2-2.11c [X. Li (Google)] [late] [miss]

[JVET-AH0297](https://jvet-experts.org/doc_end_user/current_document.php?id=14196) Crosscheck of JVET-AH0201 (EE2-2.10g: combination test of EE2-2.10d and EE2-2.11c) [C. Zhou (vivo)] [late]

[JVET-AH0209](https://jvet-experts.org/doc_end_user/current_document.php?id=14108) EE2-2.13: Matrix based intra prediction replacing conventional intra modes [B. Ray, H. Wang, P. Garus, V. Seregin, M. Karczewicz, S. Eadie, G. Verba (Qualcomm)]

[JVET-AH0260](https://jvet-experts.org/doc_end_user/current_document.php?id=14159) Crosscheck of JVET-AH0209 (EE2-2.13: Matrix based intra prediction replacing conventional intra modes) [Y. Wang (Bytedance)] [late]

[JVET-AH0244](https://jvet-experts.org/doc_end_user/current_document.php?id=14143) EE2-2.10c: MR-SAD based IntraTMP BV search with signalling [K. Naser, F. Le Léannec, T. Poirier, H. Guermoud, T. Dumas (InterDigital)] [late]

[JVET-AH0294](https://jvet-experts.org/doc_end_user/current_document.php?id=14193) Crosscheck of JVET-AH0244 (EE2-2.10c: MR-SAD based IntraTMP BV search with signalling) [S. Blasi (Nokia)] [late] [miss]

[JVET-AH0245](https://jvet-experts.org/doc_end_user/current_document.php?id=14144) EE2-2.10f: MR-SAD/SATD based IntraTMP BV search with signalling and BV reordering [K. Naser, F. Le Léannec, T. Poirier, H. Guermoud, T. Dumas (InterDigital), W. Chen, X. Xiu, X. Wang (Kwai)] [late]

[JVET-AH0308](https://jvet-experts.org/doc_end_user/current_document.php?id=14208) Crosscheck of JVET-AH0245 (EE2-2.10f: MR-SAD/SATD based IntraTMP BV search with signalling and BV reordering) [G. Verba (Qualcomm)] [late] [miss]

[JVET-AH0246](https://jvet-experts.org/doc_end_user/current_document.php?id=14145) EE2-2.10h: MR-SAD/SATD based IntraTMP BV search with signalling and BV reordering with ARBVP for IntraTMP merge [K. Naser, F. Le Léannec, T. Poirier, Guermoud, T. Dumas (InterDigital), W. Chen, X. Xiu, X. Wang (Kwai), N. Qiu, J. Huo, Y. Ma, F. Yang (Xidan Unversity), L. Zhang, Y Yue, F. Wang, H. Yu, D. Wang (Oppo)] [late]

[JVET-AH0305](https://jvet-experts.org/doc_end_user/current_document.php?id=14204) Crosscheck of JVET-AH0246 (EE2-2.10h: MR-SAD/SATD based IntraTMP BV search with signalling and BV reordering with ARBVP for IntraTMP merge) [G. Verba (Qualcomm)] [late] [miss]

[JVET-AH0314](https://jvet-experts.org/doc_end_user/current_document.php?id=14214) EE2-3.5d: Combination of EE2-3.4 and EE2-3.5c [C.-C. Chen, H. Huang, V. Seregin, M. Karczewicz (Qualcomm), L. Zhao, K. Zhang, L. Zhang (Bytedance)] [late]

[JVET-AH0319](https://jvet-experts.org/doc_end_user/current_document.php?id=14219) Crosscheck of JVET-AH0314 (EE2-3.5d: Combination of EE2-3.4 and EE2-3.5c) [H.-J. Jhu (Kwai)] [late] [miss]

### EE2 related contributions (13)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0071](https://jvet-experts.org/doc_end_user/current_document.php?id=13953) EE2-related: IntraTMP extension to TIMD [J. Fu, Z. Li, J. Zhang, C. Jia, S. Ma (PKU), Y. Gao, C. Huang (ZTE)]

[JVET-AH0323](https://jvet-experts.org/doc_end_user/current_document.php?id=14223) Crosscheck of JVET-AH0071 (EE2-related: IntraTMP extension to TIMD) [R. Chang (Tencent)] [late]

[JVET-AH0116](https://jvet-experts.org/doc_end_user/current_document.php?id=13998) EE2-3.1/2 related: Additional chained motion vector prediction candidates [N. Zhang, K. Zhang, L. Zhang (Bytedance)]

[JVET-AH0135](https://jvet-experts.org/doc_end_user/current_document.php?id=14017) EE2-1.1: Temporal partitioning prediction [G. Laroche, P. Onno (Canon)]

[JVET-AH0185](https://jvet-experts.org/doc_end_user/current_document.php?id=14084) Crosscheck of JVET-AH0135 (EE2-1.1: Temporal partitioning prediction) [R. Utida, S. Puri, F. Le Léannec (InterDigital)]

[JVET-AH0284](https://jvet-experts.org/doc_end_user/current_document.php?id=14183) Crosscheck of JVET-AH0135 (EE2-1.1: Temporal partitioning prediction) [H. Huang (Qualcomm)] [late]

[JVET-AH0136](https://jvet-experts.org/doc_end_user/current_document.php?id=14018) EE2-2.12: Chroma intra prediction mode reordering [X. Li, R.-L. Liao, J. Chen, Y. Ye (Alibaba)]

[JVET-AH0234](https://jvet-experts.org/doc_end_user/current_document.php?id=14133) Crosscheck of JVET-AH0136 (EE2-2.12: Chroma intra prediction mode reordering) [L. Xu (OPPO)] [late] [miss]

[JVET-AH0261](https://jvet-experts.org/doc_end_user/current_document.php?id=14160) Crosscheck of JVET-AH0136 (EE2-2.12: Chroma intra prediction mode reordering) [Z. Deng (Bytedance)] [late] [miss]

[JVET-AH0151](https://jvet-experts.org/doc_end_user/current_document.php?id=14033) EE2-related: IntraTMP merge candidates clustering based on refinement window [D. Ruiz Coll, J.-K. Lee (Ofinno)]

[JVET-AH0286](https://jvet-experts.org/doc_end_user/current_document.php?id=14185) Crosscheck of JVET-AH0151 (EE2-related: IntraTMP merge candidates clustering based on refinement window) [Y. Kidani, K. Kawamura (KDDI)] [late] [miss]

[JVET-AH0153](https://jvet-experts.org/doc_end_user/current_document.php?id=14035) EE2-6.3 related: Combination of EE2-6.1 and EE2-6.2 on entropy coding extension - retraining [F. Galpin, F. Lo Bianco, C. Salmon-Legagneur, M. Balcilar (InterDigital), R.-L. Liao, Yan Ye, Jie Chen, Xinwei Li (Alibaba), P. Nikitin (Qualcomm)]

[JVET-AH0309](https://jvet-experts.org/doc_end_user/current_document.php?id=14209) Crosscheck of JVET-AH0153 (EE2-6.3 related: Combination of EE2-6.1 and EE2-6.2 on entropy coding extension - retraining) [W. Chen (Kwai)] [late] [miss]

[JVET-AH0183](https://jvet-experts.org/doc_end_user/current_document.php?id=14082) EE2-related: TMVP for chained motion vector prediction [P.-H Lin, Z. Zhang, J.-L Lin, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AH0287](https://jvet-experts.org/doc_end_user/current_document.php?id=14186) Crosscheck of JVET-AH0183 (EE2-related: TMVP for chained motion vector prediction) [Y. Kidani, K. Kawamura (KDDI)] [late] [miss]

[JVET-AH0184](https://jvet-experts.org/doc_end_user/current_document.php?id=14083) EE2-4.1 related: On Multiple Transform Set Selection for LFNST/NSPT [C. Bonnineau, S. Puri, K. Naser, F. Le Léannec (InterDigital)]

[JVET-AH0193](https://jvet-experts.org/doc_end_user/current_document.php?id=14092) EE2-related: Chroma LIC derivation with template costs [T. M. Bae, S. Deshpande (Sharp)]

[JVET-AH0289](https://jvet-experts.org/doc_end_user/current_document.php?id=14188) Crosscheck of JVET-AH0193 (EE2-related: Chroma LIC derivation with template costs) [H.-J. Jhu (Kwai)] [late] [miss]

[JVET-AH0202](https://jvet-experts.org/doc_end_user/current_document.php?id=14101) EE2 related: Adaptive weighting for Inter CCP merge mode with zero luma CBF [X. Li (Google), Z. Deng, K. Zhang, L. Zhang (Bytedance)]

[JVET-AH0230](https://jvet-experts.org/doc_end_user/current_document.php?id=14129) Crosscheck of JVET-AH0202 EE2 related: Adaptive weighting for Inter CCP merge mode with zero luma CBF [X. Xiu (Kwai)] [late] [miss]

[JVET-AH0218](https://jvet-experts.org/doc_end_user/current_document.php?id=14117) EE2-4.1 related: Alternative intra mode derivation for LFNST/NSPT [L. Zhao, K. Zhang, L. Zhang (Bytedance)]

[JVET-AH0235](https://jvet-experts.org/doc_end_user/current_document.php?id=14134) Crosscheck of JVET-AH0218 (EE2-4.1 related: Alternative intra mode derivation for LFNST/NSPT) [F. Wang (OPPO)] [late] [miss]

[JVET-AH0237](https://jvet-experts.org/doc_end_user/current_document.php?id=14136) EE2-4.1 related: Alternative intra mode derivation for LFNST/NSPT kernel selection [M. Coban, M. Karczewicz, V. Seregin (Qualcomm)] [late]

[JVET-AH0274](https://jvet-experts.org/doc_end_user/current_document.php?id=14173) EE2 related: TIMD Merge Mode with Enhanced Block Vector Deployment [K. Naser, Y. Chen, F. Le Léannec, M. Radosavljević, K. Reuzé (InterDigital)] [late]

### ECM modifications and software improvements beyond EE2 (39)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

#### Intra and CIIP (12)

[JVET-AH0058](https://jvet-experts.org/doc_end_user/current_document.php?id=13940) Non-EE2: Derived MIP modes with fusion [Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AH0059](https://jvet-experts.org/doc_end_user/current_document.php?id=13941) AHG12: Temporal BV for IBC merge list construction [L. Xu, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AH0271](https://jvet-experts.org/doc_end_user/current_document.php?id=14170) Crosscheck of JVET-AH0059 (AHG12: Temporal BV for IBC merge list construction) X. Li (Alibaba) [late] [miss]

[JVET-AH0072](https://jvet-experts.org/doc_end_user/current_document.php?id=13954) AHG12: Eliminating division operations in DIMD and TIMD [Z. Fan, T. Chujoh, T. Ikai (Sharp)]

[JVET-AH0225](https://jvet-experts.org/doc_end_user/current_document.php?id=14124) Crosscheck of JVET-AH0072 (AHG12: Eliminating division operations in DIMD and TIMD) [W. Ahmad (Ericsson)] [late] [miss]

[JVET-AH0233](https://jvet-experts.org/doc_end_user/current_document.php?id=14132) Crosscheck of JVET-AH0072 (AHG12: Eliminating division operations in DIMD and TIMD) test1 [F. Wang (OPPO)] [late] [miss]

[JVET-AH0082](https://jvet-experts.org/doc_end_user/current_document.php?id=13964) Non-EE2: GPM with CCCM for intra chroma prediction [Y. Huo, Y. Liu (Transsion)]

[JVET-AH0083](https://jvet-experts.org/doc_end_user/current_document.php?id=13965) AHG12: Additional TIMD mode with different cost metric [D. Bugdayci Sansli, S. Blasi, J. Lainema (Nokia)]

[JVET-AH0091](https://jvet-experts.org/doc_end_user/current_document.php?id=13973) Non-EE2: Geometry partitioning mode with inter prediction and intra block copy [Y. Wang, K. Zhang, L. Zhang (Bytedance)]

