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| **Joint Video Experts Team (JVET)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29**  33rd Meeting, by teleconference, 17–26 January 2024 | Document: JVET-AG\_notes\_d1 |

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| *Title:* | **Meeting Report of the 33rd Meeting of the Joint Video Experts Team (JVET), by teleconference, 17–26 January 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-third meeting during 17–26 January 2024 as an online-only meeting. For ISO/IEC purposes, JVET is alternatively designated ISO/IEC JTC 1/‌SC 29/‌WG 5, and this was the fourteenth meeting as WG 5. The JVET meeting was held under the chairmanship of Dr Jens-Rainer Ohm (RWTH Aachen/Germany). For rapid access to particular topics in this report, a subject categorization is found (with hyperlinks) in section 2.16 of this document. It is further noted that work items which had originally been conducted by the Joint Collaborative Team on Video Coding (JCT-VC) were continued in JVET as a single joint team, and explorations towards possible future need of standardization in the area of video coding are also conducted by JVET, as negotiated by the parent bodies.

The JVET meeting began at approximately 0500 UTC on Wednesday 17 January 2024. Meeting sessions were held on all days except the weekend days of Saturday and Sunday 20 and 21 January 2024, until the meeting was closed at approximately XXXX hours UTC on Friday 26 January 2024. Approximately XXX people attended the JVET meeting, 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 coordination with a meeting of various SC29 Working Groups and Advisory Groups – where WG 5 is representing the Joint Video Coding Team(s) and their activities from the perspective of the SC 29 parent body, under whose auspices this JVET meeting was held. The subject matter of the JVET meeting activities consisted of work on further development and maintenance of the twin-text video coding technology standards *Advanced Video Coding* (AVC), *High Efficiency Video Coding* (HEVC), *Versatile Video Coding* (VVC)*, Coding-independent Code Points (Video)* (CICP), and *Versatile Supplemental Enhancement Information Messages for Coded Video Bitstreams* (VSEI), as well as related technical reports, reference software and conformance testing packages. Further important goals were reviewing the results of the Exploration Experiment (EE) on Neural Network-based Video Coding, of the EE on Enhanced Compression beyond VVC capability, of other technical input on novel aspects of video coding technology, and to plan next steps for investigation of candidate technology towards further standard development.

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

a) JVET documents

* [JVET-AF1004](https://jvet-experts.org/doc_end_user/current_document.php?id=12567) Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP
* [JVET-AF1006](https://jvet-experts.org/doc_end_user/current_document.php?id=12568) New profiles, colour decriptors, and SEI messages for HEVC (draft 2), also issued as WG 5 DAM N 244
* [JVET-AF1016](https://jvet-experts.org/doc_end_user/current_document.php?id=12568) AVC with extensions and corrections (draft 2), also issued as WG 5 DIS of AVC 11th edition N 241
* [JVET-AF2002](https://jvet-experts.org/doc_end_user/current_document.php?id=12574) Algorithm description for Versatile Video Coding and Test Model 21 (VTM 21), also issued as WG 5 N 245
* [JVET-AF2016](https://jvet-experts.org/doc_end_user/current_document.php?id=12576) Common test conditions and evaluation procedures for neural network-based video coding technology
* [JVET-AF2017](https://jvet-experts.org/doc_end_user/current_document.php?id=12576) Common test conditions and evaluation procedures for enhanced compression tool testing
* [JVET-AF2019](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 5, also issued as WG 5 N 248
* [JVET-AF2021](https://jvet-experts.org/doc_end_user/current_document.php?id=12578) Verification test plan for VVC multilayer coding (update 2)
* [JVET-AF2023](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 247
* [JVET-AF2024](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 249
* [JVET-AF2025](https://jvet-experts.org/doc_end_user/current_document.php?id=12580) Algorithm description of Enhanced Compression Model 11 (ECM 11), also issued as WG 5 N 250
* [JVET-AF2027](https://jvet-experts.org/doc_end_user/current_document.php?id=12582) SEI processing order and processing order nesting SEI messages in VVC (Draft 6), also issued as WG 5 preliminary WD N 246
* [JVET-AF2031](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Common test conditions for optimization of encoders and receiving systems for machine analysis of coded video content
* [JVET-AF2032](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Technologies under consideration for future extensions of VSEI (draft 2), also issued as WG 5 N 242
* [JVET-AF2033](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Report of verification test on VVC multi-layer coding: Content layering, also issued as AG 5 N 105

b) documents produced as WG 5 documents only:

* WG 5 N 240 Disposition of comments received on ISO/IEC CD 14496-10:202x
* WG 5 N 243 Disposition of comments received on ISO/IEC 23008-2:202x (5th ed.) CDAM 1
* WG 5 N 251 Liaison statement to ISO/IEC JTC 1/SC 29/WG 1 (JPEG) on JPEG AI and explorations on video coding
* WG 5 N 252 Liaison response to 3GPP on feasibility study on film grain synthesis

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

* [JVET-AF1004](https://jvet-experts.org/doc_end_user/current_document.php?id=12567) Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP
* [JVET-AF1006](https://jvet-experts.org/doc_end_user/current_document.php?id=12568) New profiles, colour decriptors, and SEI messages for HEVC (draft 2), also issued as WG 5 DAM N 244
* [JVET-AF1016](https://jvet-experts.org/doc_end_user/current_document.php?id=12568) AVC with extensions and corrections (draft 2), also issued as WG 5 DIS of AVC 11th edition N 241
* [JVET-AF2002](https://jvet-experts.org/doc_end_user/current_document.php?id=12574) Algorithm description for Versatile Video Coding and Test Model 21 (VTM 21), also issued as WG 5 N 245
* [JVET-AF2016](https://jvet-experts.org/doc_end_user/current_document.php?id=12576) Common test conditions and evaluation procedures for neural network-based video coding technology
* [JVET-AF2017](https://jvet-experts.org/doc_end_user/current_document.php?id=12576) Common test conditions and evaluation procedures for enhanced compression tool testing
* [JVET-AF2019](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 5, also issued as WG 5 N 248
* [JVET-AF2021](https://jvet-experts.org/doc_end_user/current_document.php?id=12578) Verification test plan for VVC multilayer coding (update 2)
* [JVET-AF2023](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 247
* [JVET-AF2024](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 249
* [JVET-AF2025](https://jvet-experts.org/doc_end_user/current_document.php?id=12580) Algorithm description of Enhanced Compression Model 11 (ECM 11), also issued as WG 5 N 250
* [JVET-AF2027](https://jvet-experts.org/doc_end_user/current_document.php?id=12582) SEI processing order and processing order nesting SEI messages in VVC (Draft 6), also issued as WG 5 preliminary WD N 246
* [JVET-AF2031](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Common test conditions for optimization of encoders and receiving systems for machine analysis of coded video content
* [JVET-AF2032](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Technologies under consideration for future extensions of VSEI (draft 2), also issued as WG 5 N242
* [JVET-AF2033](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Report of verification test on VVC multi-layer coding: Content layering

The following 4 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 240 Disposition of comments received on ISO/IEC CD 14496-10:202x
* WG 5 N 243 Disposition of comments received on ISO/IEC 23008-2:202x (5th ed.) CDAM 1
* WG 5 N 251 Liaison statement to ISO/IEC JTC 1/SC 29/WG 1 (JPEG) on JPEG AI and explorations on video coding
* WG 5 N 252 Liaison response to 3GPP on feasibility study on film grain synthesis

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 17 – 24 April 2024 under ITU-T SG16 auspices in Rennes, FR; during 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 January 2025 under ITU-T SG16 auspices, date and location t.b.d.; during April 2025 under ISO/IEC JTC 1/‌SC 29 auspices, date and location t.b.d.; during 26 June – 4 July 2025 under ISO/IEC JTC 1/‌SC 29 auspices in Daejeon, KR; during October 2025 under ITU-T SG 16 auspices, date and location t.b.d.; and during January 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-third meeting during 17–26 January 2023 as an online-only meeting. For ISO/IEC purposes, JVET is alternatively designated ISO/IEC JTC 1/‌SC 29/‌WG 5, and this was the fourteenth meeting as WG 5. The JVET meeting was held under the chairmanship of Dr Jens-Rainer Ohm (RWTH Aachen/Germany).

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, consisting of two parts, (B1) in-person attendees as recorded by a sign-in sheet circulated in meeting rooms, (B2) remote attendees as recorded by the teleconferencing tool used for the meeting
* Annex C contains the meeting recommendations of ISO/IEC JTC 1/‌SC 29/‌WG 5 for purposes of results reporting to ISO/IEC.

## Meeting logistics

Information regarding logistics arrangements for the meeting had been provided via the email reflector [jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de) and at <http://wftp3.itu.int/av-arch/jvet-site/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-first JVET meeting in producing the following output documents:

a) JVET documents

* [JVET-AF1004](https://jvet-experts.org/doc_end_user/current_document.php?id=12567) Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP
* [JVET-AF1006](https://jvet-experts.org/doc_end_user/current_document.php?id=12568) New profiles, colour decriptors, and SEI messages for HEVC (draft 2), also issued as WG 5 DAM N 244
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* [JVET-AF2025](https://jvet-experts.org/doc_end_user/current_document.php?id=12580) Algorithm description of Enhanced Compression Model 11 (ECM 11), also issued as WG 5 N 250
* [JVET-AF2027](https://jvet-experts.org/doc_end_user/current_document.php?id=12582) SEI processing order and processing order nesting SEI messages in VVC (Draft 6), also issued as WG 5 preliminary WD N 246
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* [JVET-AF2032](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Technologies under consideration for future extensions of VSEI (draft 2), also issued as WG 5 N242
* [JVET-AF2033](https://jvet-experts.org/doc_end_user/current_document.php?id=12584) Report of verification test on VVC multi-layer coding: Content layering, also issued as AG 5 N 105

b) documents produced as WG 5 documents only:

* WG 5 N 240 Disposition of comments received on ISO/IEC CD 14496-10:202x
* WG 5 N 243 Disposition of comments received on ISO/IEC 23008-2:202x (5th ed.) CDAM 1
* WG 5 N 251 Liaison statement to ISO/IEC JTC 1/SC 29/WG 1 (JPEG) on JPEG AI and explorations on video coding
* WG 5 N 252 Liaison response to 3GPP on feasibility study on film grain synthesis

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 January 2024. Any documents uploaded after 1159 hours Paris/Geneva time on Thursday 11 January 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-AG0215 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-AG0XXX (a proposal on …), uploaded 01-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-AG0XXX (a document presenting …), uploaded 01-XX,
* … .

All cross-verification reports at this meeting (except for JVET-AG0119) 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-AG0050, JVET-AG0181, JVET-AG0189, JVET-AG0190, JVET-AG0218, JVET-AG0238, JVET-AG0239, ….

The following cross-verification reports were still missing three weeks after the end of the meeting: JVET-AG0XXX, …. This was 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-AG0XXX 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-AF1000, the Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP JVET-AF1004, the New profiles, colour descriptors, and SEI messages for HEVC (draft 2) JVET-AF1006, the AVC specification with extensions and corrections (draft 2) JVET-AF1016, the Algorithm description for Versatile Video Coding and Test Model 21 (VTM 21) JVET-AF2002, the Common test conditions and evaluation procedures for neural network-based video coding technology JVET-AF2016, the Common test conditions and evaluation procedures for enhanced compression tool testing JVET-AF2017, the Description of algorithms and software in neural network-based video coding (NNVC) version 5 JVET-AF2019, the Verification test plan for VVC multilayer coding (update 2) JVET-AF2021, the Description of the EE on Neural Network-based Video Coding JVET-AF2023, the Description of the EE on Enhanced Compression beyond VVC capability JVET-AF2024, the Algorithm description of Enhanced Compression Model 11 (ECM 11) JVET-AF2025, the SEI processing order SEI message in VVC (Draft 6) JVET-AF2027, the Common test conditions for optimization of encoders and receiving systems for machine analysis of coded video content [JVET-AF2031](https://jvet-experts.org/doc_end_user/current_document.php?id=12584), the Technologies under consideration for future extensions of VSEI (draft 2) JVET-AF2032, and the Report of verification test on VVC multi-layer coding: Content layering JVEZT-AF2033, 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 versions 22.2 and 23.0, ECM versions 10.1 and 11.0, and NNVC (versions 7.0 and 7.1) were also approved.

Only minor editorial issues were found in the meeting report JVET-AF1000; no need to produce an update was identified (see section 2.14 for details).

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

## Attendance

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

The meeting was open to those qualified to participate either in ITU-T WP3/16 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 plans for the times of meeting sessions were established as follows, in UTC (which for this meeting was 1 hour behind the time in Geneva and Paris; 8 hours ahead of the time in Los Angeles, etc.). No session was scheduled to last longer than 2 hrs.

* 0500–0700 1st “morning” session [break after 2 hours]
* 0720–0920 2nd “morning” session
* [“overday” break – nearly 12 hours]
* 2100–2300 1st “night” session [break after 2 hours]
* 2320–0120+1 2nd “night” session

It was also pointed out that the session times had been changed from meeting to meeting, such that different time zones of the world might be treated approximately equally fairly either in one meeting or another. For the current meeting, the same UTC session times were used as in the 26th JVET meeting (which had been the ninth meeting conducted as an online-only meeting, whereas the current one is the twelfth).

## ISO and IEC Code of Conduct reminders

Participants were reminded of the ISO and IEC Codes of Conduct, found at (check for new version)

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

<https://www.iecapc.jp/F/IEC_Code_of_Conduct.pdf>

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/>. It was noted that the previous site <http://phenix.int-evry.fr/jvet/> is still accessible, but was 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 1241 (as of 16 January 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 (check if recommendation to keep email addresses updated is included) 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)
* **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 January at 0500 UTC were as follows.

* Timing and organization of the meeting and online access, calendar posting of session plans
  + The initial number of documents was approximately the same as the previous meeting (approximately 170 by the time of opening the meeting) – parallel sessions will be necessary. Y. Ye was asked to chair sessions on EE2 related discussions. Considering that items about JVET management structure had been discussed in the December meeting of WP 3, objection were raised on this aspect by on expert. It is noted that the fact that the JVET chair asked Y. Ye for chairing those sessions (under the aspect of her being experienced in that) does not anticipate any later decision of parent bodies on that aspect. Other potential candidates for chairing parallel discussions could be F. Bossen and J. Boyce.
  + Scheduling of NNVC discussions – should be done early (some overlap with JPEG meeting this time, JPEG meets from Jan. 21, but the 5UTC and 720UTC sessions could be used)
* Plans for subsequent F2F meeting in April (Rennes), July (Sapporo), and November 2024 (Antalya).
* 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-AF1000 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:
  + In the summary (section 1) and in annex C (WG 5 recommendations), it is wrongly stated that the meeting in October 2025 would be under SC 29 auspices. Actually, it can be expected to be held under SG16 auspices, but date and location are still unknown. In section 11 (future meeting plans), the correct information is given.
  + In the summary (section 1), for some documents without standards deliverable status the statement that they had been “also issued as WG 5 Nxxx” was missing.
* 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.
* It was noted that during the interim period since the last meeting, a crash happened to the password database of the jvet.org site. Therefore, it was necessary for all registered users to reset passwords. This caused problems in some cases where the registered email address had become obsolete (e.g., after change of employer).
* The primary goals of the meeting were:
  + Plan for new version of VVC software as standards part – target April 2024, for inclusion of NNPF SEI, software from TRs, layered coding, bug fixes, etc.
  + 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 was not yet 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 issue the FDIS in April.
  + TR on film grain synthesis technology for video applications – the DTR ballot had not been issued as expected, due to referencing and other issues. ITU consent is targeted for April 2024, possibly second DTR by April as well. Any preliminary draft at the current meeting?
  + Optimization of encoders and receiving systems for machine analysis of coded video content – no new WD of TR was issued from last meeting, more input this time, discuss how to proceed
  + Preparation of subjective tests for film grain, new content available – expert viewing to be planned for April meeting
  + Expert viewing for multi-layer verification test to be planned for April meeting
  + Any action items on reference software JM/HM? Status of MV-HEVC software and test conditions (refer to resolution of a previous meeting for the latter)?
  + New edition of AVC
    - 11th ed. 14496-10 under DIS ballot (to close 2024-04-15; response expected before April 2024 meeting)
    - ITU consent for new H.264 edition was targeted for April 2024
  + HEVC updates
    - Amd.1 of 5th ed. is under DAM ballot (to close 2024-04-08; responses expected before April 2024 meeting).
    - 5th edition was published in 2023-10. This will allow for a next edition including the ongoing Amd.1 in 2024 (converting FDAM into FDIS in April)
    - Consent for next H.265 edition was targeted for April 2024 with new elements from DAM
  + Exploration Experiments
    - Neural network-based video coding
    - Enhanced compression beyond VVC
* Liaison communication:
  + Incoming liaison statements: XXXX.
* Joint meetings were expected with AG 5 (on XXX) and possibly with other groups.
* Principles of standards development were discussed.
* Scheduling of sessions was discussed – see under 2.6 and 2.15.

## Scheduling of discussions

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

* 0500–0700 1st “morning” session [break after 2 hours]
* 0720–0920 2nd “morning” session

[“overday” break – nearly 12 hours]

* 2100–2300 1st “night” session [break after 2 hours]
* 2320–0120+1 2nd “night” session

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

* Wed. 17 January, 1st day
  + Morning sessions:
    - 0500–0600 Opening remarks, review of practices, agenda, codes of conduct, IPR policy reminder
    - 0605–0700 Reports of AHGs 1, 3-7
    - 0720–0920 Reports of AHGs 2, 8-16
  + Late-night sessions:
    - 2100–2310 EE1 summary report
    - 2330–0120+1 EE2 summary report
* Thu. 18 January, 2nd day
  + Morning sessions:
    - 0500–0700 EE2+EE2 related
    - 0720–0920 HLS/SEI (J. Ohm)
    - 0720-0920 non-EE2 (Y. Ye)
  + Late-night sessions:
    - 2100–2300 TBD
    - 2320–0120+1 TBD
* Fri. 19 January, 3rd day
  + Morning sessions:
    - 0500–0700 TBD
    - 0720–0920 TBD
  + Late-night sessions:
    - 2100–2300 TBD
    - 2320–0120+1 TBD
* Mon. 22 January, 4th day
  + 0500–0800 MPEG information sharing session
  + Morning session
    - 0820–0920 TBD
  + Late-night sessions:
    - 2100–2300 TBD
    - 2320–0120+1 TBD
* Tue 23 January, 5th day
  + Morning sessions:
    - 0500–0700 TBD
    - 0720–0920 TBD
  + Late-night sessions:
    - 2100–2300 TBD
    - 2320–0120+1 TBD
* Wed. 24 January, 6th day
  + 0500–0600 MPEG information sharing session
  + Morning sessions:
    - 0600–0700 TBD
    - 0720–0920 TBD
  + Late-night sessions:
    - 2100–2300 TBD
    - 2320–0120+1 TBD
* Thu. 25 January, 7th day
  + Morning sessions:
    - 0500–0700 TBD
    - 0720–0920 TBD
  + Late-night sessions:
    - 2100–2300 TBD
    - 2320–0120+1 TBD
* Fri. 26 January, 8th day
  + 0500–0920 (with break) JVET wrap-up plenary:
    - Approval of output docs
    - Establishment of AHGs
    - Review of meeting recommendations
    - Future planning, a.o.b.
  + 2100–2300 MPEG information sharing session
  + XXXX–XXXX WG 5 approval of meeting recommendations, closing of meeting

## Contribution topic overview

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: Deployment and advertisement of standards (2)
  + AHG2: Text development and errata reporting (2)
  + AHG3: Test conditions (0)
  + AHG3: Software development (0)
  + AHG4: Subjective quality testing and verification testing (2)
  + AHG4: Test Material (1)
  + AHG4: Codec performance with alternative test material (0)
  + AHG5: Conformance test development (0)
  + AHG7: ECM tool assessment (1)
  + AHG8: Optimization of encoders and receiving systems for machine analysis of coded video content (7)
  + AHG10: Encoding algorithm optimization (1)
  + AHG13: Film grain synthesis (3)
  + Implementation studies (0)
  + Profile/tier/level specification (1)
  + Gaming content compression (1)
  + Generative face video (4)
* Low-level tool technology proposals (section 5) with subtopics (number counts excluding BoG and summary reports)
  + AHG11/AHG14 and EE1: Neural network-based video coding (18) (section 5.1)
  + AHG6/AHG12 and EE2: Enhanced compression beyond VVC capability (85) (section 5.2)
* AHG9: High-level syntax (HLS) proposals (section 6) with subtopics
  + SEI messages on NNPF and processing order (11) (sections 6.1, 6.2, 6.3)
  + SEI messages on other topics (30) (sections 6.4, 6.5, 6.6, 6.7, 6.8, 6.9)
  + Non-SEI HLS aspects (3) (section 6.10)
* Joint meetings, plenary discussions, BoG reports (X), liaison (X), summary of actions (section 6)
* 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 0505–0700 and 0720-0915 on Wednesday 17 Jan. 2024 (chaired by JRO).

[JVET-AG0001](https://jvet-experts.org/doc_end_user/current_document.php?id=13774) JVET AHG report: Project Management (AHG1) [J.-R. Ohm (chair), G. J. Sullivan (vice chair)]

[JVET-AG0002](https://jvet-experts.org/doc_end_user/current_document.php?id=13776) JVET AHG report: Draft text and test model algorithm description editing (AHG2) [B. Bross, C. Rosewarne (co-chairs), F. Bossen, A. Browne, S. Kim, S. Liu, J. R. Ohm, G. J. Sullivan, A. Tourapis, Y.-K. Wang, Y. Ye (vice chairs)]

1. **Ad hoc group activity**
   1. **Output documents produced**
      1. **JVET-AF1004 Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP**

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

Incorporated items at the JVET-AF meeting:

* For VVC:
  + Add a missing space in "if(IntraSubPartitionsSplitType != ISP\_NO\_SPLIT )" (JVET-AF0064).
  + On coding of syntax elements of fix-valued, non-reserved bits using f(N) instead of u(N). (JVET-AF0064).
  + Replace the two instances of "in the first access unit of the CVS" with "in the first access unit of the CVS in decoding order". (JVET-AF0189)
* For VSEI:
  + Replace each of the 10 instances of "nuh\_layer\_id" in subclauses 8.22.2 and 8.23.2 with "layer identification". (from Gary J. Sullivan)
  + On cancellation of the persistence of a CTI SEI message by another CTI SEI message. (JVET-AF0064)
  + On coding of syntax elements of fix-valued, non-reserved bits using f(N) instead of u(N). (JVET-AF0064).
  + Consider adding a NOTE in VSEI telling something like: 1) AVC can reference VSEI for enabling the inclusion of only those SEI messages for which the SEI payloads are specified in VSEI but the syntax has not been extended; 2) HEVC and VVC can reference VSEI for enabling the inclusion of SEI messages for which the SEI payloads are specified in VSEI regardless of whether the syntax has been extended or not. (from Ye-Kui Wang)
* For HEVC:
  + Updated the publication status background.
  + (Perhaps for other specs such as AVC, VVC, and VSEI as well) On that the term of "true subset" should be replaced with "proper subset" or "strict subset". (from Gary J. Sullivan)
  + (Perhaps for other specs such as AVC, VVC, and VSEI as well) On that the mixed uses of Boolean operators on numerical values and vice versa should cleaned up. (from Gary J. Sullivan)
  + Removed obsoleted HEVC errata items that were included in JVET-AE1004.
* For AVC:
  + Removed obsoleted AVC errata items that were included in JVET-AE1004.
    1. **JVET-AF1006 New profiles, colour descriptors, and SEI messages for HEVC (draft 2)**

This document contains the draft text for changes on new profiles, colour descriptors, and SEI messages for the 5th edition of the High Efficiency Video Coding (HEVC) standard (Rec. ITU-T H.265 | ISO/IEC 23008-2). The changes include: 1) the support of four new profiles, namely the Multiview Main 10, Multiview Monochrome, Multiview Monochrome 10, and Multiview Monochrome 12 profiles; 2) the support of three additional colour type identifiers; 3) the HEVC-specific supports for some supplemental enhancement information (SEI) messages that may be included in HEVC bitstreams but are not to be specified in the HEVC specification, and 4) some technical corrections and editorial improvements to the 5th edition text of HEVC. The SEI messages are the neural network post-filter characteristics (NNPFC) SEI message, the neural-network post-filter activation (NNPFA) SEI message, and the phase indication SEI message, that are to be specified in the 3rd edition of the Versatile Supplemental Enhancement Information messages for coded video bitstreams (VSEI) standard (ITU‑T H.274 | ISO/IEC 23002-7).

Draft 2 incorporated items:

* In 7.2: Added a NOTE on the b(8) syntax descriptor. [JVET-AF0064]
* In 8.5.3.2.2, bullet item 6: Replaced "variable" with "variables". [Email from C. Reader]
* In D.2.24: Changed the coding of nesting\_zero\_bit from u(1) to f(1). [JVET-AF0064]
* In D.2.44: Changed the coding of mcts\_nesting\_zero\_bit from u(1) to f(1). [JVET-AF0064]
* In D.3.13, Eqn. D-15: Added a closing curly bracket after "G[ c ][ x + 1 ][ y − 1 ]". [FR008 in WG 5 N 243]
* In D.3.45: Improved the phrasing of an SEI message being indicated by the encoder (i.e., the content producer) as being "necessary". [Email from G. J. Sullivan]
* In D.3.45, D.3.46, and I.14.3.3: Appended "in decoding order" after "the first access unit of the CVS". [JVET-AF0189]
* In F.3.29: Improved the phrasing of the NOTE. [Email dicussion between A. Tourapis and Y.-K. Wang]
* In F.7.4.2.2: Improved the phrasing of NOTE 1. [Email dicussion between A. Tourapis and Y.-K. Wang]
* In F.14.2.5: Changed the coding of bsp\_nesting\_zero\_bit from u(1) to f(1). [JVET-AF0064]
* In G.11.1.1, first sentence: Changed "the Multiview Main and Multiview Main 10 profile" to "the Multiview Main or Multiview Main 10 profile". [JVET-AF0063]
* In G.11.1.1 and I.11.1.1: Removed "to" from "greater than to". [JVET-AF0063]
* In G.11.1.1: Applied the following constraint to the Multiview Main 10 profile: "All active PPSs for layers in subBitstream shall have colour\_mapping\_enabled\_flag equal to 0 only." [JVET-AF0063]
* In G.11.1.2: Changed the constraint for the multiview monochrome profiles requiring chroma\_format\_idc to be equal to 1 to requiring chroma\_format\_idc to be equal to 0. [JVET-AF0063]
* In G.11.1.2: Replaced "exensions" with "extensions". [JVET-AF0063]
  + 1. **JVET-AF1016 AVC with extensions and corrections (draft 2)**

(not available at the time of preparing this AhG report)

* + 1. **JVET-AF2002 Algorithm description for Versatile Video Coding and Test Model 21 (VTM 21)**

The JVET established the VVC Test Model 23 (VTM23) software at its 32nd meeting (13-20 October 2023, Hannover). This document serves as a source of general tutorial information on the VVC design and also provides an algorithm description and encoding method description of VTM23 software. It is noted that, as no update of the algorithm description document was released at either the 27th or the 31st JVET meetings, the numbering of the VTM software version is two higher than that of this description document. In the main body of the text, numbering refers to the software version. The VVC has been developed by a joint collaborative team of ITU-T and ISO/IEC experts known as the Joint Video Experts Team (JVET), which is a partnership of ITU-T Study Group 16 Question 6 (known as VCEG) and ISO/IEC JTC 1/SC 29/WG 11 (known as MPEG). This new standard has been designed with two primary goals. The first of these is to specify a video coding technology with a compression capability that is substantially beyond that of the prior generations of such standards, and the second is for this technology to be highly versatile for effective use in a broadened range of applications. In addition to the applications that have commonly been addressed by prior video coding standards, some key application areas for the use of this standard include in particular ultra-high-definition video (e.g., with 3840×2160 or 7620×4320 picture resolution and bit depth of 10 or 12 bits as specified in Rec. ITU-R BT.2100), video with a high dynamic range and wide colour gamut (e.g., with the perceptual quantization or hybrid log-gamma transfer characteristics specified in Rec. ITU-R BT.2100), and video for immersive media applications such as 360° omnidirectional video projected using a common projection format such as the equirectangular or cubemap projection format.

Ed. Notes:

VVC Test Model 21 (VTM21) algorithm description and encoding method v1

• Incorporated JVET-AF0111: AHG10: MTT split modes early termination

• General editorial improvements

* + 1. **JVET-AF2027 SEI processing order and processing order nesting SEI messages in VVC (draft 6)**

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 and processing order nesting SEI messages.

**Changes yet to be integrated:**

None.

**Changes that have been integrated:**

1. Addition of po\_id (JVET-AF0061, JVET-AF0174, JVET-AF0067, JVET-AF0310) [Bytedance/HHI/MediaTek/Nokia/Dolby]
2. On the persistence scope of the SPO SEI message (JVET-AF0189, JVET-AF0049, JVET-AF0061, JVET-AF0174, JVET-AF0310) [Dolby/Nokia/Bytedance/HHI/MediaTek]
3. Addition of the processing order nesting SEI message (JVET-AF0049, JVET-AF0174, JVET-AF0310) [Nokia/HHI/Dolby/Bytedance/MediaTek]
4. Removal of the constraint requiring that there shall be at least two values of po\_sei\_processing\_order[ i ] that are not equal, which is redundant, from JVET-AF0049 and JVET-AF0062 [Nokia/Bytedance]
5. The SEI prefix indications, when present, are signalled in units of bits instead of in units of bytes, same as in the SEI prefix indication SEI message, from JVET-AF0189, JVET-AF0062, and JVET-AF0049. [Dolby/Bytedance/Nokia]
6. Move po\_sei\_prefix\_flag[ i ] from immediately before po\_sei\_payload\_type[ i ] to be immediately after po\_sei\_payload\_type[ i ], from JVET-AF0062. [Bytedance]
7. Clarify the following aspects: In the semantics of the SPO SEI message, two different types of SEI messages may have the same SEI payloadType value but are differentiated by some syntax elements in the SEI payload. For example, two NNPFC SEI messages with different nnpfc\_id values are considered as having two different SEI message types. From JVET-AF0062. [Bytedance]
8. Using separate loops for the payload type and processing order information, from JVET-AF0189. [Dolby]
9. Removing the constraint that “The value of po\_sei\_processing\_order[ po\_num\_sei\_messages\_‌minus2 + 1 ] shall not be equal to 0”, from JVET-AF0189. [Dolby]
10. Modifying the use of SeiProcessingOrderSeiList such that it determines which SEI messages are allowed to appear in an SEI processing order SEI message, and update the values in the list, including disallowing the SEI payloadType value of the decoded picture hash SEI message from being included in the list, from JVET-AF0189 and JVET-AF0070. [Dolby/Sharp]
11. **Related input contributions**

The following input contribution was noted as relevant to the work of this ad hoc group:

* [JVET-AG0079](https://jvet-experts.org/doc_end_user/current_document.php?id=13635) AHG2/AHG9: VUI extension mechanism and picture modality information for AVC and HEVC
* [JVET-AG0213](https://jvet-experts.org/doc_end_user/current_document.php?id=13769) AHG1/AHG2/AHG8: On project management related to the encoder optimization information SEI message

1. **Remaining 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.

New:

* [#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

1. **Recommendations**

The AHG recommends to:

* Approve JVET-AF1004, JVET-AF1006, JVET-AF1016, JVET-AF2002, and JVET-AF2027 documents as JVET outputs,
* Compare the VVC documents with the VVC software and resolve any discrepancies that may exist, in collaboration with the software AHG,
* Encourage the use of the issue tracker to report issues with the text of both the VVC specification text and the algorithm and encoder description,
* Continue to improve the editorial consistency of VVC text specification and Test Model documents,
* Ensure that, when considering changes to VVC, properly drafted text for addition to the VVC Test Model and/or the VVC specification text is made available in a timely manner,
* Review bug tickets, and other AHG2 related inputs and act on them if found to be necessary.

[JVET-AG0003](https://jvet-experts.org/doc_end_user/current_document.php?id=13777) 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 23.0](https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/-/releases/VTM-23.0) (Dec. 2023)
* [HM-18.0](https://vcgit.hhi.fraunhofer.de/jvet/HM/-/releases/HM-18.0) (Apr. 2023)
* [HM-16.21+SCM-8.8](https://vcgit.hhi.fraunhofer.de/jvet/HM/-/tags/HM-16.21+SCM-8.8) (Mar. 2020)
* [SHM 12.4](https://vcgit.hhi.fraunhofer.de/jvet/SHM/-/tags/SHM-12.4) (Jan. 2018)
* [HTM 16.3](https://vcgit.hhi.fraunhofer.de/jvet/HTM/-/tags/HTM-16.3) (Jul. 2018)
* [JM 19.1](https://vcgit.hhi.fraunhofer.de/jvet/JM/-/releases/JM-19.1) (Apr. 2023)
* [JSVM 9.19.15](https://vcgit.hhi.fraunhofer.de/jvet/jsvm/-/tags/JSVM_9_19_15)
* [JMVC 8.5](https://vcgit.hhi.fraunhofer.de/jvet/jmvc/-/tags/JMVC_8_5)
* [3DV ATM 15.0](https://vcgit.hhi.fraunhofer.de/jvet/3dv-atm/-/tags/3DV-ATM_v15.0) (no version history)
* [HDRTools 0.24](https://gitlab.com/standards/HDRTools/-/tags/v0.24) (March 2023)

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

1. **Software development**

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

The server is located at:

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

The registration and development workflow are documented at:

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

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

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

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.

1. **VTM related activities**

The VTM software can be found at

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

The software development continued on the GitLab server. VTM versions 22.1 and 22.2 were tagged on Oct. 22, and VTM version 23.0 was tagged on Dec. 12. VTM 23.1 is expected during the 33rd JVET meeting.

VTM 22.1 was tagged on Oct. 22, 2023. Changes include:

* FIX #1611: use pic->reconstructed and pic->layerId for computing HashME condition
* FIX #1613: Fix transform skip cost for non-CTC conditions
* Update software manual on max transform size (#1614)
* Clean up IBC-related code
* Fix #1616: NNPFC SEI nnpfc\_chroma\_sample\_loc\_type\_frame value is checked even when not signalled
* Fix #1612: PO-SEI message
* JVET-AE0156: Message wrapping and importance indication for the SEI processing order SEI message
* Free vector data memory when destroying CodingStructure buffers
* Port CS mem reduction from ecm/ECM!525
* Port using actual CTU size instead of MAX\_CU\_SIZE at encoder from ecm/ECM!516
* Relax strict equality when comparing floating-point numbers
* Port picture buffer refactoring from ecm/ECM!523
* Fix unreleased RPR temp buffer
* Fix #1615: Encoding exception with VS compiler
* Fix y4m header writing when RPR is used and UpscaledOutput=2

VTM 22.2 was tagged on Oct. 23, 2023. Changes include:

* Remove macros from previous cycle

VTM 23.0 was tagged Dec. 12, 2023. Changes include:

* Add SIMD implementations of transforms
* TileIdx as a new type
* Fix crash for class F: set SPS in CodingStructure
* Fix debugBitstream functionality
* Fix out-of-bounds access in EncCu::updateRdCheckingNum
* Remove parameter UseBLambdaForNonKeyLowDelayPictures
* Remove toLast and unused variables in ClpRngs
* Fix #1622: Initialising NNPFC SEI attributes in the default constructor
* Fix #1621: Compilation issue in non-X86 environments
* JVET-AF0122-SW: Lagrange multiplier optimization for ALF
* Fix debug bitstream for multilayer
* JVET-AF0310: Processing Order Nesting SEI message
* Cleanup: replace TAB characters with spaces in config files

VTM 23.1 is expected to be tagged during the 33rd JVET meeting. Changes are expected to include bug fixes and code optimizations.

* 1. ***CTC Performance***

The following tables shows **VTM 20.0** performance over **HM 17.0** (not updated, results identical with previous versions).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra Main10** |  |  |
|  |  |  | **Over HM-17.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -29.50% | -32.81% | -33.83% | 1273% | 166% |
| Class A2 | -29.73% | -24.39% | -21.58% | 2142% | 174% |
| Class B | -22.32% | -27.21% | -30.98% | 2397% | 175% |
| Class C | -22.89% | -19.53% | -23.19% | 3348% | 179% |
| Class E | -26.04% | -25.90% | -24.15% | 1869% | 158% |
| **Overall** | -25.50% | -25.75% | -27.02% | 2187% | 171% |
| Class D | -18.80% | -13.85% | -13.68% | 4270% | 189% |
| Class F | -39.49% | -40.23% | -42.90% | 4220% | 171% |
|  |  |  |  |  |  |
|  |  |  | **Random access Main10** |  |  |
|  |  |  | **Over HM-17.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | -40.60% | -40.71% | -47.16% | 586% | 158% |
| Class A2 | -44.02% | -41.73% | -40.78% | 679% | 170% |
| Class B | -37.41% | -50.12% | -48.51% | 672% | 161% |
| Class C | -33.86% | -36.28% | -38.21% | 923% | 164% |
| Class E |  |  |  |  |  |
| **Overall** | -38.42% | -42.87% | -43.95% | 713% | 163% |
| Class D | -31.72% | -32.60% | -31.95% | 970% | 161% |
| Class F | -46.07% | -49.76% | -50.65% | 490% | 145% |
|  |  |  |  |  |  |
|  |  |  | **Low delay B Main10** |  |  |
|  |  |  | **Over HM-17.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -30.40% | -37.43% | -35.12% | 629% | 152% |
| Class C | -28.18% | -21.23% | -21.06% | 817% | 167% |
| Class E | -31.16% | -35.72% | -28.79% | 309% | 140% |
| **Overall** | -29.85% | -31.60% | -28.85% | 575% | 154% |
| Class D | -26.75% | -16.50% | -14.88% | 881% | 179% |
| Class F | -42.17% | -44.02% | -44.14% | 435% | 137% |
|  |  |  |  |  |  |
|  |  |  | **Low delay P Main10** |  |  |
|  |  |  | **Over HM-17.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -34.52% | -38.34% | -36.12% | 526% | 160% |
| Class C | -28.07% | -17.73% | -18.09% | 670% | 176% |
| Class E | -33.06% | -37.89% | -31.10% | 280% | 146% |
| **Overall** | -32.01% | -31.36% | -28.85% | 487% | 161% |
| Class D | -26.68% | -12.73% | -11.47% | 762% | 175% |
| Class F | -40.13% | -41.24% | -41.72% | 437% | 145% |

According to common test conditions in random access configuration HM is using a GOP size of 16 pictures compared to VTM using a GOP of 32 pictures. Random access points are inserted approximately every second aligned with a GOP boundary of GOP 32 in both VTM and HM. VTM uses two more reference pictures in random access than HM (due to more memory being availably in typical level settings).

The following table shows **VTM 23.0** performance over **VTM 22.0** using SDR CTC:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **All Intra Main10** |  |  |
|  |  |  | **Over VTM-22.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.00% | 0.00% | 0.00% | 94% | 91% |
| Class A2 | 0.00% | 0.00% | 0.00% | 96% | 94% |
| Class B | 0.00% | 0.00% | 0.00% | 97% | 94% |
| Class C | 0.00% | 0.00% | 0.00% | 98% | 97% |
| Class E | 0.00% | 0.00% | 0.00% | 97% | 93% |
| **Overall** | 0.00% | 0.00% | 0.00% | 96% | 94% |
| Class D | 0.00% | 0.00% | 0.00% | 98% | 98% |
| Class F | 0.00% | 0.00% | 0.00% | 90% | 97% |
|  |  |  |  |  |  |
|  |  |  | **Random access Main10** |  |  |
|  |  |  | **Over VTM-22.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 | 0.00% | -0.08% | 0.01% | 93% | 94% |
| Class A2 | 0.06% | 0.07% | 0.06% | 93% | 96% |
| Class B | 0.02% | -0.03% | -0.03% | 93% | 96% |
| Class C | 0.02% | 0.03% | -0.05% | 93% | 96% |
| Class E |  |  |  |  |  |
| **Overall** | 0.02% | 0.00% | -0.01% | 93% | 96% |
| Class D | 0.03% | -0.25% | 0.06% | 96% | 97% |
| Class F | 0.14% | 0.17% | 0.12% | 91% | 96% |
|  |  |  |  |  |  |
|  |  |  | **Low delay B Main10** |  |  |
|  |  |  | **Over VTM-22.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | 0.06% | 0.14% | 0.44% | 93% | 94% |
| Class C | 0.03% | 0.02% | -0.25% | 94% | 96% |
| Class E | 0.04% | 0.20% | -0.28% | 97% | 96% |
| **Overall** | 0.04% | 0.12% | 0.03% | 94% | 95% |
| Class D | 0.04% | 0.23% | -0.73% | 97% | 98% |
| Class F | 0.21% | 0.32% | -0.22% | 92% | 96% |
|  |  |  |  |  |  |
|  |  |  | **Low delay P Main10** |  |  |
|  |  |  | **Over VTM-22.0** |  |  |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | 0.04% | 0.24% | 0.07% | 94% | 95% |
| Class C | -0.02% | 0.22% | -0.11% | 97% | 99% |
| Class E | 0.11% | 0.39% | -0.25% | 96% | 95% |
| **Overall** | 0.04% | 0.27% | -0.07% | 95% | 96% |
| Class D | 0.04% | -0.35% | -0.34% | 98% | 98% |
| Class F | 0.30% | 0.12% | -0.20% | 92% | 96% |

For the high bit depth CTCs, there is no change in coding performance or run time between VTM 23.0 and VTM 22.0 for the low QP range. For the standard QP range (22-37), the simulations were run using VTM 23.0 with the merged fix for DualITree=0 (otherwise the software crashes).

Relative to VTM 22.0, some small differences can be seen:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access** | | | | | | | | | |
|  | **VTM23.0 + fix over VTM22.0, with CTC described in VTM-JVET-AA2018-STDQP** | | | | | | | | | |
|  |  |  | **wPSNR** |  |  | **PSNR** |  |  |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -0.07% | -0.01% | 0.00% | -0.09% | -0.10% | 0.00% | -0.07% | -0.13% | 97% | 95% |
| Class H2 |  |  |  |  |  | 0.05% | 0.15% | 0.08% | 97% | 95% |
| **Overall** | -0.07% | -0.01% | 0.00% | -0.09% | -0.10% | 0.03% | 0.04% | -0.03% | 97% | 95% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **All Intra** | | | | | | | | | |
|  | **VTM23.0 + fix over VTM22.0, with CTC described in VTM-JVET-AA2018-STDQP** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -0.06% | 0.00% | 0.00% | -0.09% | -0.08% | 0.00% | -0.05% | -0.07% | 100% | 97% |
| Class H2 |  |  |  |  |  | 0.00% | 0.00% | 0.00% | 98% | 96% |
| **Overall** | -0.06% | 0.00% | 0.00% | -0.09% | -0.08% | 0.00% | -0.03% | -0.03% | 99% | 97% |

Results using HDR CTC show slight differences between **VTM 23.0** and **VTM 23.0**, as depicted in table below.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access** | | | | | | | | | |
|  | **Over VTM22.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -0.03% | 0.00% | 0.00% | -0.13% | 0.19% | 0.01% | -0.09% | -0.10% | 100% | 100% |
| Class H2 |  |  |  |  |  | 0.00% | -0.03% | 0.10% | 100% | 102% |
| **Overall** | 0.08% | 0.02% | 0.02% | 0.25% | 0.19% | 0.00% | -0.07% | -0.03% | 100% | 101% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **All Intra** | | | | | | | | | |
|  | **Over VTM22.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -0.08% | 0.00% | 0.00% | -0.09% | -0.06% | 0.00% | -0.06% | -0.04% | 102% | 100% |
| Class H2 |  |  |  |  |  | 0.00% | 0.00% | 0.00% | 100% | 100% |
| **Overall** | -0.08% | 0.00% | 0.00% | -0.09% | -0.06% | 0.00% | -0.04% | -0.02% | 101% | 100% |

The following tables show **VTM 22.0** performance over **HM 18.0** using HDR CTC:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access** | | | | | | | | | |
|  | **Over HM18.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -39.50% | -37.55% | -36.66% | -54.93% | -48.46% | -33.67% | -49.42% | -40.87% | 288% | 101% |
| Class H2 |  |  |  |  |  | -31.96% | -57.71% | -63.32% | 257% | 92% |
| **Overall** | -39.50% | -37.55% | -36.66% | -54.93% | -48.46% | -33.07% | -52.43% | -49.03% | 276% | 98% |
|  |  |  |  |  |  |  |  |  |  |  |
|  | **All Intra** | | | | | | | | | |
|  | **Over HM18.0** | | | | | | | | | |
|  |  |  | **wPSNR** | | | **PSNR** | | |  |  |
|  | DE100 | PSNR-L100 | Y | U | V | Y | U | V | EncT | DecT |
| Class H1 | -41.45% | -27.31% | -26.79% | -57.74% | -52.79% | -24.00% | -52.93% | -45.13% | 1537% | 117% |
| Class H2 |  |  |  |  |  | -21.76% | -47.21% | -50.57% | 1274% | 109% |
| **Overall** | -41.45% | -27.31% | -26.79% | -57.74% | -52.79% | -23.18% | -50.85% | -47.11% | 1436% | 114% |

* 1. ***Issues in VTM affecting conformance***

The following issues in VTM master branch may affect conformance:

* Missing HLS features (see sections below)
  1. ***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.
  1. ***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 is expected to be tagged during the 33rd JVET meeting. Changes so far include:

* JVET-AF0088
* JVET-AF0167 MPIISEI message
* JVET-AF0107-TuC: Implementation of Encoder Optimization Info SEI message
* JVET-AF2032 SPTI SEI message

1. **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.

1. **360Lib related activities**

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

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

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

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

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

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

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

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

1. **SCM related activities**

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

1. **SHM related activities**

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

1. **HTM related activities**

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

One merge request is 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

1. **HDRTools related activities**

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

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

There had not been any further developments to 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.

1. **Bug tracking**

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

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

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

1. **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

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

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

1. **Guidelines for reference software development**

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

1. **Recommendations**

The AHG recommends to:

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

[JVET-AG0004](https://jvet-experts.org/doc_end_user/current_document.php?id=13778) JVET AHG report: Test material and visual assessment (AHG4) [V. Baroncini, T. Suzuki, M. Wien (co-chairs), W. Husak, S. Iwamura, P. de Lagrange, S. Liu, X. Meng, S. Puri, A. Segall, S. Wenger (vice-chairs)]

1. **Activities**
   1. ***Verification tests for VVC multilayer coding***

The output document JVET-AF2021 of the previous meeting documenting the updated version of the verification test plan was produced and uploaded to the document system.

The output document JVET-AF2033 of the previous meeting reporting the results of the demonstration of content layering using VVC multilayer coding was produced and uploaded to the document system.

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

In this meeting period, candidate sequences for visual testing of filmgrain characteristics proposed at the previous meeting have been made available on the ftp site in the directory ./ahg/viewingtests/filmgrain/JVET-AF0262.

* 1. ***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 may be replaced by a new system in the near future. Potential solutions and a transition plan are currently under discussion.