[JVET-AH0095](https://jvet-experts.org/doc_end_user/current_document.php?id=13977) AHG12: Regularized EIP [H. Qin, J. Konieczny, K. Ding, Z. Xu (TCL)]

[JVET-AH0105](https://jvet-experts.org/doc_end_user/current_document.php?id=13987) AHG12: Multiple Reference Area Decoder-side Intra Mode Derive [J. Fan, J. Huo, Z. Zhang, Y. Ma, F. Yang (Xidian Univ.), M. Li (OPPO)]

[JVET-AH0131](https://jvet-experts.org/doc_end_user/current_document.php?id=14013) AhG12: Fix on BV Filtering for IntraTMP Fusion [S. Kim, D. Jun (Dong-A University)]

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[JVET-AH0310](https://jvet-experts.org/doc_end_user/current_document.php?id=14210) Crosscheck of JVET-AH0131 (AhG12: Fix on BV Filtering for IntraTMP Fusion) [L. Zhang (OPPO)] [late]

[JVET-AH0156](https://jvet-experts.org/doc_end_user/current_document.php?id=14053) AHG12: Neural Network-based Intra Prediction [F. Urban, T. Dumas, F. Galpin (InterDigital)]

[JVET-AH0210](https://jvet-experts.org/doc_end_user/current_document.php?id=14109) Non-EE2: Modifications to Matrix-Based Intra Prediction [H. Wang, B. Ray, V. Seregin, M. Karczewicz, P. Garus, S. Eadie (Qualcomm)]

[JVET-AH0211](https://jvet-experts.org/doc_end_user/current_document.php?id=14110) Non-EE2: Intra merge mode [Y.-J. Chang, V. Seregin, M. Karczewicz (Qualcomm)]

#### Inter (9)

[JVET-AH0141](https://jvet-experts.org/doc_end_user/current_document.php?id=14023) AHG12: Sharp motion compensation filter for bi-prediction [J. Samuelsson-Allendes (Sharp)]

[JVET-AH0144](https://jvet-experts.org/doc_end_user/current_document.php?id=14026) AHG12: Hierarchical Subblock based DMVR [[K. Andersson](mailto:kenneth.r.andersson@ericsson.com), [C. Hollmann (Ericsson)](mailto:christopher.hollmann@ericsson.com)]

[JVET-AH0145](https://jvet-experts.org/doc_end_user/current_document.php?id=14027) AHG12: Follow up on normative DMVR fix for ECM as in JVET-AG0125 (Parallel friendly use of boundary distortion for DMVR) [K. Andersson (Ericsson)]

[JVET-AH0315](https://jvet-experts.org/doc_end_user/current_document.php?id=14215) Crosscheck of JVET-AH0145 (AHG12: Follow up on normative DMVR fix for ECM) [J. Lainema (Nokia)] [late] [miss]

[JVET-AH0152](https://jvet-experts.org/doc_end_user/current_document.php?id=14034) Ahg12: adaptive dual-tree coding in B slices [F. Le Léannec, K. Naser, T. Dumas, T. Poirier, F. Urban, E. François (InterDigital)]

[JVET-AH0178](https://jvet-experts.org/doc_end_user/current_document.php?id=14077) Non-EE2: High Accuracy Sample Based Bi-Directional Optical Flow [M. Salehifar, Y. He, K. Zhang, L. Zhang (Bytedance)]

[JVET-AH0208](https://jvet-experts.org/doc_end_user/current_document.php?id=14107) Non-EE2: Affine candidates derived from temporal collocated picture [C. Ma, X. Xiu, C.-W. Kuo, W. Chen, X. Wang (Kwai)]

[JVET-AH0213](https://jvet-experts.org/doc_end_user/current_document.php?id=14112) Non-EE2: MVP extension [Z. Zhang, J.-L Lin, H. Huang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AH0215](https://jvet-experts.org/doc_end_user/current_document.php?id=14114) Non-EE2: Adaptive Cost Function Selection in Merge Mode [K. Cui, Z. Zhang, Y. Zhang, H. Huang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AH0222](https://jvet-experts.org/doc_end_user/current_document.php?id=14121) Non-EE2: GPM-Affine with MMVD and TM [Y. Wang, K. Zhang, L. Zhang (Bytedance)]

#### Cross Component Prediction (1)

[JVET-AH0203](https://jvet-experts.org/doc_end_user/current_document.php?id=14102) Non-EE2: On BVG-CCCM [K. Zhang, Z. Deng, L. Zhang (Bytedance)]

[JVET-AH0316](https://jvet-experts.org/doc_end_user/current_document.php?id=14216) Crosscheck of JVET-AH0203 (Non-EE2: On BVG-CCCM) [J. Lainema (Nokia)] [late] [miss]

#### In-Loop Filters (6)

[JVET-AH0060](https://jvet-experts.org/doc_end_user/current_document.php?id=13942) Non-EE2: On residual adjustments for adaptive loop filters [Z. Dai, N. Song, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AH0061](https://jvet-experts.org/doc_end_user/current_document.php?id=13943) Non-EE2: CCALF with Chroma SAO input [Z. Dai, N. Song, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AH0318](https://jvet-experts.org/doc_end_user/current_document.php?id=14218) Crosscheck of JVET-AH0061(Non-EE2: CCALF with Chroma SAO Input) [W. Yin (Bytedance)] [late] [miss]

[JVET-AH0062](https://jvet-experts.org/doc_end_user/current_document.php?id=13944) Non-EE2: CCALF with Chroma Fixed Filter Input [N. Song, Z. Dai, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AH0163](https://jvet-experts.org/doc_end_user/current_document.php?id=14062) AHG12: ALF syntax modification [F. Galpin, G. Boisson, P. Bordes, F. Lefebvre, I. Marzuki (InterDigital)]

[JVET-AH0170](https://jvet-experts.org/doc_end_user/current_document.php?id=14069) Non-EE2: ALF residuals scaling [P. Bordes, F. Galpin, G. Boisson (InterDigital)]

[JVET-AH0275](https://jvet-experts.org/doc_end_user/current_document.php?id=14174) Non-EE2: CCALF with chroma ALF outputs [N. Hu, M. Karczewicz, V. Seregin (Qualcomm)] [late]

#### Entropy coding, transforms, quantization, and transform coefficient coding (9)

[JVET-AH0063](https://jvet-experts.org/doc_end_user/current_document.php?id=13945) AHG12: On Shifting Quantization Center [Y. Yu, H. Yu, L. Xu, J. Gan, F. Wang, Z. Xie, D. Wang (OPPO)]

[JVET-AH0288](https://jvet-experts.org/doc_end_user/current_document.php?id=14187) Crosscheck of JVET-AH0063 (AHG12: On Shifting Quantization Center) [H.-J. Jhu (Kwai)] [late] [miss]

[JVET-AH0321](https://jvet-experts.org/doc_end_user/current_document.php?id=14221) Crosscheck of JVET-AH0063 (AHG12: On Shifting Quantization Center) [M. Balcilar (InterDigital)] [late] [miss]

[JVET-AH0089](https://jvet-experts.org/doc_end_user/current_document.php?id=13971) AhG12: On entropy models training [F. Galpin, F. Lo Bianco, C. Salmon-Legagneur (InterDigital)]

[JVET-AH0103](https://jvet-experts.org/doc_end_user/current_document.php?id=13985) Non-EE2: Low-delay configurations for LFNST/NSPT [M. Koo, Y. Ahn, J. Nam, J. Zhao, J. Lim, S. Kim (LGE)]

[JVET-AH0231](https://jvet-experts.org/doc_end_user/current_document.php?id=14130) Crosscheck of JVET-AH0103 Non-EE2: Low-delay configurations for LFNST/NSPT [M. Coban, V. Seregin (Qualcomm)] [late] [miss]

[JVET-AH0232](https://jvet-experts.org/doc_end_user/current_document.php?id=14131) Crosscheck of JVET-AH0103 (Non-EE2: Low-delay configurations for LFNST/NSPT) [F. Wang (OPPO)] [late] [miss]

[JVET-AH0117](https://jvet-experts.org/doc_end_user/current_document.php?id=13999) AHG12: Modification of chroma QP mapping table for ECM [Y. Wang, K. Zhang, L. Zhang (Bytedance), J. Chen, R.-L. Liao, Y. Ye (Alibaba), V. Seregin, M. Karczewicz (Qualcomm), F. Le Léannec, K. Naser, E. François (InterDigital)]

[JVET-AH0317](https://jvet-experts.org/doc_end_user/current_document.php?id=14217) Crosscheck of JVET-AH0117 (AHG12: Modification of chroma QP mapping table for ECM) [F. Wang (OPPO)] [late] [miss]

[JVET-AH0181](https://jvet-experts.org/doc_end_user/current_document.php?id=14080) AHG12: Adaptation of intra/inter LFNST/NSPT for low-delay configuration [C. Bonnineau, F. Le Léannec, K. Naser, S. Puri, I. Marzuki, R. Utida (InterDigital)]

[JVET-AH0182](https://jvet-experts.org/doc_end_user/current_document.php?id=14081) Non-EE2: On intra and inter LFNST/NSPT for low delay configuration [Y. Kidani, H. Kato, K. Kawamura (KDDI)]

[JVET-AH0219](https://jvet-experts.org/doc_end_user/current_document.php?id=14118) Non-EE2: Improvements on Inter LFNST/NSPT [L. Zhao, K. Zhang, L. Zhang (Bytedance)]

[JVET-AH0223](https://jvet-experts.org/doc_end_user/current_document.php?id=14122) AHG12: Context retraining for ECM-12.0 [V. Seregin, M. Coban, M. Karczewicz (Qualcomm)]

[JVET-AH0307](https://jvet-experts.org/doc_end_user/current_document.php?id=14207) AHG12: Multiple Transform Set Selection for Intra MTS [C. Bonnineau, K. Naser, S. Puri, F. Le Léannec (InterDigital)] [late] [miss]

#### Other (3)

[JVET-AH0155](https://jvet-experts.org/doc_end_user/current_document.php?id=14052) AHG12: Restricting BT CUs to apply QT-like partitioning structure [W. Ahmad, P. Wennersten, K. Andersson (Ericsson)]

[JVET-AH0221](https://jvet-experts.org/doc_end_user/current_document.php?id=14120) Crosscheck of JVET-AH0155 (AHG12: Restricting BT CUs to apply QT-like partitioning structure) [Z. Fan (Sharp)] [late]

[JVET-AH0168](https://jvet-experts.org/doc_end_user/current_document.php?id=14067) Template Matching Picture Boundary Padding [N. Neumann, M. Wien (RWTH Aachen Univ.)]

[JVET-AH0171](https://jvet-experts.org/doc_end_user/current_document.php?id=14070) AHG10/AHG12 GOP-based RPR encoder control results on UHD test data [K. Andersson, J. Ström, P. Wennersten, W. Ahmad, C. Hollmann (Ericsson)]

### CTC for EE2/ECM and general ECM improvements (1)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0180](https://jvet-experts.org/doc_end_user/current_document.php?id=14079) AHG12: Modified CTC for encoding time reduction under low-delay configuration [R. Utida, S. Puri, I. Marzuki, C. Bonnineau (InterDigital)]

# High-level syntax (HLS) and related proposals (38)

## AHG9: Aspects on SEI messages in VSEIv4 draft (5)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0108](https://jvet-experts.org/doc_end_user/current_document.php?id=13990) AHG9: Editorial improvements of the encoder optimization information SEI messages [C. Kim, Hendry, J. Lim, S. Kim (LGE)]

This contribution proposes some changes to the Encoder Optimization Information SEI and they are asserted to be editorial / bug fixes / clarification to the intent. The proposed changes are:

1. Change the coding of syntax element eoi\_object\_based\_idc from ue(v) to u(8).
2. Clarify the semantics of eoi\_privacy\_protected\_info\_type when its value is equal to 0
3. Modify the semantics of value 0 for eoi\_privacy\_protection\_type\_idc from "unknown" to "determined by the application"

Regarding #1, an expert said bit masks can still be used with the current design, and switching to u(8) reduces extensibility.

Decision (Ed.):

For #2, editorial improvement agreed in principle. Editors are suggested to consider this language.

For #3, semantics to be modified to “unknown or determined by other means not specified in this document.”

[JVET-AH0111](https://jvet-experts.org/doc_end_user/current_document.php?id=13993) AHG9: Proposed update on the encoder optimization information SEI message [C. Kim, Hendry, J. Lim, S. Kim (LGE)]

This contribution proposes the following modifications to Encoder Optimization Information (EOI) SEI message:

1. Add a constraint on the values of eoi\_for\_human\_viewing\_idc and eoi\_for\_machine\_analysis\_idc to avoid signalling of values that do not make sense in term of optimization purpose:

* Option 1: at least eoi\_for\_human\_viewing\_idc or eoi\_for\_machine\_analysis\_idc shall be greater than 1.
* Option 2: eoi\_for\_human\_viewing\_idc and eoi\_for\_machine\_analysis\_idc shall not be both equal to 1.
* Option 3: eoi\_for\_human\_viewing\_idc and eoi\_for\_machine\_analysis\_idc shall not be both equal to 1 or both equal to 0.

1. When the optimization type of EOI SEI message includes spatial resampling, signal a flag to identify whether the spatial resampling is an up-sampling or subsampling.

For aspect 1, option 1, it was commented that with this proposal, the EOI SEI message would require explicit indication of either optimization for machine or optimization for human viewing.

Decision: Adopt aspect 1 Option 2, eoi\_for\_human\_viewing\_idc and eoi\_for\_machine\_analysis\_idc shall not be both equal to 1.

Decision: Adopt aspect 2, When the optimization type of EOI SEI message includes spatial resampling, signal a flag to identify whether the spatial resampling is an up-sampling or subsampling.

[JVET-AH0115](https://jvet-experts.org/doc_end_user/current_document.php?id=13997) AHG9: Bit-depth truncation as optimization type in EOI SEI message [C. Kim, Hendry, J. Lim, S. Kim (LGE), D. Ding, R. Chernyak, G. Teniou, S. Wenger, S. Liu (Tencent)]

In the last two JVET meetings, bit-depth truncation technique that can be applied at encoder side has been demonstrated to be able to reduce bit-rate of the coded bitstream without significant effect to the performance of processes that may be applied to the reconstructed pictures of the bitstream such as machine analysis tasks.

This contribution proposes to include the bit-depth truncation as an optimization type that encoder may do into the current Encoder Optimization Information SEI message.

An expert noted that the JVET-AF0138 contribution sometimes inverts the bit shifting operation but sometimes does not. This contribution doesn’t signal a recommendation of whether the decoder should do the inverse operation. If the decoder was recommended to do an operation, perhaps this EOI SEI message is not the appropriate location because it would go beyond describing what the encoder had done.

Other use cases than machine applications were suggested verbally by the proponents including bitrate efficiency, but no experimental results for human vision use cases was provided.

An expert indicated that the draft VCM standard includes bit shifting operations, but not in an SEI message. Another expert requested a comparison with the approach in VCM.

study encouraged.

[JVET-AH0160](https://jvet-experts.org/doc_end_user/current_document.php?id=14059) AHG9: On persistence cancellation of an object mask information SEI message [Hendry, J. Nam, S. Kim, J. Lim (LGE)]

It is asserted that the while the current design of object mask information (OMI) SEI message allows the presence of multiple OMI SEI messages to be active in the CVS, the persistence cancelling mechanism is only able to cancel the persistency of any previous OMI SEI messages. A better design would be to be able to precisely cancel persistence of a specific OMI SEI message, rather than blindly cancelling persistency of all previous OMI SEI messages.

This contribution proposes to enable OMI SEI message to cancel the persistency of a specific OMI SEI message with the following modifications:

1. Move the signalling of omi\_aux\_id\_minus128 to be before syntax element omi\_cancel\_flag.
2. Change the coding of syntax element omi\_aux\_id\_minus128 from ue(v) to become u(5).
3. Update the semantics of omi\_cancel\_flag such that when it is equal to 1, it cancels previous OMI SEI message with the same omi\_aux\_id\_minus128 value, if present.

In the first revision of this contribution, the coding of the syntax element omi\_aux\_id\_minus128 is changed from ue(v) to become u(5).

An expert suggested that for splicing support some SEI messages cancel flags are used to cancel all previous SEI messages of the type.

An expert remarked that only one Aux picture can be present in a layer. An alternative design could be to clarify that the cancel flag only cancels the current layer where the SEI resides. The current text doesn’t specify in which layers the SEI can be present.

An expert suggested that aux ID values are signaled as u(8) in the SDI. It was suggested to just use the same value space, and in the range of 0 to 255.

It was suggested that if the SEI message was constrained to be in the same layer, it would allow easier extraction of the layer.

The proponent of the existing object mask information SEI said that the existing design can signal the object masks for multiple layers. A constraint seems to be missing to require that all the SDI AuxID values of all the object masks in the OMI SEI should be the same.

Revisit after side discussion coordinated by Hendry.

[JVET-AH0174](https://jvet-experts.org/doc_end_user/current_document.php?id=14073) [AHG9] Spatial extrapolation as a new NNPF purpose and some bug fixes [J. Xu, Y.-K. Wang (Bytedance)]

The following changes are proposed:

1. A new bit of nnpfc\_purpose is used to support a NNPF purpose of spatial extrapolation. Accordingly, the output width and height are adjusted and the preferred display method is indicated.

(The following changes are proposed to address some asserted issues in the semantics of nnpfc\_num\_metadata\_extension\_bits and nnpfc\_reserved\_metadata\_extension):

1. Specifies the following: When nnpfc\_num\_metadata\_extension\_bits is greater than 0, let numSpecifiedMetadataExtensionBits be the number of bits representing all syntax elements between nnpfc\_num\_metadata\_extension\_bits and nnpfc\_reserved\_metadata\_extension. nnpfc\_num\_metadata\_extension\_bits greater than 0 specifies the sum of numSpecifiedMetadataExtensionBits and the length, in bits, of nnpfc\_reserved\_metadata\_extension.
2. Specifies the following: The value of nnpfc\_num\_metadata\_extension\_bits shall be in the range of numSpecifiedMetadataExtensionBits to 2 048, inclusive. Values in the range of numSpecifiedMetadataExtensionBits + 1 to 2 048, inclusive, for nnpfc\_num\_metadata\_extension\_bits are reserved for future use by ITU-T | ISO/IEC and shall not be present in bitstreams conforming to this version of this Specification. Decoders conforming to this version of this Specification shall allow any value of nnpfc\_num\_metadata\_extension\_bits in the range of numSpecifiedMetadataExtensionBits + 1 to 2 048, inclusive.
3. In the NNPFC SEI message syntax, a closing curly bracket, '}', is added immediately after the syntax element nnpfc\_reserved\_metadata\_extension.
4. The specification for the length, in bit, of nnpfc\_reserved\_metadata\_extension syntax element is simplified as follows: When present, the length, in bits, of nnpfc\_reserved\_metadata\_extension is equal to nnpfc\_num\_metadata\_extension\_bits − numSpecifiedMetadataExtensionBits.

Spatial extrapolation represents NNPF-based outpainting.

Regarding aspect 1, it was suggested to move the new syntax elements for indicting offsets and scan type from the metadata extension to above the extension bit, conditioned on the new purpose. Backwards compatibility would be maintained because a new purpose is defined.

Decision: Adopt aspect 1 for spatial extrapolation purpose, with syntax elements relocated as described above.

Other aspects TBP with JVET-AH0125.

## AHG9: Aspects on SEI messages in TuC document (13)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

### Generative face video

[JVET-AH0053](https://jvet-experts.org/doc_end_user/current_document.php?id=13935) AHG9: Comments on Generative Face Video SEI [S. Deshpande (Sharp)]

Technologies under consideration for future extensions of VSEI includes a Generative Face Video (GFV) SEI. Some modifications are proposed to GFV SEI. Following is proposed:

* Proposal 1: It is proposed to conditionally signal gfv\_base\_pic\_flag only when gfv\_cnt is equal to 0 and infer its value otherwise.
* Proposal 2: A bitstream conformance constraint is proposed to require that the value of the syntax element gfv\_num\_matrix\_types\_minus1 is the same for the base picture and corresponding non-base picture with gfv\_matrix\_pred\_flag equal to 1. Also a bitstream conformance constraint is proposed to require that the value of derived variables numMatrices[ i ], matrixHeight[ i ], matrixWidth[ i ] is the same for the base picture and corresponding non-base picture with gfv\_matrix\_pred\_flag equal to 1, for each i in the range of 0 to gfv\_num\_matrix\_types\_minus1, inclusive.
* Proposal 3: It is asserted that when gfv\_coordinate\_present\_flag is equal to 0, gfv\_num\_matrices\_equal\_to\_num\_kps\_flag[ i ] is not present and gfv\_num\_matrices\_equal\_to\_num\_kps\_flag[ i ] does not have an inferred value when not present, but it is used in a conditional if statement (with an OR operator) to gate the syntax element gfv\_num\_matrices\_info[ i ]. It is proposed to infer a value for gfv\_num\_matrices\_equal\_to\_num\_kps\_flag[ i ] when not present to avoid undefined behavior. It is also asserted that this simplifies the if condition to signal gfv\_num\_matrices\_info[ i ] syntax element.
* Proposal 4: It is asserted that when gfv\_coordinate\_z\_present\_flag is equal to 0, syntax elements gfv\_coordinate\_z\_max\_value\_minus1, gfv\_coordinate\_z\_abs[ i ], gfv\_coordinate\_z\_sign\_flag[ i ], gfv\_coordinate\_dz\_abs[ i ], and gfv\_coordinate\_dz\_sign\_flag[ i ] are not present. Thus it is asserted that a conditional check regarding if gfv\_coordinate\_z\_present\_flag is equal to 1 needs to be performed in the derivation of coordinateZ[ i ], coordinateDeltaZ[ i ] and BaseKpCoordinateZ[ i ].

Decision: Adopt.

This includes:

* Proposal 1, conditionally signal gfv\_base\_pic\_flag.
* Proposal 2, impose bitstream conformance constraint to require that the value of the syntax element gfv\_num\_matrix\_types\_minus1 is the same for the base picture and corresponding non-base picture with gfv\_matrix\_pred\_flag equal to 1, and additional constraint.
* Proposal 3, infer a value for gfv\_num\_matrices\_equal\_to\_num\_kps\_flag[ i ] when not present and update the conditional if.
* Proposal 4, add if condition on gfv\_coordinate\_z\_present\_flag for derivations.

[JVET-AH0054](https://jvet-experts.org/doc_end_user/current_document.php?id=13936) AHG16: On the generative face video SEI message [H.-B. Teo, J.-Y. Thong, K. Abe, C.-S. Lim, K. Jayashree (Panasonic)]

This contribution proposes modifications to the generative face video (GFV) SEI message outlined in TuC for future extensions of VSEI, JVET-AG2032. In particular, the following are proposed to be included:

Aspect 1: A flag that indicates the facial parameters in current SEI message were detected with low confidence.

Aspect 2: A flag that indicates to copy facial parameters from previously decoded generative face video SEI message.

Aspect 1 has two options, either a single flag or multiple low confidence flags.

A single bit to indicate global confidence is cheap bitrate wise.

A request was made for data about the benefits of the proposal.

A suggestion was made that other alternatives could be done, such as to indicate areas of occlusion.

AHG16 has contributions that improve quality.

Revisit when AHG16 experts are available.