1. **Related contributions**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| [JVET number](https://jvet-experts.org/doc_end_user/current_meeting.php?id_meeting=195&type_order=&sql_type=document_number) | MPEG number | [Created](https://jvet-experts.org/doc_end_user/current_meeting.php?id_meeting=195&type_order=&sql_type=document_date_time) | First upload | [Last upload](https://jvet-experts.org/doc_end_user/current_meeting.php?id_meeting=195&type_order=&sql_type=upload_document_date_time) | [Title](https://jvet-experts.org/doc_end_user/current_meeting.php?id_meeting=195&type_order=&sql_type=title) | [Source](https://jvet-experts.org/doc_end_user/current_meeting.php?id_meeting=195&type_order=&sql_type=authors) |
| [JVET-AG0004](https://jvet-experts.org/doc_end_user/current_document.php?id=13778) | m66131 | 2024-01-11 13:02:08 |  |  | 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-AG0071](https://jvet-experts.org/doc_end_user/current_document.php?id=13627) | m65960 | 2024-01-10 06:49:08 | 2024-01-10 15:53:19 | 2024-01-10 15:53:19 | Informal Subjective Evaluation of Low Complexity Enhancement Video Codec (LCEVC) with VVC on SDR UHD (4K) Content | O. Chubach, H.-H. Chen, C.-Y. Chen, T.-D. Chuang, Y.-W. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek) |
| [JVET-AG0224](https://jvet-experts.org/doc_end_user/current_document.php?id=13797) | m66167 | 2024-01-11 19:47:04 |  |  | Response to JEVT-AG0071 on Informal Subjective Evaluation of Low Complexity Enhancement Video Codec (LCEVC) with VVC on SDR UHD (4K) Content | [Lorenzo Ciccarelli](mailto:lorenzo.ciccarelli@v-nova.com), [Simone Ferrara](mailto:simone.ferrara@v-nova.com) |
| [JVET-AG0228](https://jvet-experts.org/doc_end_user/current_document.php?id=13801) | m66244 | 2024-01-12 16:20:30 | 2024-01-15 16:48:27 | 2024-01-16 14:37:49 | AHG4/AHG13: source for scanned film test sequences | [P. de Lagrange (InterDigital)](mailto:philippe.delagrange@interdigital.com) |

1. **Recommendations**

The AHG recommends:

* To review and consider JVET-AE0228 in the development of the draft plan for subjective quality testing of FGC SEI message.
* To review document JVET-AF0071 and JVET-AG0224 in a joint meeting with WG 4 and 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 and subjective quality test plan for FGS, 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-AG0005](https://jvet-experts.org/doc_end_user/current_document.php?id=13779) 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)]

1. **Activities (fix numbering)**

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 32nd and 33rd meetings.

1. **Timeline**

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

* **VVCv1 conformance:**
  + ISO/IEC FDIS 23090-15 issued from 2021-10 meeting, FDIS registered for formal approval 2022-07-11, FDIS ballot closed 2022-11-04, standard published 2022-11-24
  + H.266.1 V1 Consent 2022-01-28, Last Call began 2022-04-01, Approved 2022-04-29, pre-published 2022-05-17, standard published 2022-07-12.
* **VVCv2 conformance:**
  + ISO/IEC 23090-15/Amd.1 CDAM: 2021-10
  + ISO/IEC 23090-15/Amd.1 DAM: 2022-01
  + DAM ballot closed 2022-11-15
  + ISO/IEC FDIS 23090-15:202x 2nd edition text output of 2023-01, preparation delayed to 2023-09
  + 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

1. **Status on bitstream submission**

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

* conformance bitstreams for VVC:
  + 104 bitstream categories have been identified
  + At least one bitstream has been submitted in each identified category
  + 283 total bitstreams have been provided, checked, and made available
  + No changes in bitstream between 32nd and 33rd 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 32nd and 33rd meeting.

1. **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 7 additional conformance bitstreams for VVC multilayer configurations in JVET-AE2028 are decoded correctly using VTM-23.0 and are available in <https://www.itu.int/wftp3/av-arch/jvet-site/bitstream_exchange/VVCMultilayer/under_test/VTM-23.0/>.

Volunteers to cross check these 7 conformance bitstreams for VVC multilayer configurations have been identified and cross-check is ongoing.

HEVC Multiview supporting extended bit depth activities:

A merge request (MR) implementing the HEVC Multiview Main 10 profiles in JVET-AA1011 has been submitted in <https://vcgit.hhi.fraunhofer.de/jvet/HTM/-/merge_requests/5>

An implementation for the other HEVC Multiview profiles in JVET-AA1011 (Multiview Monochrome, and Multiview Monochrome 10 profiles) is still in progress.

Cross-checking of the 4 HEVC Multiview supporting extended bit depth (Multiview Main 10) bitstreams provided in AD0232 and AE0295 is contingent to the merging of the above MR. Review of the MR is on-going.

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

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

1. **Contributions**

JVET-AG0201 – On MV-HEVC Profiles [Y.-K. Wang, H. Liu, L. Zhang, S. Jiao, C. Hu, J. Cui, G. Xu , A. M. Tourapis, D. Podborski, S. Paluri].

1. **Ftp site information**

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

* VVC:

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

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

* VVC operation range extensions:

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

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

The ftp site for uploading bitstream file is as follows.

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

(user id: avguest, passwd: Avguest201007)

If using FileZilla, the following configuration is suggested:

Graphical user interface, text, application, email

Description automatically generated

In the Filezilla Edit 🡪 Settings 🡪 Connection menu, it may also be necessary to set the minimum TLS level to 1.0.

1. **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 (JVET-AA1011).

It is noted that availability of software (HTM) and verified conformance streams for the new HEVC Multiview profiles by the next meeting would be important to progress those profiles into the standard.

[JVET-AG0006](https://jvet-experts.org/doc_end_user/current_document.php?id=13780) JVET AHG report: ECM software development (AHG6) [V. Seregin (chair), J. Chen, R. Chernyak, F. Le Léannec, K. Zhang (vice-chairs)]

1. **Software development**

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

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

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

The following changes were integrated into ECM-10.1:

Fix: high QP for AA0093 (MR 519)

Fix: reconstruction buffer copied when BIF is not performed for a sub-TU (MR 522)

Fix for uninitialized values usage reported by valgrind (MR 524)

Reduce MCTF peak memory allocation by computing applyMotion in place

Fix: memory reduction: use actual CTU size instead of MAX\_CU\_SIZE in encoder (MR 520)

ALF optimization - compute only Upper triangular part of covariance matrix (MR 521)

PU memory reduction by moving intraMPM member from PU IntraPredictionData to IntraPrediction (MR 518)

Fix: CU memory reduction. move some members from CU to intra search (MR 517)

Refactor picture buffer to allocate buffers for current frame and not for the entire GOP (MR 523)

CS memory reduction by allocating temporary CodingStructure data only for the current picture (MR 525)

Shrink some deblocking buffers and reduce length of memset() initializations (MR 526)

Memory reduction for sign prediction (MR 527)

Bugfix for multi-model BVG-CCCM (JVET\_AE0100\_BVGCCCM) (MR 530)

Use transposed buffers (MR 529)

Refactor Cabac ctx (MR 528)

Fix: fill picture level recon buffer in TU reconstruction code for BIF (MR 531)

Fix for derivation of cost in IntraTMP CandList (MR 532)

Fix the problem with disabling AE0159 macro (MR 533)

Fix unreleased RPR temp buffer (MR 534)

The following adopted aspects were integrated into ECM-11.0:

JVET-AF0133: Retraining I-slice context models (Test 6.2) (MR 537)

JVET-AF0201: Incorporate decoder memory measurement (MR 547)

JVET-AF0111: Updates the threshold for MTT modes early termination (MR 538)

JVET-AF0237: SAO/ALF encoder memory reduction (lossless) (MR 539)

JVET-AF0163: TM based subblock motion refinement (Test 3.4a) (MR 546)

JVET-AF0128: LIC flag derivation for merge candidates with template costs (Test 3.2) (MR 544)

JVET-AF0190: Enabling template-based reordering tools and LIC for scaled pictures in the RPR (Test 4.1b) (MR 542)

JVET-AF0197: Luma Residual Tap in CCALF (MR 548)

JVET-AF0079: IntraTMP block vector storing (Test 2.6c) (MR 535)

JVET-AF0177: Change data type of ALF/CCALF covariance from double to float (MR 541)

JVET-AF0073: Inter cross-component prediction merge (Test 3.1d) (MR 536)

JVET-AF0059: AHG12: Fix to interpolation filter for intra prediction (MR 554)

JVET-AF0066: Enable DBV mode in single tree configuration (MR 552)

JVET-AF0159: Affine subblock BDOF refinement (MR 550)

JVET-AF0112: Dynamic Scaling of Bilateral Filter (BIF) (Test 5.1a) (MR 556)

JVET-AF0101: Lossless code optimization by moving initialization to init() function (MR 555)

JVET-AF0057: Encoder only method for robust MV derivation in DMVR (MR 557)

Optimizations:

Memory reduction by allocating picture margin according to whether RPR is used (MR 561)

Bug fixes:

Fixes to DebugStream tool (MR 562, 566, 569, 570)

Fix gcc 13.2 compiling issues (MR 560)

Fix SAO/ALF memory reduction when RPR is enabled (MR 563)

Fix tracing (MR 565)

Fix: out of bounds access in simdFilter (MR 572)

Fix: out of bounds access in BI-GPM (MR 571)

Fix: valgrind error in Affine Merge candidates management in DecCu::xDeriveCUMV (MR 574)

Fix: inconsistent block stat by JVET-AD0222 when virtual boundary is enabled (MR 575)

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

JVET-AF0165: align VTM-11.0ecm CTCs to ECM CTCs for low-delay (MR 545)

JVET-AF0111: MTT split modes early termination threshold is updated and enabled in RA and LDB CTC (MR 540)

ECM-10.1, ECM-11.0, and VTM-11ecm11.0 were tagged on November 21, 2023.

* 1. ***CTC* Performance**

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

ECM-10.1 performance over ECM-10.0 anchor is summarized in the tables below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | |
|  | **Over ECM-10.0** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class A1 | 0.00% | 0.01% | -0.03% | 98.0% | 98.4% | 88.2% |
| Class A2 | -0.01% | -0.15% | -0.16% | 97.7% | 97.8% | 88.0% |
| Class B | -0.01% | -0.15% | -0.16% | 93.4% | 94.3% | 57.5% |
| Class C | 0.00% | 0.03% | 0.03% | 91.5% | 93.0% | 36.5% |
| Class E | 0.01% | 0.06% | -0.15% | 93.7% | 92.6% | 44.6% |
| **Overall** | 0.00% | -0.05% | -0.09% | 94.5% | 94.9% | 57.5% |
| Class D | 0.00% | -0.09% | -0.06% | 92.7% | 92.4% | 29.9% |
| Class F | -0.09% | -0.10% | -0.13% | 99.0% | 99.2% | 44.8% |
| Class TGM | -0.21% | -0.24% | -0.27% | 100.8% | 98.9% | 56.9% |
|  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | |
|  | **Over ECM-10.0** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class A1 | 0.02% | -0.21% | -0.01% | 97.7% | 98.8% | 78.5% |
| Class A2 | 0.01% | -0.17% | 0.00% | 96.2% | 97.8% | 78.1% |
| Class B | -0.05% | -0.01% | -0.20% | 94.5% | 98.4% | 60.1% |
| Class C | 0.01% | 0.06% | -0.07% | 92.6% | 96.3% | 40.4% |
| Class E |  |  |  |  |  |  |
| **Overall** | -0.01% | -0.07% | -0.09% | 94.9% | 97.8% | 60.1% |
| Class D | -0.01% | -0.23% | -0.16% | 93.0% | 96.0% | 32.2% |
| Class F | 0.03% | 0.10% | 0.17% | 101.8% | 101.0% | 51.5% |
| Class TGM | -0.11% | -0.16% | -0.06% | 104.0% | 103.1% | 67.5% |
|  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | |
|  | **Over ECM-10.0** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class A1 |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |
| Class B | -0.01% | 0.18% | 0.26% | 95.5% | 94.2% | 58.9% |
| Class C | -0.04% | -0.60% | -0.32% | 91.4% | 93.5% | 37.8% |
| Class E | -0.03% | 1.00% | -1.48% | 97.8% | 96.4% | 45.9% |
| **Overall** | -0.02% | 0.13% | -0.37% | 94.7% | 94.5% | 47.8% |
| Class D | 0.09% | -0.25% | -0.55% | 93.1% | 93.8% | 30.6% |
| Class F | 0.26% | 0.20% | 0.31% | 98.3% | 98.2% | 49.1% |
| Class TGM | -0.03% | 0.02% | -0.05% | 99.7% | 96.7% | 63.2% |
|  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | |
|  | **Over ECM-10.0** | | | | | |
|  | Y | U | V | EncT | DecT | VmPeak |
| Class A1 |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |
| Class B | 0.02% | -0.23% | 0.09% | 96.4% | 97.7% | 58.7% |
| Class C | 0.02% | 0.05% | -0.03% | 94.5% | 96.6% | 37.5% |
| Class E | -0.09% | 0.75% | -1.10% | 96.8% | 94.3% | 45.5% |
| **Overall** | -0.01% | 0.11% | -0.25% | 95.9% | 96.4% | 47.4% |
| Class D | 0.05% | -0.51% | 0.17% | 94.7% | 95.8% | 30.4% |
| Class F | 0.18% | -0.20% | 0.39% | 98.4% | 99.1% | 48.2% |
| Class TGM | 0.05% | 0.15% | 0.05% | 99.4% | 96.4% | 62.8% |

Next tables show ECM-11.0 performance over ECM-10.1 anchor.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | |
|  | **Over ECM-10.1** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -0.30% | -0.01% | -0.11% | 94.6% | 94.6% | 78.2% |  |
| Class A2 | -0.31% | -0.13% | -0.28% | 96.6% | 94.7% | 78.7% |  |
| Class B | -0.32% | -0.28% | -0.15% | 100.6% | 96.4% | 60.7% |  |
| Class C | -0.38% | -0.33% | -0.27% | 96.8% | 88.6% | 79.6% |  |
| Class E | -0.50% | -0.60% | -0.17% | 99.5% | 97.7% | 70.2% |  |
| **Overall** | -0.36% | -0.27% | -0.20% | 97.9% | 94.2% | 71.9% |  |
| Class D | -0.34% | -0.17% | -0.34% | 99.3% | 90.6% | 90.9% |  |
| Class F | -0.43% | -0.65% | -0.50% | 100.8% | 92.7% | 70.1% |  |
| Class TGM | -0.21% | -0.33% | -0.18% | 102.2% | 97.9% | 60.3% |  |
|  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | |
|  | **Over ECM-10.1** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -0.32% | -0.97% | -1.19% | 102.4% | 102.7% | 86.3% |  |
| Class A2 | -0.65% | -1.54% | -2.24% | 104.4% | 109.5% | 87.0% |  |
| Class B | -0.30% | -1.63% | -1.21% | 106.4% | 107.0% | 79.7% |  |
| Class C | -0.38% | -1.09% | -1.05% | 107.0% | 109.1% | 85.8% |  |
| Class E |  |  |  |  |  |  |  |
| **Overall** | -0.39% | -1.34% | -1.37% | 105.4% | 107.2% | 84.1% |  |
| Class D | -0.29% | -0.82% | -0.64% | 106.1% | 106.8% | 90.7% |  |
| Class F | -0.60% | -1.18% | -1.15% | 103.2% | 108.0% | 83.0% |  |
| Class TGM | -0.14% | -0.45% | -0.64% | 94.5% | 95.8% | 80.3% |  |
|  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | |
|  | **Over ECM-10.1** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -0.08% | -5.40% | -5.43% | 95.9% | 101.6% | 77.5% |  |
| Class C | -0.23% | -2.93% | -2.92% | 99.5% | 101.1% | 86.4% |  |
| Class E | -0.12% | -4.41% | -2.61% | 92.6% | 97.2% | 80.9% |  |
| **Overall** | -0.14% | -4.33% | -3.89% | 96.2% | 100.3% | 81.2% |  |
| Class D | -0.16% | -4.60% | -3.34% | 101.7% | 103.3% | 94.1% |  |
| Class F | -0.53% | -3.94% | -4.09% | 98.6% | 101.3% | 83.4% |  |
| Class TGM | -0.14% | -2.26% | -2.46% | 96.7% | 106.9% | 78.9% |  |
|  |  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | | |
|  | **Over ECM-10.1** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -0.03% | -5.83% | -4.68% | 96.4% | 100.1% | 76.8% |  |
| Class C | -0.17% | -3.40% | -3.45% | 99.0% | 108.6% | 87.4% |  |
| Class E | -0.29% | -4.28% | -2.81% | 94.0% | 107.8% | 81.1% |  |
| **Overall** | -0.14% | -4.64% | -3.80% | 96.6% | 104.8% | 81.3% |  |
| Class D | -0.10% | -5.00% | -4.71% | 101.6% | 108.1% | 94.2% |  |
| Class F | -0.95% | -3.78% | -4.60% | 101.3% | 110.8% | 83.6% |  |
| Class TGM | 0.06% | -2.38% | -2.78% | 97.7% | 98.7% | 79.3% |  |

The below tables show ECM-11.0 performance comparing to VTM-11.0ecm11.0 anchor.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main 10** | | | | | | |
|  | **Over VTM-11.0ecm11.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -10.81% | -21.80% | -29.33% | 859.1% | 400.6% |  |  |
| Class A2 | -16.95% | -28.77% | -31.78% | 860.2% | 405.4% |  |  |
| Class B | -11.31% | -26.84% | -25.03% | 784.4% | 411.0% |  |  |
| Class C | -11.41% | -16.72% | -17.24% | 810.7% | 381.9% |  |  |
| Class E | -15.01% | -24.77% | -23.07% | 750.1% | 431.9% |  |  |
| **Overall** | -12.81% | -23.73% | -24.81% | 808.6% | 405.0% |  |  |
| Class D | -9.48% | -14.56% | -14.65% | 795.1% | 383.1% |  |  |
| Class F | -26.60% | -35.72% | -35.58% | 513.6% | 392.7% |  |  |
| Class TGM | -39.53% | -47.43% | -46.69% | 457.3% | 461.2% |  |  |
|  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | |
|  | **Over VTM-11.0ecm11.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 | -22.47% | -27.84% | -36.88% | 875.4% | 769.1% |  |  |
| Class A2 | -26.01% | -36.30% | -40.11% | 824.7% | 958.3% |  |  |
| Class B | -20.80% | -35.53% | -33.16% | 714.1% | 774.7% |  |  |
| Class C | -22.22% | -27.13% | -27.05% | 748.2% | 829.1% |  |  |
| Class E |  |  |  |  |  |  |  |
| **Overall** | -22.56% | -31.91% | -33.67% | 775.1% | 821.9% |  |  |
| Class D | -23.10% | -28.71% | -28.75% | 768.1% | 898.2% |  |  |
| Class F | -28.70% | -37.47% | -37.77% | 614.7% | 505.2% |  |  |
| Class TGM | -36.82% | -43.33% | -43.43% | 566.6% | 413.2% |  |  |
|  |  |  |  |  |  |  |  |
|  | **Low delay B Main 10** | | | | | | |
|  | **Over VTM-11.0ecm11.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -17.76% | -41.31% | -38.53% | 661.6% | 649.7% |  |  |
| Class C | -19.49% | -31.72% | -31.66% | 618.2% | 678.1% |  |  |
| Class E | -16.28% | -30.12% | -30.39% | 587.1% | 406.5% |  |  |
| **Overall** | -17.97% | -35.32% | -34.21% | 627.8% | 586.1% |  |  |
| Class D | -21.22% | -34.09% | -33.02% | 659.2% | 772.5% |  |  |
| Class F | -24.87% | -39.63% | -38.99% | 575.6% | 491.8% |  |  |
| Class TGM | -35.47% | -44.37% | -44.64% | 538.8% | 424.4% |  |  |
|  |  |  |  |  |  |  |  |
|  | **Low delay P Main 10** | | | | | | |
|  | **Over VTM-11.0ecm11.0** | | | | | | |
|  | Y | U | V | EncT | DecT | EncVmPeak | DecVmPeak |
| Class A1 |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |
| Class B | -16.37% | -40.73% | -37.81% | 592.0% | 625.0% |  |  |
| Class C | -18.40% | -30.91% | -30.87% | 545.9% | 688.5% |  |  |
| Class E | -15.76% | -29.13% | -29.84% | 571.9% | 461.5% |  |  |
| **Overall** | -16.89% | -34.56% | -33.51% | 571.2% | 598.4% |  |  |
| Class D | -21.11% | -33.25% | -33.49% | 588.5% | 750.2% |  |  |
| Class F | -24.13% | -39.44% | -39.00% | 609.4% | 513.2% |  |  |
| Class TGM | -32.65% | -42.90% | -43.19% | 600.4% | 387.9% |  |  |

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 | 3 | 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.

1. **Recommendations**

The AHG recommends to:

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

It was asked what the memory consumption is compared to VTM. This was not reported, but it is estimated to be larger by a factor of approximately 2x for the current ECM software implementation.

[JVET-AG0007](https://jvet-experts.org/doc_end_user/current_document.php?id=13781) 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)]

1. **Group off tests**
   1. ***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-11. The two anchors are ECM 11.0 and VTM-11ECM11.0. The cfg files used are also attached with this report.

The testers and crosscheckers are summarized in the table below. All the tests below have been crosschecked.

|  |  |  |
| --- | --- | --- |
| 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) |

* 1. ***Group 1 off***

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

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | | | | |
|  | **Over ECM-11** | | | | | | **Over VTM-11ecm11** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 0.00% | 0.00% | 0.00% | 100.1% | 100.4% | 100% | -10.82% | -21.80% | -29.33% | 815.3% | 443.2% |
| Class A2 | 0.00% | 0.00% | 0.00% | 100.1% | 100.4% | 100% | -16.95% | -28.77% | -31.78% | 795.4% | 443.5% |
| Class B | 0.00% | 0.00% | 0.00% | 100.0% | 99.8% | 100% | -11.32% | -26.84% | -25.03% | 748.2% | 447.8% |
| Class C | 0.00% | 0.00% | 0.00% | 100.1% | 99.9% | 100% | -11.41% | -16.73% | -17.24% | 759.8% | 383.1% |
| Class E | -0.01% | -0.01% | -0.01% | 99.9% | 99.4% | 100% | -15.02% | -24.78% | -23.08% | 708.7% | 461.0% |
| **Overall** | 0.00% | 0.00% | 0.00% | 100.0% | 99.9% | 100% | -12.81% | -23.73% | -24.82% | 762.4% | 433.2% |
| Class D | -0.03% | -0.02% | -0.02% | 99.6% | 99.6% | 100% | -9.51% | -14.58% | -14.67% | 754.6% | 383.4% |
| Class F | -0.01% | -0.01% | -0.01% | 100.0% | 100.0% | 100% | -26.60% | -35.73% | -35.59% | 538.0% | 456.1% |
| Class TGM | 0.00% | 0.00% | 0.00% | 100.0% | 100.0% | 100% | -39.54% | -47.43% | -46.69% | 449.2% | 545.3% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-11** | | | | | | **Over VTM-11ecm11** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 4.03% | 3.64% | 3.74% | 90.3% | 82.3% | 100% | -19.34% | -25.32% | -34.42% | 781.0% | 715.2% |
| Class A2 | 4.63% | 4.80% | 4.92% | 88.1% | 75.6% | 100% | -22.60% | -33.25% | -37.16% | 714.2% | 841.9% |
| Class B | 3.81% | 3.76% | 3.57% | 84.8% | 76.0% | 100% | -17.76% | -33.07% | -30.74% | 589.7% | 651.0% |
| Class C | 4.22% | 4.23% | 4.44% | 81.4% | 68.7% | 99% | -18.90% | -24.02% | -23.78% | 590.5% | 552.5% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 4.13% | 4.07% | 4.11% | 85.6% | 75.1% | 100% | -19.35% | -29.15% | -30.90% | 648.4% | 668.5% |
| Class D | 3.43% | 3.79% | 3.74% | 81.1% | 67.2% | 100% | -20.41% | -25.94% | -26.00% | 630.5% | 659.2% |
| Class F | 3.18% | 3.20% | 3.14% | 90.2% | 80.9% | 100% | -26.35% | -35.42% | -35.76% | 567.8% | 429.3% |
| Class TGM | 3.78% | 3.63% | 3.61% | 91.2% | 84.6% | 100% | -34.42% | -41.23% | -41.35% | 562.6% | 441.6% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | | | | |
|  | **Over ECM-11** | | | | | | **Over VTM-11ecm11** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 4.69% | 5.49% | 5.37% | 75.7% | 66.8% | 100% | -13.88% | -38.16% | -35.35% | 507.7% | 441.8% |
| Class C | 4.93% | 4.87% | 5.00% | 71.7% | 57.0% | 100% | -15.51% | -28.42% | -28.22% | 442.1% | 406.2% |
| Class E | 4.57% | 5.49% | 5.24% | 80.7% | 76.3% | 100% | -12.47% | -26.38% | -26.80% | 474.4% | 326.1% |
| **Overall (Ref)** | 4.74% | 5.28% | 5.21% | 75.5% | 65.5% | 100% | -14.07% | -31.97% | -30.84% | 476.7% | 398.2% |
| Class D | 4.05% | 3.66% | 3.90% | 74.7% | 55.6% | 100% | -18.01% | -31.59% | -30.40% | 486.8% | 441.7% |
| Class F | 4.59% | 4.06% | 3.88% | 84.6% | 73.5% | 99% | -21.34% | -37.10% | -36.54% | 498.2% | 324.2% |
| Class TGM | 5.39% | 5.15% | 5.13% | 87.7% | 78.6% | 100% | -31.92% | -41.32% | -41.60% | 483.1% | 325.4% |