[JVET-AH0137](https://jvet-experts.org/doc_end_user/current_document.php?id=14019) AHG9: Indicating timing information for generative face video (GFV) output pictures [L. Chen, O. Chubach, Y.-W. Huang, S. Lei (MediaTek)]

[JVET-AH0138](https://jvet-experts.org/doc_end_user/current_document.php?id=14020) AHG9/AHG16: Pupil position SEI message for Generative Face Video [A. Trioux, Y. Yao, F. Ma, F. Yang (Xidian Univ.), F. Xing, Z. Wang (Hisense)]

See section 4.16

[JVET-AH0148](https://jvet-experts.org/doc_end_user/current_document.php?id=14030) AHG9/AHG16: On key point coordinates calculation for the generative face video SEI message [K. Yang (SJTU), Y.-K. Wang (Bytedance), Y. Xu, Y. Li (SJTU)]

### MPI

[JVET-AH0045](https://jvet-experts.org/doc_end_user/current_document.php?id=13927) AHG9: Report on the joint AG 5, WG 4, and WG 5 (AHG9) conference call on preparations to evaluate video quality in the context of MPI [S. McCarthy, J.-R. Ohm, M. Wien, B. Kroon]

This is the report on the joint AG 5, WG 4, and WG 5 (AHG9) conference call on preparations to evaluate video quality in the context of MPI during the MPEG meetings in Rennes, Fr, April 2024. The first conference call was held on 1330-1430 UTC March 28, 2024, by teleconference. At the first call, goals, objectives, scope, and location of the video quality evaluation were discussed.

Version 1 of this document contains an introduction and agenda. It was uploaded before the meeting on March 28, 2024.

Version 2 of this document contains the notes of the conference call.

Demos are planned this week, to be scheduled at the Chairs meeting on Sunday, so not before Monday.

[JVET-AH0150](https://jvet-experts.org/doc_end_user/current_document.php?id=14032) AHG9: On the proposed MPII SEI message for non-parallel MPI layers [Y. Li (SJTU), Y.-K. Wang (Bytedance), Y. Xu, K. Yang (SJTU)]

This contribution provides a comparison of the rendering complexity between traditional MPI and MPI with non-parallel layers. Two demos showing the rendering effects of the two methods are provided in the attachments. It is proposed to add the support of non-parallel layers into the MPII SEI message.

More information about decoder complexity is requested. Description of computer used for runtimes, as well as some analysis of expected complexity more generally than runtimes.

Presenting demo content that is more interesting would be useful.

An expert suggested that the MPII SEI message could be supported in the multi-layer context, to enable reduction in number of decoded layers when complexity constrained.

[JVET-AH0197](https://jvet-experts.org/doc_end_user/current_document.php?id=14096) AHG9: Showcase on multiplane image SEI message [A. Harinkhede, V. G. R., A. Sarate, J. R. Arumugam, J. Shingala (Ittiam), W. Husak, D. Y. Lee, S. McCarthy, S. Oh, G.-M. Su, G. J. Sullivan (Dolby)]

[JVET-AH0290](https://jvet-experts.org/doc_end_user/current_document.php?id=14189) AHG9: real-time demonstration of MPI (V3C) [R. Gendrot, F. Galpin (InterDigital)] [late] [miss]

### Other

[JVET-AH0047](https://jvet-experts.org/doc_end_user/current_document.php?id=13929) AHG9: On grouping of post-processing filters [Y.-K. Wang, W. Jia, J. Xu, L. Zhang (Bytedance)]

[JVET-AH0166](https://jvet-experts.org/doc_end_user/current_document.php?id=14065) AHG9: Improvements to the film grain regions characteristics SEI message [S. Xie, P. Wu, Y. Gao, Y. Bai, M. Jia, W. Niu, [C. Huang (ZTE)](mailto:huang.cheng5@zte.com.cn)]

[JVET-AH0167](https://jvet-experts.org/doc_end_user/current_document.php?id=14066) AHG9: On payload size signalling for SEI messages [M. Pettersson, M. Damghanian, R. Sjöberg (Ericsson)]

[JVET-AH0177](https://jvet-experts.org/doc_end_user/current_document.php?id=14076) AHG9: Move the AI Labelling SEI from TuC to VSEI WD for consent/ballot [G. Teniou, S. Wenger, A. Hinds (Tencent)]

[JVET-AH0212](https://jvet-experts.org/doc_end_user/current_document.php?id=14111) AHG9/AHG13: Updates on the implementation of film grain regions characteristics SEI message [G. Teniou (Tencent), P. De Lagrange, E. François (InterDigital)] [late] [miss]

## AHG9: SEI processing order and processing order nesting SEI message aspects (7)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0121](https://jvet-experts.org/doc_end_user/current_document.php?id=14003) AHG9: On the SEI processing order SEI message [M. M. Hannuksela, F. Cricri, J. Boyce (Nokia)]

[JVET-AH0123](https://jvet-experts.org/doc_end_user/current_document.php?id=14005) AHG9: On applying the SEI processing order to generated pictures [M. M. Hannuksela, F. Cricri (Nokia)]

[JVET-AH0124](https://jvet-experts.org/doc_end_user/current_document.php?id=14006) AHG9: Latency signalling in the SEI processing order SEI message [M. M. Hannuksela, F. Cricri (Nokia)]

[JVET-AH0132](https://jvet-experts.org/doc_end_user/current_document.php?id=14014) AHG9: On use of PON SEI messages [[L. Chen](mailto:lulin.chen@mediatek.com), O. Chubach, Y.-W. Huang, S. Lei (MediaTek)]

[JVET-AH0134](https://jvet-experts.org/doc_end_user/current_document.php?id=14016) [AHG9] Improvement on the SEI processing order SEI message [Y. Gao, P. Wu, Y.-X. Bai, S.-W. Xie, M.-H. Jia, W.-H. Niu, C. Huang (ZTE)]

[JVET-AH0158](https://jvet-experts.org/doc_end_user/current_document.php?id=14057) AHG9: On association between SEI Processing Order and Processing Order Nesting SEI messages [Hendry, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-AH0159](https://jvet-experts.org/doc_end_user/current_document.php?id=14058) AHG9: On aspects related to SEI processing order and processing order nesting SEI messages [Hendry, J. Nam, S. Kim, J. Lim (LGE)]

## AHG9: Other SEI topics (13)

Contributions in this area were discussed at XXXX–XXXX on XXday XX April 2024 (chaired by XXX).

[JVET-AH0049](https://jvet-experts.org/doc_end_user/current_document.php?id=13931) AHG9: Modality Information SEI for AVC and HEVC [J. Gao, H.-B. Teo, C.-S. Lim, K. Abe, V. Drugeon (Panasonic)]

[JVET-AH0052](https://jvet-experts.org/doc_end_user/current_document.php?id=13934) AHG9: Text Description Information SEI Message [S. Deshpande (Sharp)]

[JVET-AH0070](https://jvet-experts.org/doc_end_user/current_document.php?id=13952) AHG9: On an extension of AI text data SEI message [[T. Chujoh](mailto:chujoh.takeshi@sharp.co.jp), Z. Fan, T. Ikai (Sharp), L. Jin, H. Watanabe (Waseda Univ.)]

[JVET-AH0112](https://jvet-experts.org/doc_end_user/current_document.php?id=13994) AHG9: Signalling video usage for AI-driven processes in SEI message [C. Kim, Hendry, J. Lim, S. Kim (LGE)]

[JVET-AH0125](https://jvet-experts.org/doc_end_user/current_document.php?id=14007) AHG8/AHG9: Indication of NNPFs and processing chains for machine consumption [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

[JVET-AH0126](https://jvet-experts.org/doc_end_user/current_document.php?id=14008) [AHG9]: Neural network post-filter for recovering images from energy-aware images [C.-H. Demarty, F. Aumont, L. Blonde, E. Reinhard, O. Le Meur (InterDigital)] [late]

[JVET-AH0161](https://jvet-experts.org/doc_end_user/current_document.php?id=14060) AHG9: Region packing information SEI [J. Boyce, M. M. Hannuksela, H. Zhang (Nokia)]

[JVET-AH0162](https://jvet-experts.org/doc_end_user/current_document.php?id=14061) AHG9: Constituent rectangles SEI [J. Boyce, M. M. Hannuksela (Nokia)]

[JVET-AH0164](https://jvet-experts.org/doc_end_user/current_document.php?id=14063) AHG9: Quality metric SEI [J. Boyce, M. M. Hannuksela, F. Cricri (Nokia)]

[JVET-AH0172](https://jvet-experts.org/doc_end_user/current_document.php?id=14071) AHG9: Text comment SEI message [P. de Lagrange, D. Doyen, E. François, F. Urban, C. Salmon-Legagneur (InterDigital)]

[JVET-AH0173](https://jvet-experts.org/doc_end_user/current_document.php?id=14072) AHG9: SEI message for International Color Consortium (ICC) profiles [A. Hinds, S. Wenger, G. Teniou (Tencent)]

[JVET-AH0198](https://jvet-experts.org/doc_end_user/current_document.php?id=14097) AHG9: No display and no display purpose SEI messages [S. McCarthy, G. J. Sullivan, P. Yin (Dolby)]

[JVET-AH0204](https://jvet-experts.org/doc_end_user/current_document.php?id=14103) AHG9: Lens Optical Correction SEI message [G. Teniou, S. Wenger (Tencent)]

## Non-SEI HLS aspects (0)

Kept as template for future use.

# Plenary meetings, joint meetings, BoG reports, and liaison communications

## General

Further detail on scheduling is recorded in section 2.12.

Joint meetings involving JVET were held as follows:

* …

Further detail about these sessions with other groups is provided in the other subsections of this section.

Break-out group reports are discussed in section 7.6.

General plenary wrap-up discussions are recorded under sections 8, 9, and 10.

## Information sharing meetings

Information sharing sessions with other WGs and AGs of the MPEG community were held on Monday 22 Jan. 0500–0800, Wednesday 24 Jan. 0500–0600, and Friday 26 Jan. 2100–2300.

The status and plans for the work in the MPEG WGs and AGs was reviewed at these information sharing sessions.

## Joint session XXXX-XXXX XXday XX April on XXXX: MPEG WG 5 / JVET and XXXX

(The notes for this session were recorded by XXX)

…

The session was closed at XXXX.

## BoGs (4)

The following break-out groups were established at this meeting to conduct discussion and develop recommendations on particular subjects.

## Liaison communications (1)

…

The liaison response was reviewed in JVET on XXday XX April at XXXX-XXXX. The draft reply was also presented in the MPEG AG 3 Communication meeting Thursday 25 April at XXXX-XXXX.

# Project planning

## Software timeline (update)

ECM 12.0 software (including all adoptions) was planned to be available 3 weeks after the meeting.

The NNVC 8.0 codebase software was planned to be available 2 weeks after the meeting.

Bug fixes on top of VTM23.0 software will be released as appropriate.

Updates on top of HM17.0 software were not planned, but might be released after merging pending requests, as appropriate.

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-AH2023.

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-AH2024.

Initial versions of these documents were presented and approved.

## Drafting of specification text, encoder algorithm descriptions, and software

The following agreement has been established: the editorial team has the discretion to not integrate recorded adoptions for which the available text is grossly inadequate (and cannot be fixed with a reasonable degree of effort), if such a situation hypothetically arises. In such an event, the text would record the intent expressed by the committee without including a full integration of the available inadequate text.

## Plans for improved efficiency and contribution consideration

The group considered it important to have the full design of proposals documented to enable proper study.

Adoptions need to be based on properly drafted working draft text (on normative elements) and HM/VTM encoder algorithm descriptions – relative to the existing drafts. Proposal contributions should also provide a software implementation (or at least such software should be made available for study and testing by other participants at the meeting, and software must be made available to cross-checkers in EEs).

Suggestions for future meetings included the following generally-supported principles:

* Normative contributions (relating to changes in bitstream/decoder) shall include draft specification text
* Proposals shall contain all details relevant for understanding and be self-contained. In cases where the document is a follow-up of a previous contribution, the overall concept and the novelties should be highlighted at minimum
* Coding tool and encoder optimization proposals shall contain Excel sheets that allow assessment on a per-sequence basis
* Algorithm description text is strongly encouraged for non-normative contributions that are intended to be included in model description documents (VTM, ECM, etc.), and that is required for inclusion in TR drafts.
* Early upload deadline to enable substantial study prior to the meeting
* Using a clock timer to ensure efficient proposal presentations (5 min) and discussions (not exercised currently)

As general guidance, it was suggested to avoid usage of company names in document titles, software modules etc., and not to describe a technology by using a company name.

## General issues for experiments

It was emphasized that those rules which had been set up or refined during the 12th JVET meeting should be observed. In particular, for some CEs of some previous meetings, results were available late, and some changes in the experimental setup had not been sufficiently discussed on the JVET reflector.

Group coordinated experiments have been planned as follows:

* “Core experiments” (CEs) are the coordinated experiments on coding tools which are deemed to be interesting but require more investigation and could potentially become part of a draft standard by the next meeting or in the near future.
* “Exploration experiments” (EEs) are also coordinated experiments. These are conducted on technology which is not foreseen to become part of a draft standard in the near future. The investigating methodology for assessment of such technology can also be an important part of an EE. (Further general rules for EEs, as far as deviating from the CE rules below, should be discussed in a future meeting. For the current meeting, procedures as described in the EE description document are deemed to be sufficient.)
* A CE is a test of a specific fully described technology in a specific agreed way. It is not a forum for thinking of new ideas (like an AHG). The CE coordinators are responsible for making sure that the CE description is complete and correct and has adequate detail. Reflector discussions about CE description clarity and other aspects of CE plans are encouraged.
* A description of each experiment is to be approved at the meeting at which the experiment plan is established. This should include the issues that were raised by other experts when the tool was presented, e.g., interference with other tools, contribution of different elements that are part of a package, etc. The experiment description document should provide the names of individual people, not just company names.
* Software for tools investigated in a CE will be provided in one or more separate branches of the software repository. Each CE will have a “fork” of the software, and within the CE there may be multiple branches established by the CE coordinator. The software coordinator will help coordinate the creation of these forks and branches and their naming. All JVET members will have read access to the CE software branches (using shared read-only credentials as described below).
* During the experiment, revisions of the experiment plans can be made, but not substantial changes to the proposed technology. Withdrawing parts of experiments that were intended to show the individual benefits of a tool or parts of a tool is strongly discouraged. Combination tests may not be considered in such cases. Any changes made to individual tools in a combination shall be documented.
* The CE description must match the CE testing that is done. The CE description needs to be revised if there has been some change of plans.
* The CE summary report must describe any changes that were made in the process of finalizing the CE.
* By the next meeting it is expected that at least one independent cross-checker will report a detailed analysis of each proposed feature that has been tested and confirm that the implementation is correct. Commentary on the potential benefits and disadvantages of the proposed technology in cross-checking reports is highly encouraged. Having multiple cross-checking reports is also highly encouraged (especially if the cross-checking involves more than confirmation of correct test results). The reports of cross-checking activities may (and generally should) be integrated into the CE report rather than submitted as separate documents.
* It is mandatory to report encoder optimizations made for the benefit of a tool, and if an equivalent optimization could be applied on the anchor, a comparison against the improved anchor shall be provided.
* A new proposal can be included in a CE based on group decision, regardless if an independent party has already performed a cross-check in the meeting when it was first proposed.

It is possible to define sub-experiments within particular CEs, for example designated as CEX.a, CEX.b, etc., where X is the basic CE number.

As a general rule, it was agreed that each CE should be run under the same testing conditions using one software codebase, which should be based on the group test model software codebase. An experiment is not to be established as a CE unless there is access given to the participants in (any part of) the CE to the software used to perform the experiments.

The general agreed common conditions for single-layer coding efficiency experiments for SDR video are described in the prior output document JVET-T2010.

Experiment descriptions should be written in a way such that it is understood as a JVET output document (written from an objective “third party perspective”, not a proponent perspective – e.g. not referring to methods as “improved”, “optimized”, “enhanced”, etc.). The experiment descriptions should generally not express opinions or suggest conclusions – rather, they should just describe what technology will be tested, how it will be tested, who will participate, etc. Responsibilities for contributions to CE work should identify individuals in addition to company names.

CE descriptions contain a basic description of the technology under test, but should not contain excessively verbose descriptions of a technology (at least not unless the technology is not adequately documented elsewhere). Instead, the CE descriptions should refer to the relevant proposal contributions for any necessary further detail. However, the complete detail of what technology will be tested must be available – either in the CE description itself or in documents that are referenced in the CE description that are also available in the JVET document archive.

Any technology must have at least one cross-check partner to establish a CE – a single proponent is not enough. It is highly desirable have more than just one proponent and one cross-checker.

The CE development workflow is described at:

<https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/wikis/Core-experiment-development-workflow>

CE read access is available using shared accounts: One account exists for MPEG members, which uses the usual MPEG account data. A second account exists for VCEG members with account information available in the TIES informal ftp area (IFA) system at:

<https://www.itu.int/ifa/t/2017/sg16/exchange/wp3/q06/vceg_account.txt>

Some agreements relating to CE activities were established as follows:

* Only qualified JVET members can participate in a CE.
* Participation in a CE is possible without a commitment of submitting an input document to the next meeting. Participation was requested by contacting the CE coordinator.
* All software, results, and documents produced in the CE should be announced and made available to JVET in a timely manner.
* A JVET CE reflector will be established and announced on the main JVET reflector. Discussion of logistics arrangements, exchange of data, minor refinement of the test plans, and preparation of documents shall be conducted on the JVET CE reflector, with subject lines prefixed by “[CEx: ]”, where “x” is the number of the CE. All substantial communications about a CE other than such details shall take place on main JVET reflector. In the case that large amounts of data are to be distributed, it is recommended to send a link to the data rather than the data itself, or upload the data as an input contribution to the next meeting.

General timeline for CEs

T1= 3 weeks after the JVET meeting: To revise the CE description and refine questions to be answered. Questions should be discussed and agreed on JVET reflector. Any changes of planned tests after this time need to be announced and discussed on the JVET reflector. Initially assigned description numbers shall not be changed later. If a test is skipped, it is to be marked as “withdrawn”.

T2 = Test model software release + 2 weeks: Integration of all tools into a separate CE branch of the VTM is completed and announced to JVET reflector.

* Initial study by cross-checkers can begin.
* Proponents may continue to modify the software in this branch until T3.
* 3rd parties are encouraged to study and make contributions to the next meeting with proposed changes

T3: 3 weeks before the next JVET meeting or T2 + 1 week, whichever is later: Any changes to the CE test branches of the software must be frozen, so the cross-checkers can know exactly what they are cross-checking. A software version tag should be created at this time. The name of the cross-checkers and list of specific tests for each tool under study in the CE plan description shall be documented in an updated CE description by this time.

T4: Regular document deadline minus 1 week: CE contribution documents including specification text and complete test results shall be uploaded to the JVET document repository (particularly for proposals targeting to be promoted to the draft standard at the next meeting).

The CE summary reports shall be available by the regular contribution deadline. This shall include documentation about crosscheck of software, matching of CE description and confirmation of the appropriateness of the text change, as well as sufficient crosscheck results to create evidence about correctness (crosscheckers must send this information to the CE coordinator at least 3 days ahead of the document deadline). Furthermore, any deviations from the timelines above shall be documented. The numbers used in the summary report shall not be changed relative to the description document.

CE reports may contain additional information about tests of straightforward combinations of the identified technologies. Such supplemental testing needs to be clearly identified in the report if it was not part of the CE plan.

New branches may be created which combine two or more tools included in the CE document or the VTM (as applicable).

It is not necessary to formally name cross-checkers in the initial version of the CE description document. To adopt a proposed feature at the next meeting, JVET would like to see comprehensive cross-checking done, with analysis of whether the description matches the software, and a recommendation of the value of the tool and given tradeoffs.

The establishment of a CE does not indicate that a proposed technology is mature for adoption or that the testing conducted in the CE is fully adequate for assessing the merits of the technology, and a favourable outcome of CE does not indicate a need for adoption of the technology into a standard or test model.

Availability of specification text is important to have a detailed understanding of the technology and also to judge what its impact on the complexity of the specification will be. There must also be sufficient time to study this in detail. CE contributions without sufficiently mature draft specification text in the CE input document should not be considered for adoption.

Lists of participants in CE documents should be pruned to include only the active participants. Read access to software will be available to all members.

# Establishment of ad hoc groups

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)).

Review of AHG plans was conducted during the plenary on XXday XX April 2024 at XXXX-XXXX.