* 1. ***Group 2 off***

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

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | | | | |
|  | **Over ECM-11** | | | | | | **Over VTM-11ecm11** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 0.39% | 0.67% | 0.67% | 92.8% | 95.9% | 101% | -10.45% | -21.30% | -28.83% | 753.8% | 423.9% |
| Class A2 | 0.53% | 0.77% | 0.80% | 91.7% | 96.3% | 102% | -16.50% | -28.24% | -31.25% | 726.4% | 425.3% |
| Class B | 0.51% | 0.76% | 0.79% | 90.4% | 94.8% | 103% | -10.85% | -26.24% | -24.41% | 674.6% | 425.4% |
| Class C | 0.33% | 0.43% | 0.64% | 89.3% | 94.5% | 100% | -11.11% | -16.39% | -16.72% | 679.9% | 360.8% |
| Class E | 0.74% | 0.96% | 0.99% | 91.2% | 96.0% | 101% | -14.37% | -24.03% | -22.32% | 646.2% | 446.9% |
| **Overall** | 0.49% | 0.71% | 0.77% | 90.9% | 95.4% | 101% | -12.37% | -23.19% | -24.23% | 692.0% | 413.2% |
| Class D | 0.28% | 0.55% | 0.64% | 89.4% | 89.2% | 100% | -9.23% | -14.09% | -14.14% | 674.3% | 352.0% |
| Class F | 3.64% | 3.81% | 3.94% | 91.4% | 97.3% | 100% | -24.14% | -33.61% | -33.30% | 491.6% | 437.5% |
| Class TGM | 0.91% | 0.94% | 0.93% | 90.9% | 100.2% | 100% | -38.97% | -46.94% | -46.18% | 408.8% | 553.0% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-11** | | | | | | **Over VTM-11ecm11** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 2.64% | 1.21% | 1.83% | 91.4% | 96.6% | 100% | -20.42% | -26.82% | -35.73% | 800.1% | 870.8% |
| Class A2 | 1.79% | 1.52% | 2.37% | 89.5% | 97.8% | 100% | -24.68% | -35.29% | -38.66% | 725.4% | 1098.7% |
| Class B | 1.72% | 1.44% | 1.34% | 90.0% | 97.6% | 100% | -19.42% | -34.54% | -32.18% | 651.1% | 870.8% |
| Class C | 1.26% | 1.17% | 1.42% | 88.2% | 95.3% | 100% | -21.24% | -26.28% | -25.99% | 658.4% | 784.1% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 1.80% | 1.34% | 1.67% | 89.7% | 96.8% | 100% | -21.15% | -30.94% | -32.54% | 695.4% | 887.1% |
| Class D | 0.60% | 1.11% | 0.53% | 87.5% | 94.8% | 100% | -22.63% | -27.88% | -28.33% | 687.7% | 938.7% |
| Class F | 3.99% | 3.87% | 3.81% | 88.6% | 94.8% | 100% | -25.95% | -35.17% | -35.51% | 546.6% | 478.0% |
| Class TGM | 2.08% | 2.49% | 2.68% | 90.3% | 98.5% | 100% | -35.46% | -41.95% | -41.93% | 553.6% | 508.7% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | | | | |
|  | **Over ECM-11** | | | | | | **Over VTM-11ecm11** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 1.88% | 4.45% | 4.67% | 83.0% | 96.1% | 100% | -16.20% | -38.71% | -35.75% | 555.8% | 631.1% |
| Class C | 1.72% | 3.32% | 2.81% | 82.6% | 91.7% | 100% | -18.12% | -29.50% | -29.71% | 514.9% | 652.5% |
| Class E | 1.33% | 3.37% | 2.95% | 86.6% | 96.7% | 101% | -15.16% | -27.84% | -28.28% | 516.0% | 422.0% |
| **Overall (Ref)** | 1.69% | 3.81% | 3.62% | 83.7% | 94.8% | 100% | -16.58% | -32.92% | -31.87% | 531.8% | 577.1% |
| Class D | 0.71% | 3.64% | 2.70% | 82.0% | 92.0% | 100% | -20.63% | -31.78% | -31.15% | 545.2% | 741.7% |
| Class F | 3.18% | 4.31% | 4.36% | 86.8% | 94.0% | 99% | -22.51% | -37.12% | -36.40% | 515.6% | 418.2% |
| Class TGM | 2.15% | 4.07% | 4.71% | 89.9% | 94.3% | 100% | -34.06% | -42.39% | -42.44% | 495.2% | 391.1% |

* 1. ***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.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | | | | |
|  | **Over ECM-11** | | | | | | **Over VTM-11ecm11** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 1.03% | 2.64% | 4.45% | 79.4% | 83.7% | 99% | -9.89% | -19.88% | -26.34% | 595.0% | 238.8% |
| Class A2 | 1.89% | 4.58% | 4.57% | 79.6% | 74.0% | 98% | -15.35% | -25.74% | -28.89% | 595.4% | 223.0% |
| Class B | 1.95% | 4.11% | 4.01% | 77.9% | 76.6% | 97% | -9.60% | -24.05% | -22.19% | 629.2% | 314.1% |
| Class C | 1.75% | 2.02% | 2.31% | 78.4% | 76.2% | 100% | -9.88% | -15.12% | -15.40% | 646.3% | 298.0% |
| Class E | 3.10% | 3.99% | 3.80% | 78.3% | 77.3% | 99% | -12.38% | -21.86% | -20.23% | 605.0% | 329.8% |
| **Overall** | 1.93% | 3.46% | 3.77% | 78.6% | 77.3% | 98% | -11.13% | -21.29% | -22.16% | 617.3% | 282.4% |
| Class D | 1.30% | 1.76% | 2.09% | 80.0% | 74.5% | 100% | -8.31% | -13.08% | -12.90% | 650.7% | 294.3% |
| Class F | 4.48% | 5.64% | 5.64% | 79.5% | 71.1% | 100% | -23.42% | -32.29% | -32.13% | 447.5% | 300.6% |
| Class TGM | 8.69% | 10.55% | 10.82% | 82.8% | 60.4% | 100% | -34.38% | -42.00% | -41.04% | 397.1% | 289.6% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-11** | | | | | | **Over VTM-11ecm11** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 0.95% | 2.06% | 5.33% | 94.4% | 97.8% | 100% | -21.73% | -26.40% | -34.03% | 667.3% | 560.6% |
| Class A2 | 1.15% | 3.26% | 3.11% | 94.8% | 98.0% | 100% | -25.17% | -34.31% | -38.30% | 623.9% | 701.4% |
| Class B | 1.05% | 3.97% | 3.49% | 95.2% | 98.5% | 100% | -19.97% | -32.97% | -30.86% | 688.0% | 780.8% |
| Class C | 0.84% | 1.32% | 1.44% | 94.5% | 98.9% | 100% | -21.57% | -26.14% | -25.97% | 722.1% | 834.6% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 0.99% | 2.74% | 3.24% | 94.8% | 98.4% | 100% | -21.79% | -30.10% | -31.68% | 679.3% | 728.1% |
| Class D | 0.64% | 1.54% | 1.63% | 95.3% | 98.0% | 100% | -22.61% | -27.58% | -27.51% | 742.2% | 907.9% |
| Class F | 2.83% | 3.51% | 3.84% | 92.2% | 97.3% | 100% | -26.81% | -35.46% | -35.54% | 591.8% | 469.2% |
| Class TGM | 5.63% | 7.27% | 7.75% | 94.1% | 95.9% | 99% | -33.26% | -39.24% | -39.10% | 575.8% | 427.8% |

* 1. ***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.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | | | | |
|  | **Over ECM-11** | | | | | | **Over VTM-11ecm11** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 1.58% | 5.59% | 7.61% | 87.2% | 91.6% | 99% | -9.41% | -17.76% | -24.21% | 653.6% | 261.4% |
| Class A2 | 2.50% | 6.27% | 7.35% | 83.6% | 93.4% | 99% | -14.95% | -24.55% | -27.10% | 625.5% | 281.7% |
| Class B | 1.03% | 6.65% | 5.38% | 87.0% | 95.7% | 103% | -10.41% | -22.46% | -21.31% | 702.9% | 392.5% |
| Class C | 0.89% | 2.85% | 2.85% | 84.9% | 95.4% | 99% | -10.63% | -14.51% | -15.01% | 699.5% | 372.9% |
| Class E | 1.21% | 6.71% | 4.10% | 87.5% | 96.2% | 100% | -13.99% | -20.12% | -20.17% | 675.9% | 410.2% |
| **Overall** | 1.37% | 5.58% | 5.31% | 86.1% | 94.6% | 101% | -11.65% | -19.86% | -21.17% | 675.9% | 345.7% |
| Class D | 0.87% | 2.51% | 2.58% | 85.5% | 94.1% | 100% | -8.70% | -12.47% | -12.52% | 695.6% | 371.8% |
| Class F | 1.31% | 4.37% | 4.41% | 92.2% | 94.7% | 100% | -25.65% | -33.14% | -32.92% | 518.7% | 400.6% |
| Class TGM | 2.47% | 4.15% | 4.01% | 91.0% | 94.8% | 97% | -38.10% | -45.37% | -44.68% | 436.7% | 454.3% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-11** | | | | | | **Over VTM-11ecm11** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 1.24% | 3.03% | 4.87% | 91.0% | 98.7% | 100% | -21.51% | -25.76% | -34.19% | 643.7% | 566.1% |
| Class A2 | 0.88% | 3.47% | 3.94% | 93.0% | 99.3% | 100% | -25.36% | -34.19% | -37.88% | 612.3% | 711.1% |
| Class B | 0.52% | 5.84% | 5.05% | 93.2% | 100.3% | 100% | -20.39% | -31.96% | -30.02% | 673.9% | 795.7% |
| Class C | 0.40% | 2.02% | 1.91% | 94.2% | 100.3% | 100% | -21.91% | -25.66% | -25.67% | 719.7% | 846.1% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 0.70% | 3.79% | 3.95% | 93.0% | 99.8% | 100% | -22.01% | -29.49% | -31.27% | 666.7% | 738.8% |
| Class D | 0.44% | 2.32% | 1.87% | 95.2% | 99.6% | 100% | -22.76% | -27.06% | -27.47% | 741.2% | 922.3% |
| Class F | 0.96% | 3.32% | 3.54% | 96.0% | 100.1% | 100% | -28.08% | -35.57% | -35.78% | 616.1% | 482.7% |
| Class TGM | 0.75% | 1.57% | 1.41% | 95.0% | 99.9% | 99% | -36.38% | -42.51% | -42.70% | 581.9% | 445.6% |

* 1. ***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.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | | | | |
|  | **Over ECM-11** | | | | | | **Over VTM-11ecm11** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 3.25% | 9.51% | 13.38% | 61.6% | 73.2% | 100% | -7.90% | -14.82% | -20.27% | 461.2% | 208.8% |
| Class A2 | 5.28% | 12.23% | 12.81% | 58.4% | 66.1% | 99% | -12.59% | -20.50% | -23.48% | 437.0% | 199.4% |
| Class B | 3.78% | 11.70% | 10.44% | 58.2% | 66.8% | 96% | -7.98% | -18.93% | -17.64% | 470.2% | 274.1% |
| Class C | 3.35% | 5.88% | 6.15% | 56.1% | 62.4% | 100% | -8.48% | -12.04% | -12.32% | 461.9% | 244.0% |
| Class E | 5.76% | 11.92% | 9.27% | 59.0% | 67.3% | 101% | -10.12% | -16.20% | -16.15% | 455.4% | 287.1% |
| **Overall** | 4.18% | 10.17% | 10.18% | 58.4% | 66.8% | 99% | -9.20% | -16.52% | -17.62% | 458.7% | 244.0% |
| Class D | 2.85% | 5.02% | 5.24% | 58.0% | 58.9% | 99% | -6.90% | -10.32% | -10.23% | 471.8% | 232.8% |
| Class F | 10.77% | 15.69% | 15.92% | 64.6% | 62.2% | 100% | -19.07% | -26.56% | -26.18% | 363.5% | 263.1% |
| Class TGM | 14.79% | 18.62% | 19.29% | 66.1% | 54.8% | 98% | -30.81% | -37.90% | -36.70% | 317.1% | 262.6% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Random Access Main 10** | | | | | | | | | | |
|  | **Over ECM-11** | | | | | | **Over VTM-11ecm11** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 | 9.34% | 11.00% | 17.80% | 66.8% | 77.5% | 99% | -15.21% | -20.07% | -26.47% | 472.4% | 444.1% |
| Class A2 | 9.14% | 14.17% | 15.38% | 66.5% | 73.8% | 99% | -19.24% | -27.49% | -31.05% | 437.4% | 528.0% |
| Class B | 7.44% | 15.67% | 14.57% | 64.7% | 72.8% | 99% | -14.86% | -25.58% | -23.56% | 467.4% | 577.6% |
| Class C | 6.93% | 9.39% | 9.95% | 61.6% | 64.8% | 99% | -16.78% | -20.20% | -19.64% | 470.4% | 546.7% |
| Class E |  |  |  |  |  |  |  |  |  |  |  |
| **Overall (Ref)** | 8.03% | 12.76% | 14.15% | 64.6% | 71.7% | 99% | -16.32% | -23.42% | -24.59% | 463.0% | 530.5% |
| Class D | 5.31% | 8.58% | 8.97% | 62.8% | 62.8% | 99% | -18.94% | -22.47% | -22.18% | 489.3% | 582.1% |
| Class F | 11.83% | 15.16% | 15.85% | 69.4% | 75.5% | 100% | -20.53% | -28.50% | -28.42% | 445.1% | 363.7% |
| Class TGM | 13.71% | 16.90% | 17.18% | 71.3% | 76.2% | 99% | -28.14% | -33.82% | -33.81% | 436.8% | 339.7% |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | | | | |
|  | **Over ECM-11** | | | | | | **Over VTM-11ecm11** | | | | |
|  | Y | U | V | EncT | DecT | mPeakR | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |  |  |  |
| Class B | 7.15% | 12.96% | 13.09% | 55.3% | 61.3% | 100% | -11.84% | -34.09% | -31.04% | 365.2% | 464.3% |
| Class C | 7.01% | 9.85% | 10.53% | 53.5% | 54.2% | 100% | -13.83% | -25.03% | -24.35% | 354.4% | 387.6% |
| Class E | 6.78% | 14.35% | 13.74% | 65.1% | 75.2% | 99% | -10.60% | -20.37% | -20.92% | 406.2% | 355.4% |
| **Overall (Ref)** | 7.01% | 12.27% | 12.40% | 57.0% | 61.9% | 99% | -12.20% | -27.64% | -26.28% | 371.3% | 408.9% |
| Class D | 5.19% | 10.00% | 10.65% | 55.6% | 52.2% | 99% | -17.06% | -27.72% | -25.80% | 391.4% | 422.6% |
| Class F | 10.57% | 14.24% | 15.19% | 66.2% | 68.0% | 99% | -17.00% | -31.21% | -29.99% | 382.9% | 308.2% |
| Class TGM | 13.52% | 17.29% | 18.26% | 71.5% | 64.4% | 100% | -26.65% | -34.93% | -34.90% | 394.7% | 286.0% |

* 1. ***Summary***

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

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

* Software issues #56 with tool off tests was resolved
  1. ***Open issues***
* #58, [ECM-11.0 decoding mismatch when DualITree is off](https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/issues/58)
* #53, decoding mismatch was observed when AMVR is off
* The variation of runtime over VTM11ECM9 is relatively large, for which the version of compiler matters

1. ***Input* contributions**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| [JVET-AG0173](https://jvet-experts.org/doc_end_user/current_document.php?id=13729) | m66069 | 2024-01-10 20:21:16 | 2024-01-10 20:48:21 | 2024-01-10 20:48:21 | AHG7: ECM-11 results of non-CTC sequences | [X. Li (Google)](mailto:xlxiangli@google.com) |

1. ***Recommendations***

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

It was commented by one expert that he believes to have resolved the issue with the SW mismatch and will submit a merge request.

It was suggested to perform another round of subjective testing of ECM in the near future. If some of the group-off tests would be included, a careful selection would be necessary due to limited resources in on-site expert viewing. Discuss in joint meeting with AG 5

[JVET-AG0008](https://jvet-experts.org/doc_end_user/current_document.php?id=13782) 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)]

1. ***Activities***

The AHG used the main JVET reflector, jvet@lists.rwth-aachen.de, for email discussion. The AHG kick-off email was sent on November 10, 2023, followed by announcements of CTC updates and document uploads. There were offline discussions and email exchanges about project timelines among co-chairs and editors, as well as editings to improve the quality of the technical report. The outcome was summarized in JVET-AG0090. There are total 10 input contriubtions related to AHG 8 mandates submitted to this meeting. They are listed in Section 3.

* 1. ***Common Test Conditions***

Common test conditions (CTC) for optimization of encoders and receiving systems for machine analysis of coded video content, were updated and summarized in output document 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.

Following the discussions in the last meeting, the updated CTC includes two anchors, generated by the most recent versions of VTM software, VTM21 and VTM22, respectively. Hence two reporting templates in Excel format are enclosed in the document package for reporting VTM21 and VTM22 based results accordingly. This output document package JVET-AF2031 was uploaded on 2023-11-10 to JVET document management system and is also available at <https://vcgit.hhi.fraunhofer.de/jvet-ahg-ofm>/ofm-ctc.

* 1. ***Technical Report***

Based on the latest draft (draft 3) of the technical report (TR) JVET-AE2030, further improvements with comments have been added, and submitted as an attachment of input contribution JVET-AG0090. Besides editorial refinements, the scope in Section 1 was clarified, indicating that the described algorithms were tested on a constrained set of machine vision tasks and thus might not be applicable to all machine vision tasks.

The timeline of this TR was discussed among co-chairs and editors. The following suggested timeline was submitted to this JVET meeting for review with JVET-AG0090:

* Request for subdivision: January 2024
* Committee draft (CD): April 2024
* CD ballot: May – June 2024
* Draft TR: November 2024
* DTR ballot: December 2024 – March 2025
* Finalization: April 2025

Regarding the request for subdivision, it is proposed to request a new part in ISO/IEC 23888 (Artificial Intelligence for Multimedia) with a timeline of 24 months.

Note that there is an input contribution JVET-AG0213 suggesting to align the timelines of this TR and VSEI v4. This is planned to be discussed during this meeting.

* 1. ***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. Three 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

1. **Input *contributions***

There are 10 input contriubtions related to AHG 8 mandates. They are listed below.

|  |  |  |
| --- | --- | --- |
| **Report** | | |
| JVET-AG0008 | 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) |
| **Proposal** | | |
| [JVET-AG0085](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=13641) | [AHG8] Continuation of study on different VTM versions | [C. Hollmann (Ericsson)](mailto:christopher.hollmann@ericsson.com) |
| [JVET-AG0090](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=13646) | [AHG8] Comments and editorial changes to the draft TR on optimizations for encoders and receiving systems for machine analysis of coded video content | [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-AG0178](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=13734) | AHG8: Truncating bit depth in video coding for machine tasks | [D. Ding](mailto:ddding@global.tencent.com), [X. Zhao](mailto:xinzzhao@global.tencent.com), [S. Liu (Tencent)](mailto:shanl@global.tencent.com) |
| [JVET-AG0209](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=13765) | AHG8: A suggestion for the performance evaluation of VCM | [S. Wang](mailto:shurun.wsr@alibaba-inc.com), [J. Chen](mailto:jiechen.cj@alibaba-inc.com), [Y. Ye (Alibaba)](mailto:yan.ye@alibaba-inc.com), [S. Wang (CityU)](mailto:shiqwang@cityu.edu.hk) |
| [JVET-AG0212](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=13768) | AHG8: A post-processing algorithm for machine consumption | [B. Li](mailto:libinzhe.lbz@alibaba-inc.com), [S. Wang](mailto:shurun.wsr@alibaba-inc.com), [J. Chen](mailto:jiechen.cj@alibaba-inc.com), [Y. Ye(Alibaba)](mailto:yan.ye@alibaba-inc.com), [S. Wang(Cityu)](mailto:shiqwang@cityu.edu.hk) |
| [JVET-AG0213](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=13769) | AHG1/AHG2/AHG8: On project management related to the encoder optimization information SEI message | [M. M. Hannuksela](mailto:miska.hannuksela@nokia.com), A. Aminlou, F. Cricri, H. Zhang (Nokia) |
| [JVET-AG0216](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=13772) | 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-AG0217](file:///C:\\Users\\ehollch\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\U0B9JGQQ\\current_document.php%3fid=13773) | AHG8: Reduced residual encoding in VVC for machine consumption | [A. Alireza (Nokia)](mailto:alireza.aminlou@nokia.com), A. Hallapuro, H. Zhang, |
| **Crosscheck** | | |
| JVET-AG0242 | Cross-check of JVET-AG0178 (AHG8: Truncating bit depth in video coding for machine tasks) | C. Hollmann (Ericsson) |

1. ***Recommendations***

The AHG recommends to:

* Review all input contributions.
* 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.
* Discuss TR development and finalization timeline, possibly together with other related groups.

It was pointed out that a TR could have a shorter development cycle than assumed in the report above. Further, a request for subdivision should not be done too early to avoid possible cancellation. To be further discussed in context of JVET-AG0213.

[JVET-AG0009](https://jvet-experts.org/doc_end_user/current_document.php?id=13783) 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)]

1. **Related contributions**

A total of 43 contributions are identified relating to the mandates of AHG9. Some contributions also relate to the work of AHG1, AHG2, AHG8 and AHG16.

The number of contributions relating to each AHG9 mandate is as follows (some contributions relate to more than one mandate):

* 4 contributions relate to the mandate to study the SEI messages in VSEI, VVC, HEVC, and AVC.
  + 3 contributions relate to neural network post filter characteristics SEI messages
  + 1 contribution relates to phase indication SEI message
* 24 contributions relate to the mandate to discuss the document for the TuC for future extensions of VSEI ([JVET-2032](https://jvet-experts.org/doc_end_user/current_document.php?id=13592)).
  + 9 contributions relate to aspects of SEI processing order and processing order nesting SEI messages (These relate to [JVET-AF2027](https://jvet-experts.org/doc_end_user/current_document.php?id=13590))
  + 4 contributions relate to the source picture timing information SEI message
  + 3 contributions relate to encoder optimization information SEI message
  + 2 contributions relate to picture modality information
  + 2 contributions relate to image format metadata SEI messages
  + 1 contribution relates to the object mask information SEI message
  + 1 contribution relates to the multiplane image information SEI message
  + 3 contributions relate to progression towards a working draft of VSEI version 4
* 1 contribution relates to the mandate to collect software and showcase information for SEI messages;
* 19 contributions relate to the mandate to 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.
  + 4 contribution relates to the film grain adaptive SEI message
  + 3 contributions relate to SEI messages related to generative face video
  + 2 contributions relate to image format metadata SEI messages
  + 1 contribution relates to the phase indication SEI message
  + 9 contributions relate to other SEI messages
* 0 contributions relate to the mandate to study the alignments of the same SEI messages in different standards.
* 1 contribution relate to AHG9's mandate as it allows signalling of required decoder processing of SEI messages, among other NAL units. However, it is not an SEI message proposal.

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

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

[JVET-AG0088](https://jvet-experts.org/doc_end_user/current_document.php?id=13644) AHG9: Usage of the neural-network post-filter characteristics SEI message to define the generator NN of the generative face video SEI message [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

JVET-AG0088 also relates to the mandate to identify potential needs for additional SEI messages

[JVET-AG0089](https://jvet-experts.org/doc_end_user/current_document.php?id=13645) AHG9: Temporal extrapolation purpose for the neural-network post-filter characteristics SEI message [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

[JVET-AG0192](https://jvet-experts.org/doc_end_user/current_document.php?id=13748) AHG9: Miscellaneous NNPF items related to VUI [J. Xu, Y.-K. Wang (Bytedance)]

* + 1. **Phase *indication* SEI message**

[JVET-AG0107](https://jvet-experts.org/doc_end_user/current_document.php?id=13663) AHG9: On phase indication SEI message [T. Chujoh, T. Ikai (Sharp), K. Kawamura (KDDI)]

JVET-AG0107 also relates to the mandate to identify potential needs for additional SEI messages.