|  |  |  |
| --- | --- | --- |
| **Title and Email Reflector** | **Chairs** | **Mtg** |
| **Project Management (AHG1)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Coordinate overall JVET interim efforts. * Supervise AHG and experiment studies. * Report on project status to JVET reflector. * Provide a report to the next meeting on project coordination status. * Supervise processing and delivery of output documents | J.-R. Ohm (chair), G. J. Sullivan (vice‑chair) | N |
| **Draft text and test model algorithm description editing (AHG2)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Produce and finalize draft text outputs of the meeting (J JVET-AG2027 and JVET-AG2034). * Collect reports of errata for the VVC, VSEI, HEVC, AVC, CICP, and the published related technical reports and produce the JVET-AG1004 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, 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 a first test for VVC multi-layer features by the next meeting, and update the test plan according to subsequent tests. * Coordinate with AHG13 on assessing new test material and investigating metrics that could be used to assess quality of synthesized film grain; improve and update the draft test plan for subjective quality testing of the FGC SEI message. * Maintain the video sequence test material database for testing the VVC and HEVC standards and potential future extensions, as well as exploration activities. * Study coding performance and characteristics of available and proposed video test material. * Identify and recommend appropriate test material for testing the VVC standard and potential future extensions, as well as exploration activities. * Identify and characterize missing types of video material, solicit contributions, collect, and make available a variety of video sequence test material, in coordination with other AHGs, as appropriate. * Maintain and update the directory structure for the test sequence repository, as necessary. * Collect information about test sequences that have been made available by other organizations. * Prepare and conduct expert viewing for purposes of subjective quality evaluation. * Coordinate with AG 5 in studying and developing further methods of subjective quality evaluation, e.g. based on crowd sourcing. * Coordinate with AHG15 on investigating sequences with gaming content, and make such sequences available for study. * Define testing conditions and prepare bitstreams for subjective evaluation of ECM by expert viewing at the next meeting in coordination with AG 5, AHG6, and AHG12. * 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), first on Feb. 13 |
| **Conformance testing (AHG5)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study the draft of additional conformance bitstreams for VVC multilayer configurations JVET-AE2028, and investigate the need for future improvements of conformance testing specifications. * Study the conformance needs for HEVC multi-view profiles, and develop a set of conformance bitstreams as appropriate. * 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, K. Kawamura, P. de Lagrange, T. Ikai, S. Iwamura, H.-J. Jhu, 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-12.0 software version (and potential updates) 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. * Define testing conditions and prepare bitstreams for subjective evaluation of ECM by expert viewing at the next meeting in coordination with AG 5, AHG4, and AHG12. | 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. * 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. * 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. * Investigate the possibility of conducting subjective tests on subsets of tools in coordination with AHG4 and AG 5. * Develop methodology of more reliable runtime measurement | X. Li (chair), L.-F. Chen, Z. Deng, J. Gan, E. François, H.-J. Jhu, X. Li, H. Wang (vice‑chairs) | N |
| **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. * Generate anchors according to the common test conditions JVET-AF2031. * Discuss improvements on the evaluation framework, including evaluation procedures and methodologies. * Coordinate software development, and continue to migrate the software basis used in AHG8 to newest VTM version. * Coordinate experiments on optimization of encoders and receiving systems for machine analysis of coded video content. * Maintain the software implementation example algorithms 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 the working draft JVET-AG2030 on optimization of encoders and receiving systems for machine analysis of coded video content. * Study the potential of using SEI messages for the purpose of machine analysis in coordination with AHG9. * Investigate the impact of using different machine task models in the evaluation of the compression performance of tools optimized for machine analysis tasks. * Coordinate with WG 4 VCM AHG on aspects such as unified common test conditions, evaluation metrics, test and training materials, usage of SEI messages, and on studying characteristics and requirements of machine analysis tasks, etc. | C. Hollmann, S. Liu, 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. * Discuss JVET-AG2027, JVET-AG2032, and JVET-AG2034, and propose improvements as appropriate. * Collect software and showcase information for SEI messages, including encoder and decoder implementations and bitstreams for demonstration and testing. * Coordinate with WG 4 and AG 5 to evaluate visual quality in the context of MPI, and prepare for conducting subjective viewing during the next meeting. * Identify potential needs for additional SEI messages, including the study of SEI messages defined in HEVC and AVC for potential use in the VVC context. * Study the alignments of the same SEI messages in different standards. * Coordinate with AHG8 and WG 4 to study mechanisms for signalling metadata in the context of machine analysis of coded video content. * Coordinate with AHG3 for software support of SEI messages. | S. McCarthy, Y.-K. Wang (co-chairs), T. Chujoh, S. Deshpande, C. Fogg, M. M. Hannuksela, Hendry, P. de Lagrange, G. J. Sullivan, A. Tourapis, S. Wenger (vice-chairs) | Y (tel., 2 weeks notice) |
| **Encoding algorithm optimization (AHG10)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study the impact of using techniques such as 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 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, or higher objective quality, and coordinate such efforts with AHG3 and AHG6. * Study the effect of varying configuration parameters depending on temporal layer, such as those related to deblocking, partitioning, chroma QP. | P. de Lagrange, A. Duenas, R. Sjöberg, A. Tourapis (AHG 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. * Discuss potential refinements of the test conditions for NN-based video coding in JVET-AF2016. Generate and distribute anchor encoding, and develop supporting software as needed. * 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. * 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. | E. Alshina, F. Galpin, S. Liu, A. Segall (co-chairs), J. Li, R.-L. Liao, D. Rusanovskyy, M. Santamaria, T. Shao, M. Wien, P. Wu (vice chairs) | Y (tel., 2 weeks notice), first on Feb. 13 |
| **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 ECM12 algorithm description JVET-AG2025. * 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-AF2017. * Analyse the results of exploration experiments described in JVET-AG2024 in coordination with the EE coordinators. * Coordinate with AHG11 to study the interaction with neural network-based coding tools. * Define testing conditions and prepare bitstreams for subjective evaluation of ECM by expert viewing at the next meeting in coordination with AG 5, AHG4, and AHG6. | 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. * Study alternative film grain models and their associated documentation. * Study the technical report JVET-AG2020, and suggest improvements for possible future versions. * 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 draft plan for subjective quality testing of the FGC SEI message JVET-AG2022, 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, D. Grois, Y. He, 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-8.0 software version (and potential updates), and provide reference configuration encodings according to the NNVC common test conditions as described in JVET-AF2016. * 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) 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-AG2019) editors to identify any mismatches between software and description document, suggest further updates to the description document as appropriate. * Coordinate with AHG11 on items related to NNVC activities. | F. Galpin (chair), Y. Li, Y. Li, J. Shingala, L. Wang, Z. Xie (vice chairs) | Y (tel., 2 weeks notice), first on Nov. 16 |
| **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. * Propose test conditions appropriate for gaming applications. * Evaluate JVET test models (such as ECM, VTM, NNVC, etc.) under the proposed test conditions. * Investigate possibilities to enhance compression capability for gaming content. * 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 (vice chairs) | Y (tel., 2 weeks notice) |
| **Generative face video compression (AHG16)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Produce the output document JVET-AG2035, and provide an associated GFVC performance reporting template. * Maintain GFVC software tools, associated configuration files, and software usage documentation. * Identify additional test content suitable for use in GFVC performance evaluation. * Investigate GFVC performance under test conditions beyond those defined in JVET-AG2035, including performance on additional test content and wider bitrate ranges. * Coordinate with AHG9 on further development of the GFVC SEI message in JVET-AG2032. | Y. Ye (chair), H.-B. Teo, Z. Lyu, S. McCarthy, S. Wang (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 270) 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 270, as noted in section 9.

New: Draft of HEVC Multiview profiles conformance.

[JVET-AH1000](https://jvet-experts.org/doc_end_user/current_document.php?id=13910) Meeting Report of the 34th JVET Meeting [J.-R. Ohm] [WG 5 N XXX] (2024-05-22)

Initial versions of the meeting notes (d0 … d8) were made available on a daily basis during the meeting.

Remains valid – not updated: [JVET-AC1001](https://jvet-experts.org/doc_end_user/current_document.php?id=12566) Guidelines for HM-based software development [K. Sühring, F. Bossen, X. Li (software coordinators)]

Remains valid – not updated: [JVET-Y1002](https://jvet-experts.org/doc_end_user/current_document.php?id=11463) High Efficiency Video Coding (HEVC) Test Model 16 (HM 16) Encoder Description Update 16 [C. Rosewarne (primary editor), K. Sharman, R. Sjöberg, G. J. Sullivan (co-editors)] [WG 5 [N 103](https://dms.mpeg.expert/doc_end_user/current_document.php?id=82085&id_meeting=189)]

Remains valid – not updated: [JVET-AD1003](https://jvet-experts.org/doc_end_user/current_document.php?id=12970) Coding-independent code points for video signal type identification (Draft 2 of 3rd edition) [WG 5 preliminary FDIS N 206] [G. J. Sullivan, A. Tourapis]

The technical content was submitted for ITU consent (but will not be published until ST 2128 is available); ISO FDIS was to be delayed until it is available.

Expected *de facto* primary editor for ITU consent text: G. J. Sullivan.

[JVET-AG1004](https://jvet-experts.org/doc_end_user/current_document.php?id=13911) Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP [Y.-K. Wang, B. Bross, I. Moccagatta, C. Rosewarne, G. J. Sullivan] (2024-03-29, near next meeting)

Primary editor: Y.-K. Wang.

Agreed to include items 1-3 (with slight modifications as indicated above) from JVET-AG0192 in JVET-AG1004.

These items should also be included into the AVC DIS and the HEVC DAM1 texts and their corresponding JVET output documents, when applicable.

No output: JVET-Axx1005

Remains valid – not updated: [JVET-AF1006](https://jvet-experts.org/doc_end_user/current_document.php?id=13584) New profiles, colour descriptors, and SEI messages for HEVC (draft 2) [WG 5 DAM N 244] [Y.-K. Wang, B. Bross, T. Ikai, G. J. Sullivan, A. Tourapis]

Primary editor for this document and WG 5 N 244: Y.-K. Wang.

A DoCR on ISO/IEC 23008-2/CDAM1 was issued as WG 5 N 243.

Remains valid – not updated: [JCTVC-V1007](http://phenix.it-sudparis.eu/jct/doc_end_user/current_document.php?id=10312) 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]

No output: JVET-Axx1008

Remains valid – not updated: [JCTVC-AC1009](https://jvet-experts.org/doc_end_user/current_document.php?id=12569) Common test conditions for SHVC [K. Sühring]

Remains valid – not updated [JCTVC-O1010](http://phenix.it-sudparis.eu/jct/doc_end_user/current_document.php?id=8511) Guidelines for Conformance Testing Bitstream Preparation [T. Suzuki, W. Wan]

No output: JVET-Axx1011

Remains valid – not updated: JVET-[AD1012](https://jvet-experts.org/doc_end_user/current_document.php?id=12973) Overview of IT systems used in JVET [J.-R. Ohm, I. Moccagatta, K. Sühring, M. Wien]

Remains valid – not updated: [JCT3V-G1003](http://phenix.int-evry.fr/jct3v/doc_end_user/current_document.php?id=1884) 3D-AVC Test Model 9 [D. Rusanovskyy, F. C. Chen, L. Zhang, T. Suzuki] [WG 11 N 14239]

Remains valid – not updated: [JCT3V-K1003](http://phenix.int-evry.fr/jct3v/doc_end_user/current_document.php?id=2499) 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]

Remains valid – not updated [JCTVC-V1014](http://phenix.it-sudparis.eu/jct/doc_end_user/current_document.php?id=10316) 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]

Remains valid – not updated: [JVET-AF1016](https://jvet-experts.org/doc_end_user/current_document.php?id=13585) AVC with extensions and corrections (draft 2) [WG5 DIS of 11th ed. N 241] [B. Bross, T. Ikai, G. J. Sullivan, A. Tourapis, Y.-K. Wang]

Primary editor of this document and WG 5 N 241: B. Bross.

A DoCR on ISO/IEC CD 14496-10 was issued as WG 5 N 240.

No output: JVET-Axx1017 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.

**No output: JVET-Axx2001**

Remains valid – not updated: [JVET-AF2002](https://jvet-experts.org/doc_end_user/current_document.php?id=13586) Algorithm description for Versatile Video Coding and Test Model 21 (VTM 21) [A. Browne, Y. Ye, S. Kim] [WG 5 N 245]

New elements from notes elsewhere in this report:

* …

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

It was suggested that editorial improvements submitted as input to the next meeting would be welcome.

Remains valid – not updated: [JVET-AC2003](https://jvet-experts.org/doc_end_user/current_document.php?id=12573) 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]

Remains valid – not updated: [JVET-AE2005](https://jvet-experts.org/doc_end_user/current_document.php?id=13270) New level and systems-related supplemental enhancement information for VVC (Draft 6) [B. Bross, E. François, M. M. Hannuksela, A. Tourapis, Y.-K. Wang]

Primary editor for this document, the corresponding ITU consent text, and the corresponding FDIS text WG 5 N 228: B. Bross.

Remains valid – not updated: [JVET-AE2006](https://jvet-experts.org/doc_end_user/current_document.php?id=13271) Additional SEI messages for VSEI (Draft 5) [S. McCarthy, T. Chujoh, M. M. Hannuksela, G. J. Sullivan, Y.-K. Wang]

Primary editor for this document, the corresponding ITU consent text, and the corresponding FDIS text WG 5 N 220: Y.-K. Wang.

Remains valid – not updated: [JVET-AD2007](https://jvet-experts.org/doc_end_user/current_document.php?id=12977) 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]

Remains valid – not updated: [JVET-Y2009](https://jvet-experts.org/doc_end_user/current_document.php?id=11470) Reference software for versatile video coding (Draft 3) [F. Bossen, K. Sühring, X. Li]

Remains valid – not updated [JVET-AB2010](https://jvet-experts.org/doc_end_user/current_document.php?id=12216) 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]

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]

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]

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]

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]

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]

Remains valid – not updated: [JVET-AF2016](https://jvet-experts.org/doc_end_user/current_document.php?id=13587) Common test conditions and evaluation procedures for neural network-based video coding technology [E. Alshina, R.-L. Liao, S. Liu, A. Segall]

Remains valid – not updated: [JVET-AF2017](https://jvet-experts.org/doc_end_user/current_document.php?id=13588) Common test conditions and evaluation procedures for enhanced compression tool testing [M. Karczewicz, Y. Ye]

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]

[JVET-AG2019](https://jvet-experts.org/doc_end_user/current_document.php?id=13912) Description of algorithms and software in neural network-based video coding (NNVC) version 6 [F. Galpin, Y. Li, D. Rusanovskyy, J. Ström, L. Wang] [WG 5 N 265] (2024-03-15)

New elements from notes elsewhere in this report:

* Decision: Adopt JVET-AG0174.
* Decision: Adopt JVET-AG0130 LOP configuration to NNVC software and JVET-AG2019, disabled by default.
* Adoptions to NNVC-8.0 software only (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.

[JVET-AG2020](https://jvet-experts.org/doc_end_user/current_document.php?id=13275) Film grain synthesis technology for video applications (Draft 6) [D. Grois, Y. He, W. Husak, P. de Lagrange, A. Norkin, M. Radosavljević, A. Tourapis, W. Wan] [WG 5 DTR N 260] (2024-02-02)

Remains valid – not updated: [JVET-AF2021](https://jvet-experts.org/doc_end_user/current_document.php?id=13589) Verification test plan for VVC multilayer coding (update 2) [S. Iwamura, P. de Lagrange, M. Wien]

[JVET-AG2022](https://jvet-experts.org/doc_end_user/current_document.php?id=13914) Draft plan for subjective quality testing of the FGC SEI message [P. de Lagrange, W. Husak, M. Radosavljević, M. Wien] (2024-03-29)

See BoG JVET-AG0330 for details.

[JVET-AG2023](https://jvet-experts.org/doc_end_user/current_document.php?id=13908) Exploration experiment on neural network-based video coding (EE1) [E. Alshina, F. Galpin, Y. Li, D. Rusanovskyy, M. Santamaria, J. Ström, R. Chang, Z. Xie] [WG 5 N 264] (2024-02-09)

An initial draft of this document was reviewed and approved at 0710-0730 on Friday 26 Jan.

This round of EE1 tests will include:

* EE1-1: LOP in-loop filter
  + EE1-1.0: LOP re-training training strategy [JVET-AG0156](https://jvet-experts.org/doc_end_user/current_document.php?id=13712)
  + EE1-1.1: training of EE1-0 with architecture change [JVET-AG0163](https://jvet-experts.org/doc_end_user/current_document.php?id=13719) (merge convolutions) & [JVET-AG0155](https://jvet-experts.org/doc_end_user/current_document.php?id=13711) (separable convolutions).
  + EE1-1.2: training of EE1-0 for [JVET-AG0163](https://jvet-experts.org/doc_end_user/current_document.php?id=13719) (merge convolutions) & [JVET-AG0155](https://jvet-experts.org/doc_end_user/current_document.php?id=13711) (separable convolutions) & [JVET-AG0069](https://jvet-experts.org/doc_end_user/current_document.php?id=13625) (transformed input).
  + EE1-1.3: training from the scratch for [JVET-AG0163](https://jvet-experts.org/doc_end_user/current_document.php?id=13719) (merge convolutions) & [JVET-AG0155](https://jvet-experts.org/doc_end_user/current_document.php?id=13711) (separable convolutions) & [JVET-AG0069](https://jvet-experts.org/doc_end_user/current_document.php?id=13625) (transformed input).
  + EE1-1.4: LOP2 architecture (training of EE1-0) with content adaptivity [JVET-AG0111](https://jvet-experts.org/doc_end_user/current_document.php?id=13667)
* EE1-2: HOP in-loop filter
  + EE1-2.1: Separate HOP model [JVET-AG0175](https://jvet-experts.org/doc_end_user/current_document.php?id=13731)
  + EE1-2.2: Wide activation HOP model [JVET-AG0179](https://jvet-experts.org/doc_end_user/current_document.php?id=13735)
  + EE1-2.3: HOP with transformers [JVET-AG0162](https://jvet-experts.org/doc_end_user/current_document.php?id=13718)

*Note*: training should be aligned with NNVC-8.0 HOP3.

* EE1-3: NN-inter prediction
  + EE1-3.1: Deep Reference Frame Generation for Inter Prediction Enhancement [JVET-AG0122](https://jvet-experts.org/doc_end_user/current_document.php?id=13678)
* EE1-4: NN-super-resolution
  + EE1-4.0: adaptive resolution (s=2) coding for NNVC-8 (NNIntra and LOP2 filter) with NNVC SR filter
  + EE1-4.1: adaptive resolution coding for NNVC-8 (NNIntra and LOP2 filter) with RPR
    - EE1-4.1.1: scaling factor s=2
    - EE1-4.1.2: scaling factor s=1.5
  + EE1-4.2: adaptive resolution coding for NNVC-8 (NNIntra and LOP2 filter) with [[JVET-AG0129](https://jvet-experts.org/doc_end_user/current_document.php?id=13685)](https://jvet-experts.org/doc_end_user/current_document.php?id=13686)
    - EE1-4.2.1: scaling factor s=2
    - EE1-4.2.2: scaling factor s=1.5
  + EE1-4.3: adaptive resolution (s= 2) coding for NNVC-8 (NNIntra and LOP2 filter) with [JVET-[AG0114](https://jvet-experts.org/doc_end_user/current_document.php?id=13670)](https://jvet-experts.org/doc_end_user/current_document.php?id=13686) (LOP version)

*Note*: strategy for scaling factor, QP selection to be same for all tests, choose best strategy for RPR (in EE1-4.1), announced during 1st teleconference and shared in all tests of this category.

* EE1-5. Very Low Operational Point
  + EE1-5.1 Study of the NN architecture at Very Low Operational Point (JVET-AG0155, JVET-AG0057, JVET-AF0206)

It is noted that in the SR category, a large variety of comparisons (including RPR and the new LOP in NNVC) is planned.

It was emphasized that upload of frozen software will only be possible until 29 March.

[JVET-AG2024](https://jvet-experts.org/doc_end_user/current_document.php?id=13909) Exploration experiment on enhanced compression beyond VVC capability (EE2) [V. Seregin, J. Chen, R. Chernyak, K. Naser, J. Ström, F. Wang, M. Winken, X. Xiu, K. Zhang] [WG 5 N 267] (2024-02-23)

An initial draft of this document was reviewed and approved at 0730-0735 on Friday 26 Jan.

Categories and experiments are listed in the following table:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Partitioning** | | | |
| 1.1a | Temporal prediction of split modes | G. Laroche  (Canon) |  |
| 1.1b | Test 1.1a + Maximum MTT depth adaptation | G. Laroche  (Canon) |  |
| 1.1c | Test 1.1b + Prediction of split syntax elements order | G. Laroche  (Canon) |  |
| **2 Intra prediction** | | | |
| 2.1 | TIMD merge mode | R. Youvalari (Xiaomi) | Y. Wang  (Bytedance) |
| 2.2 | Occurrence-based intra coding | R. Youvalari (Xiaomi) |  |
| 2.3a | Intra prediction using merged histogram of gradients | S. Blasi  (Nokia) |  |
| 2.3b | Intra prediction using merged histogram of gradients (without restrictions) | S. Blasi  (Nokia) |  |
| 2.4 | DIMD merge list | M. Blestel  (Ofinno) |  |
| 2.5a | Test 2.3a + Test 2.4 | S. Blasi  (Nokia)  M. Blestel  (Ofinno) |  |
| 2.5b | Test 2.3a + Test 2.4 + Test 2.2 | R. Youvalari (Xiaomi)  S. Blasi  (Nokia)  M. Blestel  (Ofinno) |  |
| 2.6a | Adaptive MRL fusion with fixed weights | S. Blasi  (Nokia) |  |
| 2.6b | Adaptive MRL fusion with adaptive weights | S. Blasi  (Nokia) |  |
| 2.7 | Relaxing line buffer restriction | Z. Deng  (Bytedance) |  |
| 2.8 | Test 2.6b + Test 2.7 | Z. Deng  (Bytedance)  S. Blasi  (Nokia) |  |
| 2.9a | EIP with bias | J. Lainema (Nokia) |  |
| 2.9b | EIP with clipping | J. Lainema (Nokia) |  |
| 2.9c | EIP with bias and clipping | J. Lainema (Nokia) |  |
| 2.10a | SATD based IntraTMP BV search without signalling | W. Chen  (Kwai) |  |
| 2.10b | SATD based IntraTMP BV search with signalling | K. Naser  (InterDigital) |  |
| 2.10c | MR-SAD based IntraTMP BV search with signalling | K. Naser  (InterDigital) |  |
| 2.10d | IntraTMP BV reordering | W. Chen  (Kwai) |  |
| 2.10e | Test 2.10a + Test 2.10d | W. Chen  (Kwai) |  |
| 2.10f | Test 2.10b + Test 2.10d | K. Naser  (InterDigital)  W. Chen  (Kwai) |  |
| 2.11a | Auto-relocated BVP for IntraTMP merge candidates | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) |  |
| 2.11b | Template matching based sorting of IntraTMP merge candidates with maximum list size of N | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) |  |
| 2.11c | Test 2.11a + Test 2.11b | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) |  |
| 2.11d | Test 2.11c + Restricting the BV range for IntraTMP merge candidates | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) |  |
| 2.12a | Chroma mode reordering based on unextended list | X. Li  (Alibaba) |  |
| 2.12b | Chroma mode reordering based on extended list | X. Li  (Alibaba) |  |
| 2.13 | Matrix based intra prediction replacing conventional intra modes | B. Ray  (Qualcomm) |  |
| 2.14a | Bilateral filtering for intra prediction (not applied to planar mode) | W. Yin  (Bytedance) |  |
| 2.14b | Bilateral filtering for intra prediction (applied to planar mode) | W. Yin  (Bytedance) |  |
| **3** **Inter prediction** | | | |
| 3.1a | Chained motion vector prediction | Y. Kidani (KDDI) |  |
| 3.1b | Test 3.1a + Restriction of only motion from collocated pictures | Y. Kidani (KDDI) |  |
| 3.2a | Removing the one-CTU-row temporal buffer constraint for all relevant tools | Z. Deng  (Bytedance) |  |
| 3.2b | Imposing the one-CTU-row temporal buffer constraint on all relevant tools | Z. Deng  (Bytedance) |  |
| 3.2c | Test 3.2a + Test 3.1a | Z. Deng  (Bytedance)  Y. Kidani (KDDI) |  |
| 3.2d | Test 3.2b + Test 3.1a | Z. Deng  (Bytedance)  Y. Kidani (KDDI) |  |
| 3.3 | Inter CCP merge mode with zero luma CBF | Z. Deng  (Bytedance) |  |
| 3.4 | Adaptive GPM blending | L. Zhao  (Bytedance) |  |
| 3.5a | LIC model inheritance for GPM | C.-C. Chen  (Qualcomm) |  |
| 3.5b | Test 3.5a + LIC model inheritance for merge modes at LIC flag swapping stage | C.-C. Chen  (Qualcomm) |  |
| 3.5c | Test 3.5a + LIC model inheritance for merge modes at ARMC stage | C.-C. Chen  (Qualcomm) |  |
| 3.6a | Reference filtering for inter-prediction (with reference sample classification into 2 groups) | V. Rufitskiy (Ofinno) |  |
| 3.6b | Reference filtering for inter-prediction (with reference sample classification into the extended number of groups) | V. Rufitskiy (Ofinno) |  |
| 3.7a | TM-based motion refinement with more candidates for SbTMVP | J. Chen  (Alibaba) |  |
| 3.7b | TM-based motion refinement for affine candidates | J. Chen  (Alibaba) |  |
| 3.7c | Test 3.7a + Test 3.7b | J. Chen (Alibaba) |  |
| **4 Transform and coefficients coding** | | | |
| 4.1 | Multiple transform set selection for LFNST/NSPT | F. Wang  (OPPO) |  |
| 4.2 | Fix on LFNST/NSPT index signalling for inter coding | M. Koo  (LGE) |  |
| 4.3 | 16 states TCQ | M. Balcilar  (InterDigital) |  |
| **5 In-loop filtering** | | | |
| 5.1a | Adaptive precision for CCALF coefficients | N. Hu  (Qualcomm)  N. Song  (OPPO) |  |
| 5.1b | Adaptive precision for CCALF coefficients with precision used for luma ALF coefficients | N. Hu  (Qualcomm)  N. Song  (OPPO) |  |
| 5.1c | Removal of power of 2 constrain for CCALF coefficients | N. Hu  (Qualcomm) |  |
| 5.1d | Test 5.1a + Test 5.1c | N. Hu  (Qualcomm)  N. Song  (OPPO) |  |
| 5.1e | Test 5.1b + Test 5.1c | N. Hu  (Qualcomm)  N. Song  (OPPO) |  |
| 5.2a | Coding information based classification for ALF (with partitioning info only) | W. Yin  (Bytedance)  N. Hu  (Qualcomm) |  |
| 5.2b | Coding information based classification for ALF (with prediction info only) | W. Yin  (Bytedance)  N. Hu  (Qualcomm) |  |
| 5.2c | Test 5.2a + Test 5.2b | W. Yin  (Bytedance)  N. Hu  (Qualcomm) |  |
| **6 Entropy coding** | | | |
| 6.1a | Switching of context initialization for B-slice at slice level | R.-L. Liao  (Alibaba) |  |
| 6.1b | Switching of context initialization for B-slice at sequence level | R.-L. Liao  (Alibaba) |  |
| 6.2a | Extended entropy coding with non equiprobable coding | F. Galpin (InterDigital) |  |
| 6.2b | Test 6.2a but trained on another dataset | F. Galpin (InterDigital) |  |
| 6.3 | Test 6.1 + Test 6.2 | F. Galpin (InterDigital)  R.-L. Liao  (Alibaba) |  |