* 1. ***Discuss the document for the TuC for future extensions of VSEI***
     1. **SEI *processing* order and processing order nesting SEI messages**

[JVET-AG0052](https://jvet-experts.org/doc_end_user/current_document.php?id=13608) AHG9: On using SEI processing order for NNPF grouping [Hendry, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-AG0053](https://jvet-experts.org/doc_end_user/current_document.php?id=13609) AHG9: On activation and cancelling persistence of SEI message included in a processing order nesting SEI message [Hendry, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-AG0054](https://jvet-experts.org/doc_end_user/current_document.php?id=13610) AHG9: On the case an SEI message included in multiple sei processing order SEI messages [Hendry, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-AG0105](https://jvet-experts.org/doc_end_user/current_document.php?id=13661) AHG9: On the SEI processing order SEI message [Y. Gao, Y.-X. Bai, S.-W. Xie, M.-H. Jia, C. Huang, P. Wu (ZTE)]

[JVET-AG0165](https://jvet-experts.org/doc_end_user/current_document.php?id=13721) AHG9: On the processing order nesting SEI message [L. Chen, O. Chubach, Y. Huang, S. Lei (MediaTek)]

[JVET-AG0166](https://jvet-experts.org/doc_end_user/current_document.php?id=13722) AHG9: On grouping the SEI prefix data as a new SEI message [L. Chen, O. Chubach, Y. Huang, S. Lei (MediaTek)]

[JVET-AG0168](https://jvet-experts.org/doc_end_user/current_document.php?id=13724) AHG9: Proposed update for the SEI processing order SEI message [L. Chen, O. Chubach, Y. Huang, S. Lei (MediaTek)]

[JVET-AG0169](https://jvet-experts.org/doc_end_user/current_document.php?id=13725) AHG9: Comments on use of NNPF SEI messages in the SEI processing order SEI message [L. Chen, O. Chubach, Y. Huang, S. Lei (MediaTek)]

[JVET-AG0180](https://jvet-experts.org/doc_end_user/current_document.php?id=13736) AHG9: On the SEI processing order SEI message [Y. Sanchez, R. Skupin, C. Hellge, T. Schierl (HHI)]

* + 1. **Source *picture* timing information SEI message**

[JVET-AG0070](https://jvet-experts.org/doc_end_user/current_document.php?id=13626) AHG9: Comments on Source Picture Timing Information Message [S. Deshpande, J. Samuelsson-Allendes (Sharp)]

[JVET-AG0082](https://jvet-experts.org/doc_end_user/current_document.php?id=13638) AHG9: On Source Picture Timing SEI message [j. Samuelsson-Allendes, S. Deshpande (Sharp)]

[JVET-AG0188](https://jvet-experts.org/doc_end_user/current_document.php?id=13744) AHG9: On source picture timing information SEI message specification text [J.R. Arumugam, L. Jawale (Ittiam), P. Yin, G.J. Sullivan, S. McCarthy (Dolby)]

[JVET-AG0191](https://jvet-experts.org/doc_end_user/current_document.php?id=13747) AHG9: Reference software for source picture timing information SEI message [J.R. Arumugam, L. Jawale (Ittiam), P. Yin, S. McCarthy (Dolby)]

JVET-AG0191 also relates to the mandate to collect software and showcase information.

* + 1. **Encoder *optimization* information SEI message**

[JVET-AG0081](https://jvet-experts.org/doc_end_user/current_document.php?id=13637) AHG9: On signalling privacy protection information in SEI message [C. Kim, Hendry, J. Lim, S. Kim (LGE)]

JVET-AG0081 also relates to the mandate to identify potential needs for additional SEI messages

[JVET-AG0083](https://jvet-experts.org/doc_end_user/current_document.php?id=13639) AHG9: On feature-based optimization type [C. Kim, Hendry, J. Lim, S. Kim (LGE)]

[JVET-AG0086](https://jvet-experts.org/doc_end_user/current_document.php?id=13642) AHG9: On the encoder optimization information SEI message [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

* + 1. **Picture modality information**

[JVET-AG0077](https://jvet-experts.org/doc_end_user/current_document.php?id=13633) AHG9: On Picture Modality Information [J. Gao, H.-B. Teo, C.-S. Lim, K. Abe, V. Drugeon (Panasonic)]

[JVET-AG0079](https://jvet-experts.org/doc_end_user/current_document.php?id=13635) AHG2/AHG9: VUI extension mechanism and picture modality information for AVC and HEVC [J. Gao, H.-B. Teo, C.-S. Lim, K. Abe, V. Drugeon (Panasonic)]

* + 1. **Image format metadata SEI messages**

[JVET-AG0182](https://jvet-experts.org/doc_end_user/current_document.php?id=13738) AHG9: JPEG segments SEI message [P. de Lagrange, D. Doyen, E. François, F. Urban, C. Salmon-Legagneur (InterDigital)]

JVET-AF0182 also relates to the mandate to identify potential needs for additional SEI messages.

[JVET-AG0183](https://jvet-experts.org/doc_end_user/current_document.php?id=13739) AHG9: TIFF data SEI message [P. de Lagrange, D. Doyen, E. François, F. Urban, C. Salmon-Legagneur (InterDigital)]

JVET-AG0183 also relates to the mandate to identify potential needs for additional SEI messages.

* + 1. **Object mask *information* SEI message**

[JVET-AG0148](https://jvet-experts.org/doc_end_user/current_document.php?id=13704) AHG9: On object mask information SEI message [J. Chen, Y. Ye, S. Wang (Alibaba)]

JVET-AG0148 also relates to 2.2.8 Progression towards a working draft of VSEI version 4.

* + 1. **Multiplane *image* information SEI message**

[JVET-AG0232](https://jvet-experts.org/doc_end_user/current_document.php?id=13805) AHG9: Support of non-parallel MPI layers in the MPII SEI message [Y. Li (SJTU), Y.-K. Wang (Bytedance), Y. Xu, K. Yang (SJTU)]

* + 1. ***Progression* towards a working draft of VSEI version 4**

[JVET-AG0148](https://jvet-experts.org/doc_end_user/current_document.php?id=13704) AHG9: On object mask information SEI message [J. Chen, Y. Ye, S. Wang (Alibaba)]

JVET-AG0148 also relates to 2.2.6 Object mask information.

[JVET-AG0204](https://jvet-experts.org/doc_end_user/current_document.php?id=13760) AHG9: On VSEI version 4 [Hendry (LGE), S. McCarthy (Dolby), J. Chen, Y. Ye (Alibaba)]

[JVET-AG0213](https://jvet-experts.org/doc_end_user/current_document.php?id=13769) AHG1/AHG2/AHG8: On project management related to the encoder optimization information SEI message [M. M. Hannuksela, A. Aminlou, F. Cricri, H. Zhang (Nokia)]

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

[JVET-AG0191](https://jvet-experts.org/doc_end_user/current_document.php?id=13747) AHG9: Reference software for source picture timing information SEI message [J.R. Arumugam, L. Jawale (Ittiam), P. Yin, S. McCarthy (Dolby)]

JVET-AG0191 also relates to the mandate to discuss the document for the TuC for future extensions of VSEI.

* 1. ***Identify potential needs for additional SEI messages, including study of AVC and HEVC SEI messages for use in VVC***
     1. **Film *grain* related SEI message**

[JVET-AG0101](https://jvet-experts.org/doc_end_user/current_document.php?id=13657) AHG9: Film grain adaptive SEI message [Y. Gao, S.-W. Xie, Y.-X. Bai, M.-H. Jia, C. Huang, P. Wu (ZTE)]

[JVET-AG0140](https://jvet-experts.org/doc_end_user/current_document.php?id=13696) AHG9/AHG13: FGS Extension SEI message for spatial adaptation [G.Teniou, S. Wenger, A. Hinds]

[JVET-AG0160](https://jvet-experts.org/doc_end_user/current_document.php?id=13716) AHG9/AHG13: FGS Extension SEI message useful descriptors [G. Teniou, S. Wenger, A. Hinds]

[JVET-AG0215](https://jvet-experts.org/doc_end_user/current_document.php?id=13771) AHG9/AHG13: Region-dependent film grain characteristics [P. de Lagrange, E. François, M. Le Pendu, C. Salmon-Legagneur (InterDigital)]

* + 1. ***Generative* face video SEI message**

[JVET-AG0087](https://jvet-experts.org/doc_end_user/current_document.php?id=13643) AHG9: On the generative face video SEI message [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

[JVET-AG0088](https://jvet-experts.org/doc_end_user/current_document.php?id=13644) AHG9: Usage of the neural-network post-filter characteristics SEI message to define the generator NN of the generative face video SEI message [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

JVET-AG0088 also relates to the mandate to discuss the document for the TuC for future extensions of VSEI.

[JVET-AG0203](https://jvet-experts.org/doc_end_user/current_document.php?id=13759) AHG9/AHG16: Common text for proposed generative face video SEI message [J. Chen, B. Chen, Y. Ye (Alibaba), S. Yin, S. Wang (CityU), S. McCarthy, P. Yin, G.-M. Su, A. K. Choudhury, W. Husak, G. J. Sullivan (Dolby)]

* + 1. **Image *format* metadata SEI messages**

[JVET-AG0182](https://jvet-experts.org/doc_end_user/current_document.php?id=13738) AHG9: JPEG segments SEI message [P. de Lagrange, D. Doyen, E. François, F. Urban, C. Salmon-Legagneur (InterDigital)]

JVET-AG0182 also relates to the mandate to discuss the document for the TuC for future extensions of VSEI.

[JVET-AG0183](https://jvet-experts.org/doc_end_user/current_document.php?id=13739) AHG9: TIFF data SEI message [P. de Lagrange, D. Doyen, E. François, F. Urban, C. Salmon-Legagneur (InterDigital)]

JVET-AG0183 also relates to the mandate to discuss the document for the TuC for future extensions of VSEI.

* + 1. **Phase *indication* SEI message**

[JVET-AG0107](https://jvet-experts.org/doc_end_user/current_document.php?id=13663) AHG9: On phase indication SEI message [T. Chujoh, T. Ikai (Sharp), K. Kawamura (KDDI)]

JVET-AG0107 also relates to the mandate to study the SEI messages in VSEI, VVC, HEVC and AVC.

* + 1. **Other SEI messages and aspects**

[JVET-AG0044](https://jvet-experts.org/doc_end_user/current_document.php?id=13598) AHG9: Copyright SEI message [S. Wenger, A. Hinds, G. Teniou]

[JVET-AG0045](https://jvet-experts.org/doc_end_user/current_document.php?id=13599) AHG9: AI marking SEI [S. Wenger, A. Hinds, G. Teniou]

[JVET-AG0046](https://jvet-experts.org/doc_end_user/current_document.php?id=13600) Application-required NAL Units [G. Teniou. S. Wenger]

[JVET-AG0049](https://jvet-experts.org/doc_end_user/current_document.php?id=13603) AHG9: SEI message extension of VVC for computer-generated hologram use [H. Kojima, K. Nonaka, R. Koiso, K. Kawamura, H. Kato (KDDI)]

[JVET-AG0051](https://jvet-experts.org/doc_end_user/current_document.php?id=13607) AHG9: On design for new SEI RBSP and SEI message [Hendry, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-AG0081](https://jvet-experts.org/doc_end_user/current_document.php?id=13637) AHG9: On signalling privacy protection information in SEI message [C. Kim, Hendry, J. Lim, S. Kim (LGE)]

JVET-AG0081 also relates to the mandate to discuss the document for the TuC for future extensions of VSEI.

[JVET-AG0144](https://jvet-experts.org/doc_end_user/current_document.php?id=13700) AHG9: Carriage of depth and alpha maps as HEVC single-layer bitstreams [E. Thomas, E. Potetsianakis, E. Alexiou, R. Ghaznavi-Youvalari, M. Abdoli, M-L. Champel (Xiaomi)]

[JVET-AG0167](https://jvet-experts.org/doc_end_user/current_document.php?id=13723) AHG9: Text prompt for generative AI SEI [A. Hinds, G. Teniou, S. Wenger]

[JVET-AG0184](https://jvet-experts.org/doc_end_user/current_document.php?id=13740) AHG9: Text comment SEI message [P. de Lagrange, D. Doyen, E. François, F. Urban, C. Salmon-Legagneur (InterDigital)]

* 1. ***Study the alignments of the same SEI messages in different standards***

No contributions

* 1. ***Non-SEI proposals closely related to SEI messages***

[JVET-AG0046](https://jvet-experts.org/doc_end_user/current_document.php?id=13600) Application-required NAL Units [G. Teniou, S. Wenger]

1. ***Activities***

The regular JVET e-mail reflector was used for discussions ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de)) with [AHG9] in message headers. There were no emails sent to the JVET reflector during the AHG period with [AHG9] in the message header. However, there was one email to the JVET reflector relating to the proposed copyright and AI marking SEI messages.

1. ***Recommendations***

The AHG recommends to:

* Review all related contributions; and
* Continue SEI messages studies.
* Update AHG9 mandates to include SEI-related document drafts (e.g., [JVET-AF2027](https://jvet-experts.org/doc_end_user/current_document.php?id=13590)) in addition to the TuC for future extensions of VSEI (e.g., [JVET-AF2032](https://jvet-experts.org/doc_end_user/current_document.php?id=13592))

It was asked what the status of the software related to the MPI message was. It was reported that a merge request was issued, but a merge had not yet been made. However, some problem of using the MIV content for testing this SEI message still needs to be resolved. Proponents were asked to provide downsampled content. A link to an external renderer was also provided, but not included in the software itself.

Experts were asked to raise any issues they detect on experimenting with the MPI software during the meeting.

[JVET-AG0010](https://jvet-experts.org/doc_end_user/current_document.php?id=13784) JVET AHG report: Encoding algorithm optimization (AHG10) [P. de Lagrange, A. Duenas, R. Sjöberg, A. Tourapis (AHG chairs)]

1. ***Related* contributions**

Three contributions in total, not including cross-checks, are identified relating to AHG10, and summarized in the following sections.

* 1. **Adaptive *resolution***
     1. **JVET-AG0116 – AHG12: GOP-based RPR encoder control for ECM**

This contribution is a follow-up of JVET-AF0058 that was porting the adaptive resolution algorithm available in the VTM (using the “GOPBasedRPR” configuration parameter) to ECM. Half the gain compared to the VTM case was reported, however such gain still considered as significant (around 1.5%; more than 3% in class A). Benefit was mostly reported for high resolution content and high QPs. The proponents were asked to provide full CTC results: it turns out that the objective performance results are almost neutral for the CTC (gains are still observed in class A), but the proponent reports some visual benefit.

* 1. ***Local QP* optimization**
     1. **JVET-AG0055 - CTU-Level Lagrange Multiplier and QP Adaptation for VVC Low-Delay Configuration**

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

During the 32nd JVET meeting, several experts commented that the contribution was interesting, and further optimization could be applied to reduce loss, optimize the interaction with BIM (Block Importance Mapping, a single-pass MCTF-dependent QP adaptation in the same spirit, already available in the VTM and the HM), etc. It was suggested for the proponents to also examine the impact on subjective quality.

In this follow-up version, scene cut detection has been introduced to mitigate the effect on the computation of the “distortion propagation factor”. BD-rate difference of -4% is reported in low-delay configurations, with a moderate increase of encoding time (around 2 to 3%).

A comparison with BIM is given, notably stating that BIM is active only on 1 picture out of 8 (the rate at which MCTF is active), while the method in this contribution impacts every picture, and has finer control over the Lagrange multiplier. As a reminder, the gains of BIM are around 2.3% in the low-delay and 2% in the random-access test conditions.

* 1. ***Residual* spatial *weighting***
     1. **JVET-AG0217 – Reduced residual encoding in VVC for machine consumption**

This contribution reports about a residual spatial weighting method (attenuating the residuals by 75% in the center of a coding block -when larger than 4 in either dimension- but preserving DC), which is said to provide gains for machine related tasks (a few % BD-rate (mAP); incomplete results). BD-rate (PSNR) loss is around 0.45%.

1. **Recommendation**

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

[JVET-AG0011](https://jvet-experts.org/doc_end_user/current_document.php?id=13785) 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)]

1. **Activities**

The AHG used the main JVET reflector, jvet@lists.rwth-aachen.de, for email. Two emails were exchanged on the reflector related to the AHG mandates.

* 1. **Common *Test Conditions***
     1. **Document**

The AHG released revised common test conditions as decided at the 32rd meeting, including the following changes:

* Clarification on averaging test results over different classes.
* Other editorial improvements.

Document was uploaded on 04.11.2023.

* + 1. **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.

* 1. ***EE* Coordination**

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

|  |  |  |
| --- | --- | --- |
| JVET-AG0023 | 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) |

* 1. **Teleconferences**

The AHG conducted a joint teleconference with AHG14 and EE1 during the interim period. The teleconference was held on November 16, 2023. In this teleconference following topics have been discussed

* EE1-0, HOP retraining and luma/chroma balance changes.
* Lower complexity NN intra training cross check results.
* integration of some bug fix in NNVC-7.1.
* clarification of algorithm description for Unified Filter usage in JVET-AF2019

Re-trained with better Luma-Chroma compression performance balance HOP filter (EE1-1.0) was added to NNVC-7.1 SW as HOP2 and became comparison point for all tests in EE1 targeting improvement of HOP filter.

Lower complexity variant of NN Intra cross-check results have been reported to be successful, tool has been added to NNVC-7.1 SW, disabled by default.

* 1. **Performance *Evaluation***

The performance of the NNVC-7.1 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-7.1.

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 ×3-4 Encoder and around ×2000 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 ×90 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

* Base HOP had performance improvement using retraining and configuration changes.
* complexity reduction (visible in both kMAC/pxl and run time) with even minor performance improvement is possible both for HOP and LOP filters,
* NN-Inter complexity (both kMAC/pxl and run time) significantly improved, training cross-check has been completed,
* Content adaptivity for LOP filter (overfitting) reported significant speed up,
* Two operation points for NN-based super resolution (20 kMAC/pxl and 469 kMAC/pxl) have been demonstrated,
* New training data base was identified and used for EE1-3.1 test.

1. **Input contributions**

There are 25 input contributions related to the AHG mandates. The list of input contributions is provided below.

* 1. ***EE and Related Input Contributions***

|  |  |  |
| --- | --- | --- |
| **Reporting** | | |
| [JVET-AG0023](file:///\\\\Users\\shanl\\Documents\\contribution\\jvet31ae\\current_document.php%3fid=13091) | 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) |
| **EE Technology** | | |
| [JVET-AG0056](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13612) | EE1-1.4: Joint design of rotation and flipping on NNLF | [Z. Xie](mailto:xiezhihuang@oppo.com), [Y. Yu](mailto:yue.yu@oppo.com), [H. Yu](mailto:v-yuhaoping@oppo.com), [D. Wang(OPPO)](mailto:wangdong7@oppo.com), [R. Chang](mailto:renjiechang@tencent.com), [L. Wang](mailto:liqiangwang@tencent.com), [X. Xu](mailto:xiaozhongxu@tencent.com), [S. Liu(Tencent)](mailto:shanl@tencent.com) |
| [JVET-AG0111](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13667) | EE1-2.2 : Content-adaptive LOP filter | [R. Yang](mailto:ruiying.yang@nokia.com), [M. Santamaria](mailto:maria.santamaria_gomez@nokia.com), [F. Cricri](mailto:francesco.cricri@nokia.com), [M. M. Hannuksela](mailto:miska.hannuksela@nokia.com), [H. Zhang](mailto:honglei.1.zhang@nokia.com), [J. Lainema](mailto:jani.lainema@nokia.com), [A. Hallapuro](mailto:antti.hallapuro@nokia.com), [D. Bugdayci Sansli (Nokia)](mailto:done.bugdayci_sansli) |
| [JVET-AG0122](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13678) | EE1-3.1: Deep Reference Frame Generation for Inter Prediction Enhancement | [X. Chen](mailto:cinched@whu.edu.cn), [W. Bao](mailto:baoweijie@whu.edu.cn), [J. Jia](mailto:jiajh2021@whu.edu.cn), [Z. Chen (Wuhan Univ.)](mailto:zzchen@whu.edu.cn), [Z. Liu](mailto:zizhengliu@tencent.com), [X. Xu](mailto:xiaozhongxu@tencent.com), [S. Liu (Tencent)](mailto:shanl@tencent.com) |
| [JVET-AG0130](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13686) | EE1-4.1: Unified CNN-based super resolution for resampling-based video coding | [C. Lin](mailto:linchaoyi.cy@bytedance.com), [Y. Li](mailto:yue.li@bytedance.com), [J. Li](mailto:lijunru@bytedance.com), [K. Zhang](mailto:zhangkai.video@bytedance.com), [L. Zhang (Bytedance)](mailto:lizhang.idm@bytedance.com) |
| [JVET-AG0162](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13718) | EE1-1.5: Report on implementation of HOP In-loop filter with Transformer blocks | [Y. Li](mailto:yli30@qti.qualcomm.com), [D. Rusanovskyy](mailto:dmytror@qti.qualcomm.com), [M. Karczewicz (Qualcomm)](mailto:martak@qti.qualcomm.com) |
| [JVET-AG0163](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13719) | EE1-2.3: Further complexity reduction on the joint LOP.2 | [T. Shao](mailto:tong.shao@dolby.com), [P. Yin](mailto:pyin@dolby.com), S. McCarthy (Dolby), [J. N. Shingala](mailto:jay.shingala@ittiam.com), [A. Shyam](mailto:ajayshyam@ittiam.com), A. Suneja, S. P. Badya (Ittiam) |
| [JVET-AG0174](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13730) | EE1-1.1: Report on training with HOP architecture change for EE1-0 (variant 1) | [Y. Li](mailto:yue.li@bytedance.com), C. Lin, J. Li, K. Zhang, L. Zhang (Bytedance), [D. Rusanovskyy](mailto:dmytror@qti.qualcomm.com), Y. Li, M. Karczewicz (Qualcomm), [R. Chang](mailto:renjiechang@tencent.com), L. Wang, X. Xu, S. Liu (Tencent) |
| [JVET-AG0175](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13731) | EE1-1.3: Separate models for HOP filter | [Y. Li](mailto:yue.li@bytedance.com), C. Lin, J. Li, K. Zhang, L. Zhang (Bytedance), [F. Galpin (InterDigital)](mailto:Franck.galpin@interdigital.com), [D. Rusanovskyy (Qualcomm)](mailto:dmytror@qti.qualcomm.com), [R. Chang (Tencent)](mailto:renjiechang@tencent.com) |
| **EE Technology related** | | |
| [JVET-AG0155](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13711) | EE1-Related: On Low Complexity Operational Point for In-Loop Filtering | D. Rusanovskyy, Y. Li, M. Karczewicz (Qualcomm) |
| [JVET-AG0156](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13712) | EE1-Related: On LOP2 training process | D. Rusanovskyy, Y. Li, M. Karczewicz (Qualcomm) |
| [JVET-AG0179](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13735) | EE1-1.1-related: HOP filter complexity alignment with wider activation | [Y. Li](mailto:yue.li@bytedance.com), C. Lin, J. Li, K. Zhang, L. Zhang (Bytedance) |
| **Cross Checks** | | |
| [JVET-AG0161](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13717) | Cross-check of EE1-2.3 | D. Rusanovskyy (Qualcomm) |
| [JVET-AG0226](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13799) | Crosscheck of JVET-AG0130 (EE1-4.1: Unified CNN-based super resolution for resampling-based video coding) | [Jiedong Ye](mailto:ye_jd@hust.edu.cn), Xu Li, Yiqing Zhu, Qiong Liu (HUST) |
| [JVET-AG0235](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13808) | Crosscheck of JVET-AG0122 (EE1-3.1: Deep Reference Frame Generation for Inter Prediction Enhancement) | [Z. Xie (OPPO)](mailto:xiezhihuang@oppo.com) |
| [JVET-AG0241](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13814) | Crosscheck of JVET-AG0162 (EE1-1.5: Report on implementation of HOP In-loop filter with Transformer blocks) | [D. Liu (Ericsson)](mailto:du.liu@ericsson.com) |
| [JVET-AG0294](https://jvet-experts.org/doc_end_user/current_document.php?id=13867) | Crosscheck of JVET-AG0056 (EE1-1.4) | Junru Li |

* 1. ***Non-EE Input Contributions***

|  |  |  |
| --- | --- | --- |
| **Reporting** | | |
| [JVET-AG0011](file:///C:\\Users\\e00443164\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\8LUVY5N7\\current_document.php%3fid=13382) | 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) |
| [JVET-AG0041](file:///C:\\Users\\e00443164\\Downloads\\current_document.php%3fid=13594) | AhG11/AhG14 teleconference | [E. Alshina](mailto:elena.alshina@huawei.com), [F. Galpin](mailto:franck.galpin@interdigital.com), [D. Rusanovskyy](mailto:dmytror@qti.qualcomm.com) |
| Proposal | | |
| [JVET-AG0050](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13604) | AHG11: A Transformer-based Intra Luma Enhancement for H.266/VVC | [Hui Yuan](mailto:huiyuan@sdu.edu.cn), Wenrui Lv, [Ming Li](mailto:myron.li@oppo.com), [Dan](mailto:Zou) |
| [JVET-AG0057](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13613) | [AHG11] Study on lower-complexity NNLF | [Z. Xie](mailto:xiezhihuang@oppo.com), [Y. Yu](mailto:yue.yu@oppo.com), [H. Yu](mailto:v-yuhaoping@oppo.com), [D. Wang(OPPO)](mailto:wangdong7@oppo.com) |
| [JVET-AG0069](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13625) | AhG11: LOP with inputs transformed | [D. Liu](mailto:du.liu@ericsson.com), [J. StrÃ¶m](mailto:jacob.strom@ericsson.com), [M. Damghanian](mailto:mitra.damghanian@ericsson.com), [P. Wennersten (Ericsson)](mailto:per.wennersten@ericsson.com) |
| [JVET-AG0114](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13670) | AHG11: On new input and backbone enhancement of model for super-resolution | [Jiedong Ye](mailto:ye_jd@hust.edu.cn), Xu Li, Yiqing Zhu, Qiong Liu (HUST), [Chuan Zhou](mailto:chuan.zhou@vivo.com), M. Rafie, Zhuoyi Lv (vivo) |
| [JVET-AG0129](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13685) | AHG11: Unified CNN-based super resolution | [C. Zhou](mailto:chuan.zhou@vivo.com), [Z. Lv (vivo)](mailto:zhuoyi.lv@vivo.com) |
| Cross Checks | | |
| [JVET-AG0258](file:///D:\\Users\\e00443164\\Documents\\___JVET\\JVET-AG\\AhG11\\current_document.php%3fid=13831) | Crosscheck of JVET-AG0069 (AhG11: LOP with inputs transformed) | [Y. Li (Qualcomm)](mailto:yli30@qti.qualcomm.com) |
| JVET-AG0241 | Crosscheck of JVET-AG0162 (EE1-1.5: Report on implementation of HOP In-loop filter with Transformer blocks) | D. Liu (Ericsson) |

1. ***Recommendations***

The AHG recommends:

* Review all input contributions.
* Continue investigating neural network-based video coding tools, including coding performance and complexity.
* Continue collecting training materials for neural network-based video coding tool development.

It was suggested to also test HOP on intra.

It was suggested to investigate combinations of NNVC with ECM (add mandate to AHG), also potentially in subjective test.

[JVET-AG0012](https://jvet-experts.org/doc_end_user/current_document.php?id=13786) 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)]

1. ***Activities***

The primary activity of the AHG was the “Exploration experiment on enhanced compression beyond VVC capability” (JVET-AF2024). The combined improvements of the ECM-11.0 over VTM-11.0ecm11.0 anchorfor AI, RA and LB configurations are:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | All Intra Main10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -10.81% | -21.80% | -29.33% | 859.1% | 400.6% |
| Class A2 | -16.95% | -28.77% | -31.78% | 860.2% | 405.4% |
| Class B | -11.31% | -26.84% | -25.03% | 784.4% | 411.0% |
| Class C | -11.41% | -16.72% | -17.24% | 810.7% | 381.9% |
| Class E | -15.01% | -24.77% | -23.07% | 750.1% | 431.9% |
| Overall | **-12.81%** | **-23.73%** | **-24.81%** | **808.6%** | **405.0%** |
| Class D | -9.48% | -14.56% | -14.65% | 795.1% | 383.1% |
| Class F | -26.60% | -35.72% | -35.58% | 513.6% | 392.7% |
| Class TGM | -39.53% | -47.43% | -46.69% | 457.3% | 461.2% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Random Access Main 10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 | -22.47% | -27.84% | -36.88% | 875.4% | 769.1% |
| Class A2 | -26.01% | -36.30% | -40.11% | 824.7% | 958.3% |
| Class B | -20.80% | -35.53% | -33.16% | 714.1% | 774.7% |
| Class C | -22.22% | -27.13% | -27.05% | 748.2% | 829.1% |
| Class E |  |  |  |  |  |
| Overall | **-22.56%** | **-31.91%** | **-33.67%** | **775.1%** | **821.9%** |
| Class D | -23.10% | -28.71% | -28.75% | 768.1% | 898.2% |
| Class F | -28.70% | -37.47% | -37.77% | 614.7% | 505.2% |
| Class TGM | -36.82% | -43.33% | -43.43% | 566.6% | 413.2% |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Low Delay B Main 10 | | | | |
|  | Y | U | V | EncT | DecT |
| Class A1 |  |  |  |  |  |
| Class A2 |  |  |  |  |  |
| Class B | -17.76% | -41.31% | -38.53% | 661.6% | 649.7% |
| Class C | -19.49% | -31.72% | -31.66% | 618.2% | 678.1% |
| Class E | -16.28% | -30.12% | -30.39% | 587.1% | 406.5% |
| Overall | **-17.97%** | **-35.32%** | **-34.21%** | **627.8%** | **586.1%** |
| Class D | -21.22% | -34.09% | -33.02% | 659.2% | 772.5% |
| Class F | -24.87% | -39.63% | -38.99% | 575.6% | 491.8% |
| Class TGM | -35.47% | -44.37% | -44.64% | 538.8% | 424.4% |

The rate reduction for natural sequences over VTM in RA configuration for {Y, U, V} increased from ECM-10.0’s {-22.23%, -30.91%, -32.63%} to ECM-11.0’s {-22.56%, -31.91%, -33.67%}. For SCC sequences (class TGM) the rate reduction for RA configuration increased from ECM-10.0’s {-36.63%, -43.02%, -43.08%} to ECM-11.0’s { -36.82%, -43.33%, -43.43%}.

1. ***Contributions***

In addition to 40 EE2 contributions, 43 (comparing to 48 last meeting) EE2-related and AHG12-related contributions were received. The EE2-related and AHG12-related contributions can be subdivided as follows:

* 1. ***Intra (9)***

JVET-AG0075, "AHG12: Adaptive MRL Fusion", S. Blasi, J. Lainema (Nokia)

JVET-AG0078, "AHG12: Intra-prediction using Merged Histogram of Gradients", S. Blasi, I. Zupancic, P. Astola, J. Lainema (Nokia)

JVET-AG0084, "AHG12: DIMD Merge List", M. Blestel, P. Andrivon (Ofinno)

JVET-AG0106, "AHG 12: TIMD merge mode", R. G. Youvalari, M. Abdoli (Xiaomi)

JVET-AG0120, "Non-EE2: On line buffer restriction", Z. Deng, K. Zhang, L. Zhang (Bytedance)

JVET-AG0121, "Non-EE2: Block vector guided LUT for chroma prediction", J. Huo, X. Hao, M. Chen, N. Qiu, Z. Zhang, Y. Ma, F. Yang (Xidian Univ.), M. Li, F. Wang, J. Ren (OPPO)

JVET-AG0138, "Non-EE2: Chroma intra prediction mode reordering", X. Li, R.-L. Liao, J. Chen, Y. Ye (Alibaba)

JVET-AG0141, "AHG 12: Occurrence-Based Intra Coding (OBIC)", R. G. Youvalari, M. Abdoli (Xiaomi)

JVET-AG0197, "Non-EE2: Matrix based intra prediction replacing conventional intra modes", B. Ray, H. Wang, V. Seregin, M. Karczewicz, P. Garus (Qualcomm)

* 1. ***IntraTMP and IntraBC (8)***

JVET-AG0063, "EE2-1.2 related: AR-BVP for IntraTMP merge candidates", L. Zhang, Y. Yu, F. Wang, H. Yu, D. Wang (OPPO)

JVET-AG0074, "Non-EE2: IntraTMP with HMVP Candidates", C. Zhu, G. Li, T. Tang, L. Luo, H. Guo (UESTC), Y. Huo, Y. Liu (Transsion)

JVET-AG0080, "EE2-related: Extend block vector prediction for IntraTMP merge candidates", N. Qiu, J. Huo, Y. Ma, F. Yang (Xidian Univ.)

JVET-AG0113, "Non-EE2: FIBC Extension", J. Kim, J. Kang, H. Han, H. Choi (HNU), W. Lim, S.-C. Lim (ETRI)

JVET-AG0186, "Non-EE2: FIBC Extension", H.-J. Jhu, X. Xiu, W. Chen, C.-W. Kuo, N. Yan, C. Ma, X. Wang (Kwai)

JVET-AG0193, "Non-EE2: Enhancements on IntraTMP", W. Chen, X. Xiu, C. Ma, H.-J. Jhu, C.-W. Kuo, N. Yan, X. Wang (Kwai)

JVET-AG0231, "EE2-1.7b related: unrestricted 1.7b performances" F. Le Léannec, K. Naser, T. Dumas, Y. Chen, M. Radosavljević, T. Poirier, (InterDigital)

JVET-AG0243, " EE2-1.4: IntraTMP extension to DIMD", K. Naser, F. Le Léannec, T. Poirier, H. Guermoud, T. Dumas, (InterDigital)

* 1. ***Inter (10)***

JVET-AG0073, "Non-EE2: Chained motion vector prediction", Y. Kidani, H. Kato, K. Kawamura (KDDI)

JVET-AG0096, "Non-EE2: On temporal buffer handling", Z. Deng, K. Zhang, L. Zhao, L. Zhang (Bytedance)

JVET-AG0125, "AHG12: Parallel friendly use of boundary distortion for DMVR", K. Andersson, R. Yu (Ericsson)

JVET-AG0149, "Non-EE2: Improvements to subblock merge mode", J. Chen, R.-L. Liao, Y. Zheng, X. Li, Y. Ye (Alibaba)

JVET-AG0150, "EE2-related: Adaptive GPM blending", L. Zhao, K. Zhang, L. Zhang (Bytedance)

JVET-AG0172, "EE2-related: Chroma LIC derivation with template costs", T. Bae, S. Deshpande (Sharp)

JVET-AG0194, "Non-EE2: Reference filtering for inter-prediction", A. Filippov, V. Rufitskiy, K. Suverov (Ofinno)

JVET-AG0195, "Non-EE2: LIC model parameter inheritance for merge modes", C.-C. Chen, H. Huang, V. Seregin, M. Karczewicz

JVET-AG0200, "Non-EE2: Inter CCP merge mode with zero luma CBF", Z. Deng, K. Zhang, L. Zhang (Bytedance)

JVET-AG0202, "Non-EE2: Geometry partitioning mode with inter prediction and intra block copy", Y. Wang, K. Zhang, L. Zhang (Bytedance)

* 1. ***In Loop Filters (3)***

JVET-AG0065, "Non-EE2: Adaptive coefficient precision for CCALF", N. Song, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AG0198, "Non-EE2: Coding Information based ALF Classification", W. Yin, K. Zhang, Y. Wang, Z. Deng, L. Zhao, N. Zhang, M. Salehifar, L. Zhang (Bytedance)

JVET-AG0233, " EE2-related: Adaptive precision for CCALF coefficients", [N. Hu](mailto:nanh@qti.qualcomm.com), [M. Karczewicz](mailto:martak@qti.qualcomm.com), [V. Seregin](mailto:vseregin@qti.qualcomm.com), [H. Wang (Qualcomm)](mailto:hongtaow@qti.qualcomm.com)

* 1. ***Transform (4)***

JVET-AG0062, "Non-EE2: Multiple Transform Sets Selection for LFNST/NSPT", F. Wang, Y. Yu, H. Yu, D. Wang (OPPO)

JVET-AG0208, "EE2-related: On LFNST/NSPT index signalling", M. Koo, J. Zhao, J. Lim, S. Kim (LGE)

JVET-AG0230, "EE2-3.3 related: On Inter-LFNST”, S. Puri, K. Naser, C. Bonnineau, F. Le Léannec", (InterDigital)

JVET-AG0237, "EE2-3.3 related: Fix on LFNST/NSPT index signalling", M. Koo, J. Zhao, J. Lim, S. Kim (LGE)

* 1. ***Coefficients and Entropy Coding (7)***

JVET-AG0064, "AHG12: On Context modeling in Chroma Coefficient Coding", L. Xu, H. Yu, Y. Yu, D. Wang (OPPO)

JVET-AG0066, "EE2-3.2 related: On Regular Residual Coding", Y. Yu, L. Xu, J. Gan, H. Yu, L. Zhang, H. Huang, F. Wang, Z. Xie, N. Song, D. Wang (OPPO)

JVET-AG0068, "EE2-3.2 related: On CABAC bin budget", J. Gan, Y. Yu, H. Yu (OPPO)

JVET-AG0108, "AhG12 Entropy coding extension", F. Galpin, F. Lo Bianco, C. Salmon-Legagneur, M. Balcilar (InterDigital)

JVET-AG0110, "Ahg12: 16 States TCQ with State Exchange", M. Balcilar, K. Naser, Y. Chen, Franck Galpin, Fabrice Léannec (InterDigital)

JVET-AG0102, "AHG12: New context model parameters for low delay B condition", R.-L. Liao, Y. Ye, J. Chen, X. Li (Alibaba)

JVET-AG0185, "Non-EE2: Slice based Rice parameter selection for transform skip residual coding", H.-J. Jhu, X. Xiu, W. Chen, C.-W. Kuo, N. Yan, C. Ma, X. Wang (Kwai)

* 1. ***Partitioning (1)***

JVET-AG0126, "AhG12: On ECM temporal partitioning prediction", G. Laroche, P. Onno (Canon)

* 1. ***Other (1)***

JVET-AG0116, "AHG12: GOP-based RPR encoder control for ECM", K. Andersson, J. Ström, P. Wennersten, R. Yu, W. Ahmad (Ericsson)

1. ***Recommendations***

The AHG recommends to:

* To review all the related contributions.

[JVET-AG0013](https://jvet-experts.org/doc_end_user/current_document.php?id=13787) 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)]

1. ***Discussion***

For this AHG period, there were three major topics of conversation. ISO/IEC 23002-9 DTR was edited to reflect feedback from ITU and ISO editors. The group also discussed content containing film grain for development, demonstrations, and testing of systems and processes. Also discussed were metrics and characterization for film grain synthesis. Finally, the group discussed potential future topics for the Technical Report.

Additional editing of the DTR continues due to comments that originated from the ISO and ITU editors. Most were changes due to editorial comments. Several comments related to references to AOM documents and github sites remain to be addressed.

An extensive amount of time was spent on content. Apple created a dataset using both content captured by Apple and content that is publicly available. The dataset is comprised of approximately 20 sequences with 27 variants and stored as YUVs along with proxies. Several people have copied the data and begun tests.

Disney reported on their tests on the Tears of Steel content. The tests are an effort to reduce the number of clips. The methodology and results were shared. In short, the method subtracted the original video from the video under test and analyzed the film grain characteristics. This method seems to be popular as it has been independently explored by a number of companies.

The group discussed there are outside organizations that would find value in the report. One observation is that the TR is background on film grain but not what would be considered an Engineering Guideline (EG) or a Recommended Practice (RP) in other organizations. JVET needs to consider perhaps doing best practices (ISO EG/RP) – as part of the AHG report v2. Capturing the experiences of the group and perhaps even the creatives could be useful to outside organizations.

1. **Related *contributions***

Eight contributions related to AHG13 were identified as of 01/16/2024.

* One contribution was the AHG report:
  + JVET-AG0013 JVET AHG report: Film grain technologies (AHG13)
* Seven other contributions were uploaded at the time of the report drafting:
  + JVET-AG0101 Film grain adaptive SEI message
  + JVET-AG0140 FGS Extension SEI message for spatial adaptation
  + JVET-AG0153 Proposed FGS applications
  + JVET-AG0160 FGS Extension SEI message useful descriptors
  + JVET-AG0215 Region-dependent film grain characteristics
  + JVET-AG0228 source for scanned film test sequences
  + JVET-AG0290 Compressibility analysis of Film Grain test sequences
  + JVET-AG0295 On Film Grain Synthesis Subjective Evaluation
  1. ***Contributions***

There were seven contributions uploaded other than the AHG report.

* + 1. **JVET-*AG0101* Film grain adaptive SEI message**

It is proposed to define a new film grain adaptive SEI message to specify the regions that the film grain applies, wherein:

* these regions may include the external regions or/and the internal regions.
* external regions refer to the existing available regions defined through different type of SEI messages or other approach.
* internal regions refer to the regions defined in the film grain adaptive SEI message.

In the 32nd JVET meeting, the contribution JVET-AF0142 [1] proposes to address the film grain synthesis applied locally on the picture by using the annotated regions as a mask and the contribution JVET-AF0144 [2] proposes to address the film grain synthesis applied locally on a per image basis by using the auxiliary data as a mask. Furthermore, the conclusions recorded in the meeting notes [3] confirm that the functionality as such was assessed to be useful and suggest to study the possibility of defining a new SEI message rather than changing an existing one.

Since it has been recognized that film grain may not necessarily be applicable to the entire picture but only in some parts of the picture, such as one or more annotated regions, forefront objects, etc., it would be a simple approach if these existing available regions can be used in the newly defined SEI message.

On the other hand, these existing available regions may not meet all the requirements, so it is also necessary to provide a way to describe the film grain region in the newly defined SEI message.

* + 1. **JVET-*AG0140* FGS Extension SEI message for spatial adaptation**

The proposed contribution is a follow-up of previous meeting inputs on FGS spatial adaptation. Taking into account the comments made on the importance to not modify the existing FGC SEI message, this proposal follows the suggested approach to develop a dedicated FGS Extension SEI message dealing with relative spatial application of film grain values in the picture.

During the last JVET meeting #32 in Hannover (Oct. 23) 2 contributions were presented (JVET-AF0142 and JVET-AF0144) introducing the functionality to adapt locally in the image the application of film grain values.

The proposed way forward was to revisit the proposals by developing a dedicated SEI message. The present contribution proposes a Film Grain Extension SEI message to convey the information of where film grain values are applied.

* + 1. ***JVET*-AG0153 Proposed FGS applications**

Proposal to add a new use case of FGS: Artistic intent simulation, in which FGS is used without any reference, to be differentiated from the artistic intent recovery that relies on FGS to maintain the similarity with the original content.

Film Grain Synthesis is primarily meant to optimize the video coding efficiency due to the particular nature of the grain, considered as noise with no spatio-temporal correlation. The usage of film grain as listed in the FGS Draft TR may serve the objective to maintain the artistic intent while the video source has been denoised for encoding efficiency purposes. In this case the synthetized grain is defined to emulate the original grain. The second listed scenario is the usage of FGS to mark visual artifacts such as block effects, ringing around edges or even too strong deblocking filters. Those 2 use cases are listed in clause 6.4 of the draft TR.

However, another scenario, briefly mentioned in the introduction of the Draft TR relates to the use of FGS for other artistic intent objectives (called here simulation). Film grain synthesis is a tool for increasing the depth perception, for harmonizing the cameras optics quality or simply adding an artificial movie effect, such as for some game cinematics. It is then proposed to list this type of use case and application of film grain in the Draft TR.

* + 1. ***JVET*-AG0160 FGS Extension SEI message useful descriptors**

While defining an FGS extension SEI message primarily addressing the functionality of spatial adaptation, it was felt useful to also include descriptive parameters of the film grain synthesis such as the type of grain that is meant to be reproduced, the purpose of the film grain, such as creative artistic intent or artefact masking, and its essentiality from a service viewpoint.

* + 1. **JVET-AG0215 Region-dependent film grain characteristics**

This contribution, while stating that the current FGC SEI message fits its purpose to describe the grain present on scanned film or added for artistic intent on motion pictures, and enables to recover a similar grain by driving synthesis at decoder side at reasonable cost when the grain has been lost in the encoding process for broadcast or streaming purpose, acknowledges that for other uses cases, it may be desirable to describe different film grain in different regions of the picture, for example when the picture is a composite of different sources.

A region-dependent film grain characteristics SEI message is proposed, that includes the existing FGC SEI message syntax, notably independent intensity intervals with model parameters for each interval, and adds elements to describe a list of picture regions, and associate each region with a set of intervals. The commonalities with the FGC SEI message are believed to provide a simple migration path, and simple conversion back to FGC SEI messages for parts of pictures by a network processor, for example in the context of subpictures.

* + 1. **JVET-*AG0228* source for scanned film test sequences**

This contribution reports about old film scanned by Prelinger Archives and made available on the Internet Archive website, and recommends to select a few samples to be included as candidate test sequences for FGC SEI visual testing activities planned in JVET-AD2022.

During the 30th JVET meeting, an expert viewing test was conducted to evaluate the benefit of using film grain synthesis driven by an FGC SEI message on top of VVC encodings, for a better similarity to video sources that originally contained grain and potential bitrate savings. Results were reported in JVET-AD0382, concluding that significant improvement were observed over bitrate scanning the usual MOS range, and that similarity with the source was decently preserved (-0.5 MOS) using grain synthesis on top of high-quality encoding just removing grain, leading to 90% rate savings compared to encodings just preserving grain. JVET-AD0276 reported similar conclusions based on InterDigital internal informal tests performed before the meeting. Both tests were using the same test sequences, including two sequences from a short test film by SVT shot in 2004 on 65mm film. It was questioned whether similar benefits would be observed using older film stock, that was anticipated to exhibit significantly different characteristics, likely coarser and stronger.

Since then, relevant good quality scans of older film stock was actively sought after to enable such experiments.

This contribution reports about one source where relevant material could be found, and provides information about some samples of this material.

* + 1. **JVET-AG0290 Compressibility analysis of Film Grain test sequences**

This contribution has not been uploaded.

* + 1. **JVET-*AG0295* Frequency domain Film Grain Objective Metrics with Adaptive Region Selection**

This contribution has not been uploaded.

1. ***Recommendations***

The AHG recommends:

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

Upon a question, it was reported that no progress was made on the question about potential definition of conformance.

It was commented that, in producing the DTR, one problem was referencing external entities/repositories that may not be stable (was commented as inappropriate by ISO staff). It was suggested that a possible solution might be to refer to specific versions of such references. Offline discussion (G. Sullivan, W. Husak, et al.) and later report during the meeting.

[JVET-AG0014](https://jvet-experts.org/doc_end_user/current_document.php?id=13597) JVET AHG report: NNVC software development (AHG14) [F. Galpin (chair), Y. Li, Y. Li, J. N. Shingala, L. Wang, Z. Xie (vice-chairs)]

1. **Software *development***
   1. **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-7.1 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.

* 1. **Software *changes***

Several commits were merged in the NNVC repository.

The following changes were integrated:

* HOP related:
  + JVET-AF0155/AF0180: luma/chroma balance
  + JVET-AF0296: learning rate
  + JVET-AF0150: batch size
  + improved documentation
* LOP related:
  + JVET-AF0043: LOP.2 training and model.
* LOP/HOP:
  + Training speed-up
  + Unification of code, training scripts and configuration files
  + JVET-AF0172: cleaning scale flag
  + JVET-AF0205: padding policy
  + JVET-AF0085: residual offset adjustment
  + JVET-AF0193: decoder complexity optimization (default off)
* JVET-AF0139: NN intra lower complexity
* JVET-AF0152: SADL v7
* fixes:
  + build issues fixes.
  + default to AVX2 for SADL
  + remove deprecated code.
  1. **Software *version***

NNVC-7.1 was tagged November 29th, 2023

NNVC-7.0 was tagged November 3rd, 2023

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

NNVC-6.0 was tagged September 6th, 2023.