[JVET-AG2025](https://jvet-experts.org/doc_end_user/current_document.php?id=13915) Algorithm description of Enhanced Compression Model 12 (ECM 12) [M. Coban, R.-L. Liao, K. Naser, J. Ström, L. Zhang] [WG 5 N 268] (2024-03-15)

New elements from notes elsewhere in this report:

* Decision: Adopt JVET-AG0154 test 1.1b.
* Decision: Adopt JVET-AG0137 test 1.7b.
* Decision: Adopt JVET-AG0091 test 1.8a.
* Decision: Adopt JVET-AG0058 test 1.14b.
* Decision: adopt JVET-AG0059 test 1.15c.
* Decision: Adopt JVET-AG0094 test 1.22b.
* Decision: Adopt JVET-AG0276 test 2.6j.
* Decision: Adopt JVET-AG0098 test 2.7b.
* Decision: Adopt JVET-AG0067 test 2.8d.
* Decision: Adopt JVET-AG0142 test 2.11f.
* Decision: Adopt JVET-AG0143 test 3.1c.
* Decision: Adopt JVET-AG0100 test 3.2b\*.
* Decision: Adopt JVET-AG0061 Test 3.3, disabled in CTC for LB/LP.
* Decision: Adopt JVET-AG0145 test 4.1a.
* Decision: Adopt JVET-AG0157 test 4.2b.
* Decision: Adopt JVET-AG0158 test 4.3.
* Decision (SW): Adopt JVET-AG0196 tests 5.1 and 5.2. A documentation of the script (and data to be used) should also be included in JVET-AG2025 (ECM).
* Decision: Adopt JVET-AG0117 test 5.3a.
* Decision: Adopt JVET-AG0208 (and the first aspect of JVET-AG0230, which is exactly the same). Same as the decision for EE2 Test-3.3, this should be turned on for RA config only.
* Decision (SW): Adopt JVET-AG0116.
* Decision (SW/BF): Adopt JVET-AG0334 first solution.

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-AC2026](https://jvet-experts.org/doc_end_user/current_document.php?id=12581) Conformance testing for VVC operation range extensions (Draft 4) [D. Rusanovskyy, T. Hashimoto, H.-J. Jhu, I. Moccagatta, Y. Yu]

Can be removed after publication of VVC conf. v2.

[JVET-AG2027](https://jvet-experts.org/doc_end_user/current_document.php?id=13916) SEI processing order and processing order nesting SEI messages in VVC (draft 7) [G. J. Sullivan, M. M. Hannuksela, Y.-K. Wang] [WG 5 preliminary WD 5 N 261] (2024-03-15)

Primary editor: G. J. Sullivan

Modifications:

* Agreed to include item 2 option 1 (from JVET-AG0052-v4) into JVET-AG2027
* Various aspects documented under JVET-AG0053.
* Various aspects documented under JVET-AG0169.
* It was agreed that the change as shown above (from JVET-AG0180) shall be included in JVET-AG2027.
* Decision (Ed.): Editor action item: The proponent of JVET-AG0165 suggested adding a clarifying note in the semantics to describe the flexibility supported when multiple PON SEI messages are sent. This is delegated to the editors.

Remains valid – not updated: [JVET-AE2028](https://jvet-experts.org/doc_end_user/current_document.php?id=13279) Additional conformance bitstreams for VVC multilayer configurations [S. Iwamura, P. de Lagrange, I. Moccagatta]

Remains valid – not updated: [JVET-AB2029](https://jvet-experts.org/doc_end_user/current_document.php?id=12225) Visual quality comparison of ECM/VTM encoding [V. Baroncini, J.-R. Ohm, M. Wien] [AG 5 N 75]

[JVET-AG2030](https://jvet-experts.org/doc_end_user/current_document.php?id=13917) Optimization of encoders and receiving systems for machine analysis of coded video content (draft 4) [C. Hollmann, J. Chen, S. Liu] [WG 5 WD N 263)] (2024-03-15)

Primary editor for this document: C. Hollmann.

Based on JVET-AG0090, plus some notes on placeholder sections from section 4.10, plus references to SEI messages in JVET-AG2034 as applicable.

* Decision: It was agreed to include a section on a non-normative approach into the WD of TR as a placeholder, without specific reference to the technology described in JVET-AG0212.
* Decision: In a follow-up discussion, it was agreed that a reference to this encoder optimization information SEI message (text included in JVET-AG0213) shall be included in the TR draft, provided that EOI SEI would also be included in the WD for VSEI v4.

A request for subdivision (part 3 of MPEG-AI, ISO/IEC 23888-3) was issued as WG 5 document N 262 (reviewed and approved in JVET at 0745 on Friday 26 Feb.).

It was noted that the period between November 2024 meeting and April 2025 meeting is rather short for DIS ballots, but may be OK for DTR ballot.

Remains valid – not updated: [JVET-AF2031](https://jvet-experts.org/doc_end_user/current_document.php?id=13591) Common test conditions for optimization of encoders and receiving systems for machine analysis of coded video content [S. Liu, C. Hollmann]

[JVET-AG2032](https://jvet-experts.org/doc_end_user/current_document.php?id=13918) Technologies under consideration for future extensions of VSEI (version 3) [S. McCarthy, J. Chen, S. Deshpande, M. M. Hannuksela, Hendry] [WG 5 N 259)] (2024-03-29)

New elements from notes elsewhere in this report:

* Decision: Include JVET-AG0044 proposal 1 in TuC.
* Decision: Include JVET-AG0045 proposal 1 in TuC.
* Agreed to include JVET-AG0051 in TuC, and moved to a separate section together with LSEI. Proponents of both approaches are asked to work out possible combination.
* It was agreed to include the generative face SEI message as proposed in JVET-AG0203 into TuC. This shall include the aspects that were agreed from JVET-AG0087.
* Decision: Agreed to include JVET-AG0328 in TuC.

It is noted that the list above may not be complete; if some adoption is missing that is recorded somewhere else in the meeting notes it shall also be considered included.

Remains valid – not updated: [JVET-AF2033](https://jvet-experts.org/doc_end_user/current_document.php?id=13593) Report of verification test on VVC multi-layer coding: Content layering [S. Iwamura, P. de Lagrange, M. Wien] [AG 5 N 105)] (2023-12-22)

[JVET-AG2034](https://jvet-experts.org/doc_end_user/current_document.php?id=13919) SEI messages for VSEI version 4 (Draft 1) [S. McCarthy, J. Chen, S. Deshpande, M. M. Hannuksela, Hendry, G. J. Sullivan, Y.-K. Wang] [WG 5 preliminary WD N 258)] (2024-03-29)

Primary editor for this document: S. McCarthy.

This includes modality type, source picture timing, encoder optimization, NNPFC updates, and object mask information.

It is noted that SEI messages that are transferred from TuC to WD should be removed from TuC, unless some elements for further consideration were agreed to stay in TuC.

New elements from notes elsewhere in this report:

* Decision: Include JVET-AG0089 in preliminary WD JVET-AG2034. The option of a network generating several instances at same temporal position shall be further studied, as there may be some general conflict with constraints in the existing NNPF architecture (disallowing several outputs at same time instance).
* Decision: Include the modality information SEI JVET-AG0322 in the preliminary WD for VSEIv4, JVET-AG2034.
* SPTI SEI with modifications: Various aspects from JVET-AG0070, and option 1 of JVET-AG0188, and green highlighted text from JVET-AG0082v2
* Decision (SW): Adopt JVET-AG0191 SPTI software.
* EOI SEI with modifications from JVET-AG0086 including 2-bit indicators the eoi\_for\_human\_viewing\_idc and eoi\_for\_machine\_analysis\_idc and “option a” (using separate EOI messages, one per sublayer range), and new optimization type from JVET-AG0081.
* OMI SEI with modifications from JVET-AG0148.

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-AG2035](https://jvet-experts.org/doc_end_user/current_document.php?id=13920) Test conditions and evaluation procedures for generative face video coding [S. McCarthy, B. Chen] (2024-02-23)

Developed from JVET-AG0187.

[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)] (2024-02-09)

Developed from JVET-AG0315.

The draft of WG 5 recommendations was reviewed in JVET at 0845 on Friday 26 Jan.

# Future meeting plans, expressions of thanks, and closing of the meeting

Future meeting plans were established according to the following guidelines (assuming face-to-face meetings):

* Meeting under ITU-T SG16 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 SG16 meeting – a total of 8-9 meeting days), and
* Otherwise meeting under ISO/IEC JTC 1/‌SC 29 auspices when its MPEG WGs meet (ordinarily starting meetings on the Thursday or Friday prior to the main week of such meetings and closing it on the same day as other MPEG WGs – a total of 8–9 meeting days).

In cases where an exceptionally high workload is expected for a meeting, an earlier starting date may be defined. In cases of online meetings, no sessions should be held on weekend days, such that meetings would typically start two days earlier.

Some specific future meeting plans (to be confirmed) were established as follows:

* During Fri. 12 – Fri. 19 July 2024, 35th meeting under ISO/IEC JTC 1/‌SC 29 auspices in Sapporo, JP,
* During Fri. 1 – Fri. 8 November 2024, 36th meeting under ISO/IEC JTC 1/‌SC 29 auspices in Antalya, TR (confirmed by host one week after the closing of the JVET meeting),
* During Tue. 14 – Wed. 22 January 2025, 37th meeting under ITU-T SG16 auspices in Geneva, CH,
* During Wed. 26 March – Fri. 4 April 2025, 38th meeting under ISO/IEC JTC 1/‌SC 29 auspices, to be conducted as teleconference meeting,
* During Thu. 26 June – Fri. 4 July 2025, 39th meeting under ISO/IEC JTC 1/‌SC 29 auspices in Daejeon, KR,
* During XX – XX October 2025, 40th meeting under ITU-T SG16 auspices in Geneva, CH,
* During January 2026, 41st meeting under ISO/IEC JTC 1/‌SC 29 auspices, date and location t.b.d.,
* During April 2026, 42nd meeting under ISO/IEC JTC 1/‌SC 29 auspices, date and location t.b.d.

The agreed document deadline for the 35th JVET meeting was planned to be Friday 5 July 2024.

XXX was thanked for providing video test materials with gaming content.

Marius Preda was thanked for maintaining the document site jvet-experts.org, as well as the document sites of JCT-VC and JCT-3V. Institut Mines-Télécom was thanked for hosting the sites.

The 34th JVET meeting was closed at approximately XXXX hours CEST on Wednesday 24 April. 2024.

# Annex A to JVET report: List of documents

(Dates and times in the table below are in Paris/Geneva time.)

# Annex B1 to JVET report: List of meeting participants attending in person

The participants who were personally present at the meeting site of the thirty-fourth meeting of the JVET, according to confirming in a sign-in sheet regularly circulated in the JVET meeting rooms (approximately XXX people in total), were as follows:

1. ()

# Annex B2 to JVET report: List of meeting participants attending remotely

The remote participants of the thirty-second meeting of the JVET, according to the participation records from the Zoom teleconferencing tool used for the meeting sessions (approximately 216 people in total, not including those who had attended the meeting in person at least part-time (see annex B1), and not including those who attended only the joint sessions with other groups), were as follows:

1. ( )

# Annex C to JVET report: Recommendations of the 16th meeting of ISO/IEC JTC 1/SC 29/WG 5 MPEG Joint Video Experts Team with ITU-T SG 16

**ISO/IEC JTC 1/SC 29/WG 5 N XXX**