NNVC-5.1 was tagged July 19th, 2023.

NNVC-5.0 was tagged May 11th, 2023.

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

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

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

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

1. **CTC performance**

See configurations section for naming convention.

* 1. **Comparison *to VTM***
     1. **NNVC-6.0 VTM vs NNVC-7.1 VTM**

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

* + 1. **NNVC-7.1 VTM vs NNVC-7.1 anchor**

The NNVC-7.1 anchor includes LOP.2 filter and Intra Prediction tools activated.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-7.0 == 7.1** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -7.91% | -10.09% | -10.61% | -8.48% | -11.15% | -10.66% | 129% | 9031% |
| Class A2 | -6.79% | -12.68% | -9.74% | -7.00% | -11.83% | -7.35% | 126% | 8426% |
| Class B | -6.57% | -13.94% | -12.70% | -6.78% | -12.92% | -11.88% | 127% | 9076% |
| Class C | -6.58% | -14.87% | -14.43% | -7.15% | -13.24% | -12.86% | 120% | 7892% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -6.89% | -13.17% | -12.15% | -7.26% | -12.43% | -10.99% | 126% | 8606% |
| Class D | -7.17% | -14.84% | -15.00% | -6.49% | -13.17% | -13.07% | 119% | 7530% |
| Class F | -3.71% | -9.49% | -9.41% | -4.23% | -10.19% | -9.77% | 136% | 3684% |

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|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-7.0 == 7.1** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 |  |  |  |  |  |  |  |  |
| Class A2 |  |  |  |  |  |  |  |  |
| Class B | -5.29% | -13.38% | -13.25% | -6.09% | -14.72% | -17.51% | 120% | 8941% |
| Class C | -5.53% | -13.74% | -14.88% | -7.36% | -15.51% | -16.98% | 113% | 7756% |
| Class E | -6.13% | -8.86% | -12.10% | -7.76% | -10.47% | -13.50% | 136% | 9072% |
| **Overall** | -5.58% | -12.37% | -13.51% | -6.93% | -13.92% | -16.33% | 121% | 8558% |
| Class D | -6.54% | -13.06% | -15.42% | -7.34% | -14.20% | -17.88% | 110% | 7563% |
| Class F | -3.14% | -8.73% | -8.67% | -4.24% | -9.89% | -13.21% | 129% | 4227% |

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|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-7.0 == 7.1** | | | | | | | |
|  | 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% | -14.28% | -12.61% | 187% | 6908% |
| Class A2 | -7.15% | -12.70% | -11.26% | -7.47% | -12.25% | -9.23% | 186% | 5880% |
| Class B | -7.35% | -13.02% | -13.55% | -7.37% | -13.33% | -13.41% | 181% | 5701% |
| Class C | -7.53% | -13.81% | -14.47% | -7.93% | -14.27% | -14.56% | 168% | 4342% |
| Class E | -10.71% | -14.15% | -15.12% | -10.94% | -13.61% | -14.11% | 176% | 6176% |
| **Overall** | -8.13% | -13.28% | -13.42% | -8.38% | -13.56% | -12.95% | 179% | 5644% |
| Class D | -7.65% | -12.72% | -15.05% | -7.48% | -13.58% | -15.42% | 160% | 4159% |
| Class F | -5.27% | -10.79% | -10.39% | -5.08% | -11.26% | -11.78% | 141% | 4847% |

Note: Results from Tencent, crosschecked by InterDigital for gains.

* + 1. **NNVC-7.1 VTM mode vs NNVC-7.1 HOP.2**

The NNVC-7.1 where LOP.2 filter is replaced by HOP.2 and Intra Prediction tools activated.

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|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-7.1 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -15.29% | -8.16% | -18.63% | -16.62% | -14.19% | -19.81% | 444% | 212316% |
| Class A2 | -14.52% | -11.44% | -9.50% | -14.18% | -11.71% | -5.61% | 420% | 203481% |
| Class B | -12.30% | -12.31% | -12.15% | -11.43% | -12.31% | -11.21% | 437% | 214243% |
| Class C | -13.23% | -16.68% | -16.88% | -12.41% | -12.85% | -12.90% | 351% | 197379% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -13.59% | -12.47% | -14.18% | -13.28% | -12.71% | -12.26% | 410% | 207086% |
| Class D | -14.34% | -15.82% | -17.40% | -11.21% | -12.00% | -11.59% | 342% | 185469% |
| Class F | -8.28% | -11.67% | -10.63% | -8.37% | -11.91% | -10.79% | 647% | 97257% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-7.1 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
| Class B | -11.10% | -6.55% | -7.45% | -11.04% | -11.29% | -12.22% | 413% | 214332% |
| Class C | -12.28% | -13.55% | -14.46% | -12.60% | -13.84% | -13.48% | 341% | 197098% |
| Class E | -13.31% | -3.89% | -9.88% | -14.03% | -8.57% | -11.80% | 907% | 272167% |
| **Overall** | -12.05% | -8.22% | -10.40% | -12.31% | -11.46% | -12.53% | 472% | 221253% |
| Class D | -13.56% | -12.14% | -14.84% | -12.38% | -12.34% | -13.48% | 324% | 184900% |
| Class F | -8.83% | -9.53% | -10.94% | -10.01% | -12.18% | -15.42% | 630% | 116303% |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #DIV/0! | #DIV/0! |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-7.1 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -12.82% | -8.37% | -15.39% | -14.38% | -13.29% | -17.63% | 512% | 151639% |
| Class A2 | -12.35% | -10.32% | -9.22% | -13.17% | -9.89% | -6.44% | 352% | 121892% |
| Class B | -11.01% | -10.87% | -11.24% | -10.94% | -11.58% | -11.47% | 322% | 114567% |
| Class C | -12.13% | -12.55% | -15.09% | -11.86% | -12.10% | -14.14% | 245% | 81849% |
| Class E | -15.62% | -14.68% | -14.86% | -15.75% | -13.67% | -14.67% | 350% | 127857% |
| **Overall** | -12.55% | -11.37% | -13.05% | -12.89% | -12.05% | -12.78% | 337% | 114638% |
| Class D | -11.72% | -11.38% | -15.01% | -10.82% | -11.27% | -12.86% | 223% | 76334% |
| Class F | -8.85% | -11.06% | -10.75% | -8.54% | -11.48% | -11.55% | 212% | 99222% |

Note: Results from Tencent, crosschecked by Oppo.

* + 1. **NNVC-7.1 VTM mode vs NNVC-7.1 VTM mode + LOP.2**

The results reflect LOP only performance.

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|  | **Random access Main10** | | | | | | | |
|  | **LOP2 BD-rate Over NNVC-7.0 == 7.** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT |
| Class A1 | -5.92% | -8.80% | -9.06% |  |  |  | 121% | 12269% |
| Class A2 | -5.59% | -12.12% | -8.92% |  |  |  | 113% | 9036% |
| Class B | -4.99% | -13.19% | -12.07% |  |  |  | 115% | 8850% |
| Class C | -5.12% | -13.71% | -13.20% |  |  |  | 105% | 8032% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -5.33% | -12.24% | -11.14% |  |  |  | 113% | 9245% |
| Class D | -6.01% | -14.08% | -13.94% |  |  |  | 104% | 7464% |
| Class F |  |  |  |  |  |  |  |  |

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|  | **All Intra Main10** | | | | | | | |
|  | **LOP BD-rate Over NNVC-7.0 == 7.** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT |
| Class A1 | -4.64% | -9.01% | -8.52% |  |  |  | 118% | 8037% |
| Class A2 | -4.48% | -10.12% | -8.62% |  |  |  | 108% | 6290% |
| Class B | -4.39% | -10.32% | -10.64% |  |  |  | 106% | 5134% |
| Class C | -4.64% | -11.11% | -11.70% |  |  |  | 103% | 3205% |
| Class E | -6.42% | -9.58% | -11.35% |  |  |  | 106% | 4491% |
| **Overall** | -4.84% | -10.12% | -10.31% |  |  |  | 108% | 5157% |
| Class D | -5.00% | -10.10% | -12.34% |  |  |  | 101% | 3109% |
| Class F |  |  |  |  |  |  |  |  |

Note: Results from Qualcomm, crosschecked by XX.

* + 1. **NNVC-7.1 VTM mode vs NNVC-7.1 VTM mode + HOP.2**

The results reflect HOP only performance.

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|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-7.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -13.58% | -7.16% | -17.71% |  |  |  |  |  |
| Class A2 | -13.47% | -10.84% | -8.82% |  |  |  |  |  |
| Class B | -10.95% | -11.39% | -11.44% |  |  |  |  |  |
| Class C | -11.97% | -15.75% | -15.73% |  |  |  |  |  |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -12.25% | -11.60% | -13.32% |  |  |  |  |  |
| Class D | -13.29% | -15.18% | -16.83% |  |  |  |  |  |
| Class F | -7.44% | -10.89% | -9.97% |  |  |  |  |  |

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|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-7.0 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -9.33% | -4.74% | -12.49% |  |  |  |  |  |
| Class A2 | -9.99% | -7.77% | -6.71% |  |  |  |  |  |
| Class B | -8.38% | -8.06% | -8.01% |  |  |  |  |  |
| Class C | -9.58% | -9.30% | -11.86% |  |  |  |  |  |
| Class E | -11.86% | -10.17% | -10.83% |  |  |  |  |  |
| **Overall** | -9.66% | -8.09% | -9.86% |  |  |  |  |  |
| Class D | -9.30% | -8.84% | -12.04% |  |  |  |  |  |
| Class F | -7.00% | -9.17% | -8.88% |  |  |  |  |  |

* + 1. **NNVC-7.1 VTM mode vs NNVC-7.1 VTM + NN intra low complexity**

The results reflect NN intra low complexity only performance.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-7.1 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -3.99% | -3.52% | -3.91% | -4.20% | -3.52% | -3.80% | 165% | 429% |
| Class A2 | -2.81% | -2.37% | -2.88% | -2.81% | -2.15% | -2.53% | 171% | 573% |
| Class B | -2.92% | -2.67% | -2.83% | -2.74% | -2.43% | -2.43% | 172% | 619% |
| Class C | -2.40% | -2.08% | -2.07% | -2.53% | -1.61% | -1.52% | 163% | 596% |
| Class E | -4.14% | -3.91% | -3.51% | -3.99% | -3.45% | -2.21% | 169% | 633% |
| **Overall** | -3.17% | -2.84% | -2.96% | -3.16% | -2.55% | -2.44% | 168% | 572% |
| Class D | -2.06% | -1.69% | -1.90% | -2.07% | -1.38% | -1.01% | 158% | 627% |
| Class F | -1.74% | -1.41% | -1.35% | -1.81% | -1.26% | -1.18% | 143% | 353% |

Note: Results from InterDigital, crosschecked by Oppo.

* 1. ***Comparison to previous NNVC - NNVC-6.0 anchor***
     1. ***NNVC*-6.0 anchor vs NNVC-7.1 anchor**

The results reflect LOP progress between NNVC 6.0 (as anchor) and NNVC 7.1 (as test).

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|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC 6.0** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -0.73% | -5.39% | -4.78% | 0.30% | -7.16% | -5.81% |  |  |
| Class A2 | -0.25% | -7.14% | -4.80% | -0.51% | -7.88% | -4.53% |  |  |
| Class B | -0.29% | -6.01% | -5.47% | -0.85% | -7.19% | -7.04% |  |  |
| Class C | 0.05% | -4.53% | -5.12% | -0.94% | -5.56% | -7.49% |  |  |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -0.28% | -5.72% | -5.10% | -0.58% | -6.89% | -6.41% |  |  |
| Class D | 0.46% | -5.54% | -5.53% | -0.78% | -6.42% | -7.38% |  |  |
| Class F | -0.66% | -3.76% | -4.60% | -1.21% | -5.62% | -6.47% |  |  |
| Class H | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC 6.0** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! |  |  |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! |  |  |
| Class B | -0.47% | -5.48% | -5.76% | -0.99% | -8.84% | -11.46% |  |  |
| Class C | -0.31% | -2.82% | -6.31% | -1.83% | -5.38% | -13.65% |  |  |
| Class E | -1.29% | -4.85% | -7.30% | -2.27% | -8.32% | -10.72% |  |  |
| **Overall** | -0.62% | -4.44% | -6.33% | -1.59% | -7.56% | -12.00% |  |  |
| Class D | 0.02% | -2.38% | -5.89% | -1.65% | -5.19% | -11.89% |  |  |
| Class F | -1.11% | -3.84% | -4.37% | -2.13% | -6.69% | -9.37% |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC 6.0** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -0.18% | -5.86% | -3.93% | 1.23% | -7.29% | -5.52% |  |  |
| Class A2 | -0.57% | -5.04% | -3.57% | -0.62% | -6.25% | -4.05% |  |  |
| Class B | -0.35% | -4.77% | -5.23% | -0.37% | -6.21% | -6.83% |  |  |
| Class C | -0.21% | -4.39% | -4.86% | -0.35% | -6.55% | -7.42% |  |  |
| Class E | -0.47% | -5.44% | -6.80% | -0.86% | -6.31% | -8.28% |  |  |
| **Overall** | -0.35% | -5.02% | -4.91% | -0.22% | -6.49% | -6.52% |  |  |
| Class D | -0.08% | -4.81% | -6.03% | -0.32% | -7.18% | -8.29% |  |  |
| Class F | -0.75% | -5.00% | -4.88% | -0.80% | -6.78% | -7.49% |  |  |

* + 1. **NNVC-6.0 HOP vs NNVC-7.1 HOP**

The results reflect HOP progress between NNVC 6.0 (as anchor) and NNVC 7.1 (as test).

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|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 HOP** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -3.44% | 18.42% | 11.54% | -3.47% | 14.01% | 11.76% |  |  |
| Class A2 | -2.95% | 17.74% | 18.25% | -2.78% | 16.39% | 18.04% |  |  |
| Class B | -1.44% | 20.17% | 17.60% | -1.09% | 19.65% | 18.91% |  |  |
| Class C | -1.65% | 16.96% | 16.42% | -1.47% | 17.49% | 18.43% |  |  |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -2.20% | 18.48% | 16.20% | -2.01% | 17.29% | 17.18% |  |  |
| Class D | -1.55% | 16.41% | 15.29% | -1.01% | 17.69% | 17.88% |  |  |
| Class F | -1.79% | 9.86% | 9.32% | -1.13% | 11.55% | 11.23% |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 HOP** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! |  |  |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! |  |  |
| Class B | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! |  |  |
| Class C | -1.63% | 16.82% | 11.43% | -1.66% | 16.35% | 11.10% |  |  |
| Class E | -1.60% | 15.29% | -2.81% | -2.12% | 10.42% | -3.97% |  |  |
| **Overall** | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! |  |  |
| Class D | -1.82% | 15.20% | 3.94% | -1.79% | 14.20% | 3.02% |  |  |
| Class F | -1.88% | 13.07% | 4.68% | -1.54% | 12.45% | 7.95% |  |  |

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|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-6.0 HOP** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -2.25% | 17.82% | 14.03% | -2.24% | 16.11% | 13.06% |  |  |
| Class A2 | -3.14% | 16.68% | 14.74% | -3.18% | 17.17% | 14.67% |  |  |
| Class B | -1.49% | 15.42% | 14.91% | -1.40% | 17.06% | 17.16% |  |  |
| Class C | -1.66% | 12.43% | 12.91% | -1.54% | 15.24% | 16.42% |  |  |
| Class E | -1.53% | 13.98% | 15.33% | -1.20% | 14.27% | 17.38% |  |  |
| **Overall** | -1.93% | 15.12% | 14.36% | -1.83% | 16.05% | 15.93% |  |  |
| Class D | -1.57% | 12.83% | 13.43% | -1.43% | 17.15% | 18.42% |  |  |
| Class F | -1.85% | 8.35% | 8.89% | -1.51% | 10.59% | 12.97% |  |  |

* 1. ***Comparison to NNVC-7.1 anchor***
     1. **NNVC-7.1 anchor vs NNVC-7.1 HOP.2**

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

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access Main10** | | | | | | | |
|  | **BD-rate Over NNVC-7.1** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -8.00% | 2.04% | -8.95% | -8.89% | -3.77% | -10.33% |  |  |
| Class A2 | -8.27% | 1.41% | 0.15% | -7.66% | -0.03% | 1.77% |  |  |
| Class B | -6.15% | 1.99% | 0.66% | -4.97% | 0.79% | 0.77% |  |  |
| Class C | -7.13% | -2.16% | -2.89% | -5.65% | 0.36% | -0.14% |  |  |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | -7.21% | 0.78% | -2.31% | -6.47% | -0.40% | -1.49% |  |  |
| Class D | -7.74% | -1.17% | -2.98% | -5.02% | 1.38% | 1.39% |  |  |
| Class F | -4.83% | -2.53% | -1.47% | -4.39% | -2.25% | -1.24% |  |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay B Main10** | | | | | | | |
|  | **BD-rate Over NNVC-7.1** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! |  |  |
| Class A2 | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! |  |  |
| Class B | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! |  |  |
| Class C | -7.16% | 0.44% | 0.68% | -5.64% | 2.23% | 4.49% |  |  |
| Class E | -7.63% | 5.46% | 2.64% | -6.71% | 2.24% | 2.00% |  |  |
| **Overall** | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! | #VALUE! |  |  |
| Class D | -7.52% | 1.01% | 0.76% | -5.43% | 2.83% | 5.77% |  |  |
| Class F | -5.93% | -0.76% | -2.42% | -6.08% | -2.85% | -2.61% |  |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC-7.1** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -4.59% | 4.88% | -3.46% | -5.89% | 1.08% | -5.79% |  |  |
| Class A2 | -5.62% | 2.85% | 2.26% | -6.12% | 2.73% | 3.07% |  |  |
| Class B | -3.98% | 2.77% | 2.73% | -3.83% | 2.20% | 2.29% |  |  |
| Class C | -5.02% | 1.56% | -0.72% | -4.26% | 2.48% | 0.37% |  |  |
| Class E | -5.52% | -0.68% | 0.30% | -5.29% | -0.11% | -0.70% |  |  |
| **Overall** | -4.84% | 2.29% | 0.45% | -4.89% | 1.78% | 0.15% |  |  |
| Class D | -4.42% | 1.62% | -0.04% | -3.63% | 2.86% | 2.88% |  |  |
| Class F | -3.87% | -0.22% | -0.36% | -3.63% | -0.29% | 0.42% |  |  |

* + 1. **NNVC-7.1 anchor vs NNVC-7.1 NN intra lower complexity**

The results below show the difference in performance of NN intra (as anchor) to NN intra lower complexity (as test).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra Main10** | | | | | | | |
|  | **BD-rate Over NNVC 7.1** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | 0.31% | 0.31% | 0.72% | 0.31% | 0.27% | 0.37% | 72% | 90% |
| Class A2 | -0.03% | -0.05% | -0.21% | -0.06% | -0.25% | -0.30% | 71% | 86% |
| Class B | 0.25% | 0.04% | 0.12% | 0.26% | -0.04% | -0.07% | 70% | 82% |
| Class C | 0.70% | 0.61% | 0.85% | 0.63% | 0.65% | 0.73% | 70% | 75% |
| Class E | 0.60% | 0.63% | 0.41% | 0.77% | 0.82% | 0.42% | 70% | 81% |
| **Overall** | 0.37% | 0.30% | 0.38% | 0.38% | 0.27% | 0.23% | 71% | 82% |
| Class D | 0.83% | 0.64% | 0.87% | 0.76% | 0.29% | 1.23% | 71% | 71% |
| Class F | 0.41% | 0.33% | 0.49% | 0.34% | 0.29% | 0.37% | 81% | 83% |

* 1. ***Other* tools**

Other results remain the same as tools were not changed.

1. **Discussions**
   1. **Discussions *on optimization level in NNVC***
      1. **Overall optimization level**

Current optimization level of NNVC is as follow:

* The legacy VTM code is considered less optimized than the ECM part as ECM integrated more SIMD optimization functions.
* The NN based code is mainly executed inside the SADL library, with some parts, non-SIMD optimized, executed on the NNVC side.

The complexity at encoder, as measured by the encoding time, is split in half between the VTM part and the NN based part. It is considered that the NN based part is more optimized than the VTM part since almost all the code is SIMD optimized.

The complexity at decoder, as measured by the encoding time, is mainly driven by the NN based part.

* + 1. **NN based optimization level**

The SIMD optimization parts in SADL are not all optimized at the same level.

It was noted that recent switch to AVX2 by default is slowing down NNVC significantly (about 3 or 4 times slower) compared to AVX512. A better handling of some layers for AVX2 is already prepared and solved this issue.

Other SIMD improvement have been proposed and are currently under review.

Compared to a state-of-the-art CPU inference of the same models (using optimized numpy implementation), a slowdown of a factor 2 to 3 can be observed.

1. **Configurations**

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

The column “tested” is read as follow:

* Y: the configuration has been tested using the new NNVC-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-7.1 VTM mode | none | encoder\_xxx\_vtm.cfg | P |  |
| NNVC 7.1 Anchor/EE1 | Intra Pred + LOP.2 filterset | encoder\_xxx\_nnvc.cfg | Y | Y |
| NNVC-7.1. HOP | Intra Pred + HOP.2 | 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 |
| 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 |  |
| Sr | Super-resolution | nn-based/nnsr.cfg + nn-based/nnsr\_classAx.cfg | P |  |
| Pf | Adaptive post-filters | nn-based/nnpf/nnpf\_xxx.cfg | P |  |

1. **Recommendations**

The AHG recommends to:

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

Encourage people to submit merge requests fixing identified bugs.

[JVET-AG0015](https://jvet-experts.org/doc_end_user/current_document.php?id=13788) JVET AHG report: Gaming content compression (AHG15) [S. Puri, J. Sauer (co-chairs), R. Chernyak, A. Duenas, L. Wang (vice chairs)]

1. **Testing conditions for gaming content**

This section describes simulations’ setup that is planned to be used within AhG15.

The simulations will be performed prior to the January meeting.

Anchor: VTM-11ecm11 (<https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/tree/VTM-11.0ecm11.0>)

Test: ECM-11.0 (<https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/tree/ECM-11.0>)

Configurations: AI/LDB/LDP

Testing conditions: JVET CTC with QP set [27, 32, 37, 42]

Content: 5s; TBD

Extra parameters: with and without ClassF cfg file

1. **Gaming content sequence survey**

A plenitude of candidate sequences for gaming content compression were identified by the group. The sequences along with their source are listed in the following table: In addition to the rendered view (YUV) for some sequence auxiliary information is available (depth, optical flow, etc.).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sequence name** | **Provided by** | **Resolution, FPS, color space, bit depth** | **Availability** | **Auxiliary information available** |
| Level1 | InterDigital | 1920x1080, 60p, 420, 10bits | JVET ftp | yes |
| Darktree | InterDigital | 1920x1080, 60p, 420, 10bits | JVET ftp | yes |
| ArenaOfValor | Tencent | 1920x1080, 60p, 420, 8bits | JVET ftp | no |
| ARPG | Huawei | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | to be provided | yes |
| DesertTown1 | Huawei | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | to be provided | yes |
| DesertTown2 | Huawei | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | to be provided | yes |
| Sun\_Temple1 | Huawei | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | to be provided | yes |
| Sun\_Temple2 | Huawei | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | to be provided | yes |
| CSGO | Twitch/SA4 | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | [h264](https://media.xiph.org/video/derf/twitch/H264/) [uncompressed](https://media.xiph.org/video/derf/twitch/Uncompressed/) / [ReferenceSequences](https://dash-large-files.akamaized.net/WAVE/3GPP/5GVideo/ReferenceSequences/) | to be checked |
| DOTA2 | Twitch | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | [h264](https://media.xiph.org/video/derf/twitch/H264/) [uncompressed](https://media.xiph.org/video/derf/twitch/Uncompressed/) | to be checked |
| EuroTruckSimulator2 | Twitch | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | [h264](https://media.xiph.org/video/derf/twitch/H264/) [uncompressed](https://media.xiph.org/video/derf/twitch/Uncompressed/) | to be checked |
| Fallout4 | Twitch | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | [h264](https://media.xiph.org/video/derf/twitch/H264/) [uncompressed](https://media.xiph.org/video/derf/twitch/Uncompressed/) | to be checked |
| GTAV | Twitch | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | [h264](https://media.xiph.org/video/derf/twitch/H264/) [uncompressed](https://media.xiph.org/video/derf/twitch/Uncompressed/) | to be checked |
| Hearthstone | Twitch | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | [h264](https://media.xiph.org/video/derf/twitch/H264/) [uncompressed](https://media.xiph.org/video/derf/twitch/Uncompressed/) | to be checked |
| Minecraft | Twitch/SA4 | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | [h264](https://media.xiph.org/video/derf/twitch/H264/) [uncompressed](https://media.xiph.org/video/derf/twitch/Uncompressed/) / [ReferenceSequences](https://dash-large-files.akamaized.net/WAVE/3GPP/5GVideo/ReferenceSequences/) | to be checked |
| Rust | Twitch | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | [h264](https://media.xiph.org/video/derf/twitch/H264/) [uncompressed](https://media.xiph.org/video/derf/twitch/Uncompressed/) | to be checked |
| Starcraft | Twitch/SA4 | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | [h264](https://media.xiph.org/video/derf/twitch/H264/) [uncompressed](https://media.xiph.org/video/derf/twitch/Uncompressed/) / [ReferenceSequences](https://dash-large-files.akamaized.net/WAVE/3GPP/5GVideo/ReferenceSequences/) | to be checked |
| Witcher3 | Twitch | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | [h264](https://media.xiph.org/video/derf/twitch/H264/) [uncompressed](https://media.xiph.org/video/derf/twitch/Uncompressed/) | to be checked |
| Baolei-Man | Tencent/SA4 | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | [ReferenceSequences](https://dash-large-files.akamaized.net/WAVE/3GPP/5GVideo/ReferenceSequences/) | to be checked |
| Baolei-Balloon 4K | Tencent/SA4 | 4096x2160, 60p, 10s (600 Frames), YUV420(8 bits) | [ReferenceSequences](https://dash-large-files.akamaized.net/WAVE/3GPP/5GVideo/ReferenceSequences/) | to be checked |
| Baolei-Yard 4K | Tencent/SA4 | 4096x2160, 60p, 10s (600 Frames), YUV420(8 bits) | [ReferenceSequences](https://dash-large-files.akamaized.net/WAVE/3GPP/5GVideo/ReferenceSequences/) | to be checked |
| Baolei-Woman | Tencent/SA4 | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | [ReferenceSequences](https://dash-large-files.akamaized.net/WAVE/3GPP/5GVideo/ReferenceSequences/) | to be checked |
| Jianling-Temple | Tencent/SA4 | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | [ReferenceSequences](https://dash-large-files.akamaized.net/WAVE/3GPP/5GVideo/ReferenceSequences/) | to be checked |
| Jianling-Beach | Tencent/SA4 | 1920x1080, 60p, 10s (600 Frames), YUV420(8 bits) | [ReferenceSequences](https://dash-large-files.akamaized.net/WAVE/3GPP/5GVideo/ReferenceSequences/) | to be checked |
| Heroes of the Storm part 1 | Kingston/SA4 | 1920x1080, 30p, 30s (900 Frames), YUV420(8 bits) | [ReferenceSequences](https://dash-large-files.akamaized.net/WAVE/3GPP/5GVideo/ReferenceSequences/) | to be checked |
| Project CARS | Kingston/SA4 | 1920x1080, 30p, 30s (900 Frames), YUV420(8 bits) | [ReferenceSequences](https://dash-large-files.akamaized.net/WAVE/3GPP/5GVideo/ReferenceSequences/) | to be checked |
| WoW part 2 | Kingston/SA4 | 1920x1080, 30p, 30s (900 Frames), YUV420(8 bits) | [ReferenceSequences](https://dash-large-files.akamaized.net/WAVE/3GPP/5GVideo/ReferenceSequences/) | to be checked |

1. **Auxiliary information for gaming sequences**

Various additional information may be available from the gaming engine. This can include:

|  |  |  |
| --- | --- | --- |
| **Type** | **Format** | **Used in** |
| depth map | per-pixel, 14 bit | JVET-Y0041 |
| optical flow | quarter-pel | JVET-Y0041 |
| camera information | 4x4 array, 32bit | JVET-AF0187 |
| depth map | per-pixel, 32bit | JVET-AF0187 |
| motion vector | per-pixel, 32bit | JVET-AF0187 |
| camera information | 4x4 array, 32bit | DesertTown/ Sun\_Temple when released |
| depth map | per-pixel, 32bit (R32) | DesertTown/ Sun\_Temple when released |
| motion vector | per-pixel, 2x32bit (R32G32) | DesertTown/ Sun\_Temple when released |
| albedo texture | per-pixel, 4x8bit (R8G8B8A8) | DesertTown/ Sun\_Temple when released |
| normal map | per-pixel, 3x32bit (R32G32B32) | DesertTown/ Sun\_Temple when released |

1. **Sequence segments to be simulated**

Of each sequence a segment of 5 seconds was selected for encoding for January meeting. This data should help identifying the most interesting sequences for a new class of gaming content sequences.

The table below lists the selected segments for each sequence. Note that for some sequence more than one potentially interesting segment was identified.

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

1. **Coding performance results**

Encoding ongoing. Will be added when available.

1. **Recommendations**

The AHG recommends to:

* Continue to evaluate candidate sequences for gaming content compression
* Continue to refine testing conditions (use classF yes/no, potentially adjust QPs)
* Identify if/how auxiliary information can be used for coding of gaming content
* Review input documents on gaming content compression

Further discussion on test material in joint meeting with AG 5. After availability of results, a BoG meeting (J. Sauer, S. Puri) should summarize them before the joint meeting is held.

It should be clarified if it is possible to transfer the newly proposed content to the JVET ftp (licensing conditions are included in the telco report).

[JVET-AG0016](https://jvet-experts.org/doc_end_user/current_document.php?id=13789) JVET AHG report: Generative face video compression (AHG16) [Y. Ye (chair), H.-B. Teo, Z. Lyu, S. McCarthy, S. Wang (vice chairs)]

1. **Conference calls**

AHG16 conducted two conference calls during this AHG period, with 42 and 32 participants in the first and second conference call, respectively. The following three contributions were reviewed at these conference calls:

* JVET-AG0042 “AHG 16: Proposed Common Software Tools and Testing Conditions for Generative Face Video Compression” is related to the mandates on testing conditions and software tools for GFVC experimentation; it proposes talking face video test sequences, coding configurations for VVC and GFVC, quality and distortion metrics, and proposes a software tool to evaluate and compare the GFVC coding performance with that of VVC Main 10 profile;
* JVET-AG0048 “AHG16: Interoperability Study on Parameter Translator of Generative Face Video Coding” is related to the mandate on interoperability study; it trains parameter translator networks that allow “mismatched” encoder and decoder (i.e. encoder and decoder can rely on different types of GFVC algorithm and parameters) to interoperate. The software implementation of JVET-AG0048 is based on the GFVC software tool provided by JVET-AG0042;
* JVET-AG0187 “AHG16: Study text for common test conditions and evaluation procedures for generative face video coding (draft 1)” is related to the mandate on testing conditions. It provides a template for drafting the GFVC testing conditions and reference configurations.

JVET-AG0043 “AHG16: Report on AhG meeting on generative face video compression” provides detailed notes on the discussions around the above contributions and the participant lists of the two conference calls. A brief summary of the main conclusions of the AHG16 conference calls is as follows:

* AHG16 recommends the following initial testing conditions to be used for GFVC:
  + 8-bit, SDR, low delay configurations;
  + 15 VOXCELEB test sequences and 18 CFVQA test sequences as identified in JVET-AG0042, where the 18 CFVQA sequences also include the 3 extra “bad case” sequences provided in JVET-AG0042-v3, all sequences are in 256x256 resolution;
  + VVC QP: 37, 42, 47, 52;
  + GFVC QP (for base pictures): 22, 32, 42, 52;
* Software tool: recommend to adopt the GFVC software tool proposed in JVET-AG0042 as the AHG16 software tool;
* Interoperability: recommend to adopt the translator networks proposed in JVET-AG0048 as part of the AHG16 software tool to provide an interoperability example;
* Encourage identification and study of other datasets, including test sequences with higher resolutions;
* Continue to study the behavior of GFVC within a wider bit rate range, not just the QP points suggested above.

AHG16 requests for JVET to discuss the establishment of the AHG16 software tool and testing conditions considering the above recommendations. AHG16 also requests GitHub repository to host AHG16 software tool and disk space to host the test sequences on JVET’s ftp site.

1. **Related contributions**

Besides the three contributions listed above (JVET-AG0042, JVET-AG0048, and JVET-AG0187), the following contributions are identified as being related to the activities of AHG16:

[JVET-AG0087](https://jvet-experts.org/doc_end_user/current_document.php?id=13643) AHG9: On the generative face video SEI message [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

[JVET-AG008](https://jvet-experts.org/doc_end_user/current_document.php?id=13644)8 AHG9: Usage of the neural-network post-filter characteristics SEI message to define the generator NN of the generative face video SEI message [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

[JVET-A](https://jvet-experts.org/doc_end_user/current_document.php?id=13695)[G0139](https://jvet-experts.org/doc_end_user/current_document.php?id=13595) AHG16: Depthwise separable convolution for generative face video compression [R. Zou, R.-L. Liao, B. Chen, J. Chen, Y. Ye (Alibaba)]

[JVET-AG0203](https://jvet-experts.org/doc_end_user/current_document.php?id=13759) AHG9/AHG16: Common text for proposed generative face video SEI message [J. Chen, B. Chen, Y. Ye (Alibaba), S. Yin, S. Wang (CityU), S. McCarthy, P. Yin, G.-M. Su, A. K. Choudhury, W. Husak, G. J. Sullivan (Dolby)]

1. **Recommendations**

The AHG recommends to:

* Discuss the establishment of the AHG16 software tool and testing conditions in JVET.
* Review related contributions.

It was commented that it would be beneficial to have quality metric numbers reported (could however only be done once the test conditions are agreed).

# Project development (20)

## AHG1: Deployment and advertisement of standards (2)

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

[JVET-AG0020](https://jvet-experts.org/doc_end_user/current_document.php?id=13605) Deployment status of the HEVC standard [G. J. Sullivan]

[JVET-AG0021](https://jvet-experts.org/doc_end_user/current_document.php?id=13606) Deployment status of the VVC standard [G. J. Sullivan]

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

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

[JVET-AG0204](https://jvet-experts.org/doc_end_user/current_document.php?id=13760) AHG9: On VSEI version 4 [Hendry (LGE), S. McCarthy (Dolby), J. Chen, Y. Ye (Alibaba)]

[JVET-AG0213](https://jvet-experts.org/doc_end_user/current_document.php?id=13769) AHG1/AHG2/AHG8: On project management related to the encoder optimization information SEI message [M. M. Hannuksela, A. Aminlou, F. Cricri, H. Zhang (Nokia)]

## 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 Jan. 2024 (chaired by XXX).

[JVET-AG0071](https://jvet-experts.org/doc_end_user/current_document.php?id=13627) Informal Subjective Evaluation of Low Complexity Enhancement Video Codec (LCEVC) with VVC on SDR UHD (4K) Content [O. Chubach, H.-H. Chen, C.-Y. Chen, T.-D. Chuang, Y.-W. Chen, C.-W. Hsu, Y.-W. Huang, S.-M. Lei (MediaTek)]

[JVET-AG0224](https://jvet-experts.org/doc_end_user/current_document.php?id=13797) Response to JVET-AG0071 on Informal Subjective Evaluation of Low Complexity Enhancement Video Codec (LCEVC) with VVC on SDR UHD (4K) Content [L. Ciccarelli, S. Ferrara (V-Nova)] [late] [miss]

## AHG4: Test material (1)

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

[JVET-AG0228](file:///C:\Users\Mathias%20Wien\Downloads\current_document.php%3fid=13801) AHG4/AHG13: source for scanned film test sequences [P. de Lagrange (InterDigital)] [late]

## Codec performance with alternative test materials (0)

This section is kept as a template for future use.

## AHG5: Conformance test development (0)

This section is kept as a template for future use.

## AHG7: ECM tool assessment (1)

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

[JVET-AG0173](https://jvet-experts.org/doc_end_user/current_document.php?id=13729) AHG7: ECM-11 results of non-CTC sequences [X. Li (Google)]

## AHG8: Optimization of encoders and receiving systems for machine analysis of coded video content (7+1)

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

[JVET-AG0085](https://jvet-experts.org/doc_end_user/current_document.php?id=13641) [AHG8] Continuation of study on different VTM versions [C. Hollmann (Ericsson)]

[JVET-AG0090](https://jvet-experts.org/doc_end_user/current_document.php?id=13646) [AHG8] Comments and editorial changes to the draft TR on optimizations for encoders and receiving systems for machine analysis of coded video content [C. Hollmann (Ericsson), S. Liu (Tencent), J. Chen (Alibaba)]

[JVET-AG0178](https://jvet-experts.org/doc_end_user/current_document.php?id=13734) AHG8: Truncating bit depth in video coding for machine tasks [D. Ding, X. Zhao, S. Liu]

[JVET-AG0242](https://jvet-experts.org/doc_end_user/current_document.php?id=13815) Cross-check of JVET-AG0178 (AHG8: Truncating bit depth in video coding for machine tasks) [C. Hollmann (Ericsson)] [late]

[JVET-AG0209](https://jvet-experts.org/doc_end_user/current_document.php?id=13765) AHG8: A suggestion for the performance evaluation of VCM [S. Wang, J. Chen, Y. Ye (Alibaba), S. Wang (CityU)]

[JVET-AG0212](https://jvet-experts.org/doc_end_user/current_document.php?id=13768) AHG8: A post-processing algorithm for machine consumption [B. Li, S. Wang, J. Chen, Y. Ye (Alibaba), S. Wang (CityU)]

[JVET-AG0213](https://jvet-experts.org/doc_end_user/current_document.php?id=13769) AHG1/AHG2/AHG8: On project management related to the encoder optimization information SEI message [M. M. Hannuksela, A. Aminlou, F. Cricri, H. Zhang (Nokia)]

Other contributions on related SEI messages – see section 6.6

[JVET-AG0216](https://jvet-experts.org/doc_end_user/current_document.php?id=13772) 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-AG0217](https://jvet-experts.org/doc_end_user/current_document.php?id=13773) AHG8: Reduced residual encoding in VVC for machine consumption [A. Alireza, A. Hallapuro, H. Zhang [Nokia] [late]

## AHG10: Encoding algorithm optimization (1)

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

[JVET-AG0055](https://jvet-experts.org/doc_end_user/current_document.php?id=13611) AHG10: CTU-Level Lagrange Multiplier and QP Adaptation for VVC Low-Delay Configuration [H. Guo, C. Zhu, L. Luo, J. Chen (UESTC), Y. Huo, Y. Liu (Transsion)]

[JVET-AG0280](https://jvet-experts.org/doc_end_user/current_document.php?id=13853) Crosscheck of JVET-AG0055 (AhG10: CTU-Level Lagrange Multiplier and QP Adaptation for VVC Low-Delay Configuration) [J. Huo, Z. Zhang (Xidian Univ.)] [late] [miss]

## AHG13: Film grain synthesis (3+4)

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

[JVET-AG0101](https://jvet-experts.org/doc_end_user/current_document.php?id=13657) AHG9: Film grain adaptive SEI message [Y. Gao, S.-W. Xie, Y.-X. Bai, M.-H. Jia, C. Huang, P. Wu (ZTE)]

[JVET-AG0140](https://jvet-experts.org/doc_end_user/current_document.php?id=13696) AHG9/AHG13: FGS Extension SEI message for spatial adaptation [G. Teniou, S. Wenger, A. Hinds (Tencent)]

[JVET-AG0153](https://jvet-experts.org/doc_end_user/current_document.php?id=13709) [AHG13] Proposed FGS applications [G. Teniou (Tencent)]

[JVET-AG0160](https://jvet-experts.org/doc_end_user/current_document.php?id=13716) AHG9/AHG13: FGS Extension SEI message useful descriptors [G. Teniou, S. Wenger, A. Hinds (Tencent)]

[JVET-AG0215](https://jvet-experts.org/doc_end_user/current_document.php?id=13771) AHG9/AHG13: Region-dependent film grain characteristics [P. de Lagrange, E. François, M. Le Pendu, C. Salmon-Legagneur (InterDigital)] [late]

[JVET-AG0290](https://jvet-experts.org/doc_end_user/current_document.php?id=13863) [AHG13] Compressibility analysis of Film Grain test sequences [S. Paluri, J. Kim, D. Podborski, A. M. Tourapis (Apple)] [late] [miss]

[JVET-AG0295](https://jvet-experts.org/doc_end_user/current_document.php?id=13868) AHG13: Frequency domain Film Grain Objective Metrics with Adaptive Region Selection [X. Meng, W. Zhang, S. Labrozzi (Disney Streaming)] [late]

## Implementation studies (0)

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

## Profile/tier/level specification (1)

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

[JVET-AG0201](https://jvet-experts.org/doc_end_user/current_document.php?id=13757) On MV-HEVC profiles [Y.-K. Wang, H. Liu, L. Zhang, S. Jiao, C. Hu, J. Cui, G. Xu (Bytedance), A. M. Tourapis, D. Podborski, S. Paluri (Apple)]

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

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

[JVET-AG0047](https://jvet-experts.org/doc_end_user/current_document.php?id=13601) AHG15: Report on AhG meeting on gaming content compression [S. Puri, J. Sauer, R. Chernyak, A. Duenas, L. Wang]

[JVET-AG0302](https://jvet-experts.org/doc_end_user/current_document.php?id=13875) AHG15: Description of gaming content sequences proposed by Huawei [Z. Lin, W. Chen, Y. Zhao, K. Cai, J. Sauer, E. Alshina (Huawei)] [late]

## Generative face video (AHG16) (4+4)

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

[JVET-AG0042](https://jvet-experts.org/doc_end_user/current_document.php?id=13595) AHG 16: Proposed Common Software Tools and Testing Conditions for Generative Face Video Compression [B. Chen, J. Chen, R.-L. Liao, Y. Ye (Alibaba), S. Wang (CityU)]

[JVET-AG0043](https://jvet-experts.org/doc_end_user/current_document.php?id=13596) AHG16: Report on AhG meeting on generative face video compression [J.-R. Ohm, Y. Ye, H.-B. Teo, Z. Lyu, S. McCarthy, S. Wang]

[JVET-AG0048](https://jvet-experts.org/doc_end_user/current_document.php?id=13602) AHG16: Interoperability Study on Parameter Translator of Generative Face Video Coding [S. Yin, B. Chen, J. Chen, R.-L. Liao, Y. Ye (Alibaba), S. Wang (CityU)]

[JVET-AG0087](https://jvet-experts.org/doc_end_user/current_document.php?id=13643) AHG9: On the generative face video SEI message [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

[JVET-AG0088](https://jvet-experts.org/doc_end_user/current_document.php?id=13644) AHG9: Usage of the neural-network post-filter characteristics SEI message to define the generator NN of the generative face video SEI message [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

[JVET-AG0139](https://jvet-experts.org/doc_end_user/current_document.php?id=13695) AHG16: Depthwise separable convolution for generative face video compression [R. Zou, R.-L. Liao, B. Chen, J. Chen, Y. Ye (Alibaba)]

[JVET-AG0187](https://jvet-experts.org/doc_end_user/current_document.php?id=13743) AHG16: Study text for common test conditions and evaluation procedures for generative face video coding (draft 1) [S. McCarthy, P. Yin (Dolby), B. Chen, Y. Ye (Alibaba), S. Wang (CityU)]

[JVET-AG0203](https://jvet-experts.org/doc_end_user/current_document.php?id=13759) AHG9/AHG16: Common text for proposed generative face video SEI message [J. Chen, B. Chen, Y. Ye (Alibaba), S. Yin, S. Wang (CityU), S. McCarthy, P. Yin, G.-M. Su, A. K. Choudhury, W. Husak, G. J. Sullivan (Dolby)]

# Low-level tool technology proposals (103)

## AHG11/AHG14: Neural network-based video coding (18+2)

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

Contributions in this area were discussed at 2100–2310 on Wednesday 17 Jan. 2024 (chaired by JRO).

[JVET-AG0023](https://jvet-experts.org/doc_end_user/current_document.php?id=13790) 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)]

This report summarizes the activities of the Exploration Experiment 1 (EE1) performed between the 32nd and 33rd JVET meetings to evaluate Neural Network-based Video Coding (NNVC) technologies, analyze their performance, evaluate their complexity aspects, and clarify training procedure. One teleconference has been conducted during this meeting circle.

Introduction

This round of EE1 tests includes:

* EE1-1: HOP
  + EE1-1.0: HOP re-training and luma/chroma balance changes ([JVET-AF0155](about:blank), [JVET-AF0180](about:blank)), possible tuning from JVET-AF0150, JVET-AF0296
  + EE1-1.1: EE1-0 with architecture change variant 1 (JVET-AF0102, JVET-AF0103, JVET-AF0182), as defined in [JVET-AF0307](https://jvet-experts.org/doc_end_user/current_document.php?id=13571).
  + EE1-1.2: EE1-0 with architecture change variant 2 (JVET-AF0102, JVET-AF0103, JVET-AF0153), as defined in [JVET-AF0307](https://jvet-experts.org/doc_end_user/current_document.php?id=13571).
  + EE1-1.3: Comparison test for HOP single model and two models (JVET-AF0183)
  + EE1-1.4: Study joint inference design of [JVET-AF0154](about:blank) (rotation) and [JVET-AF0086](about:blank) (flipping)
  + EE1-1.5: HOP In-loop filter with transformer blocks (JVET-AF0158)
* EE1-2: LOP
  + EE1-2.1: LOP/HOP fast training (JVET-AF0043, fast Stage III training)
  + EE1-2.2: LOP Content adaptive (JVET-AF0056)
  + EE1-2.3: Further complexity reduction of LOP (JVET-AF0071)
* EE1-3: inter prediction
  + EE1-3.1: Deep Reference Frame Generation for Inter Prediction Enhancement (JVET-AF0208)
* EE1-4: super-resolution
  + EE1-4.1: Unified CNN super resolution for resampling-based video coding (JVET-AF0143).

The anchor for EE1 tests is the default configuration of NNVC-7.0 as defined by AhG11/AhG14 (NN-intra and low complexity NN-filter are enabled by default) in JVET-AE2016. Anchor performance and reference point for HOP NN-filters was be provided by AhG14 (shown in the Table 1).

*Table 1 EE1 anchor performance vs VTM.*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Random access** | | | | | | | |
|  | **BD-rate Over NNVC-7.1 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -7.9% | -10.1% | -10.6% | -8.5% | -11.2% | -10.7% | 129% | 9031% |
| Class A2 | -6.8% | -12.7% | -9.7% | -7.0% | -11.8% | -7.3% | 126% | 8426% |
| Class B | -6.6% | -13.9% | -12.7% | -6.8% | -12.9% | -11.9% | 127% | 9076% |
| Class C | -6.6% | -14.9% | -14.4% | -7.1% | -13.2% | -12.9% | 120% | 7892% |
| Class E |  |  |  |  |  |  |  |  |
| **Overall** | **-6.9%** | **-13.2%** | **-12.1%** | **-7.3%** | **-12.4%** | **-11.0%** | 126% | 8606% |
| Class D | -7.2% | -14.8% | -15.0% | -6.5% | -13.2% | -13.1% | 119% | 7530% |
| Class F | -3.7% | -9.5% | -9.4% | -4.2% | -10.2% | -9.8% | 136% | 3684% |
|  |  |  |  |  |  |  |  |  |
|  | **Low delay B** | | | | | | | |
|  | **BD-rate Over NNVC-7.1 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class B | -5.3% | -13.4% | -13.3% | -6.1% | -14.7% | -17.5% | 120% | 8941% |
| Class C | -5.5% | -13.7% | -14.9% | -7.4% | -15.5% | -17.0% | 113% | 7756% |
| Class E | -6.1% | -8.9% | -12.1% | -7.8% | -10.5% | -13.5% | 136% | 9072% |
| **Overall** | **-5.6%** | **-12.4%** | **-13.5%** | **-6.9%** | **-13.9%** | **-16.3%** | 121% | 8558% |
| Class D | -6.5% | -13.1% | -15.4% | -7.3% | -14.2% | -17.9% | 110% | 7563% |
| Class F | -3.1% | -8.7% | -8.7% | -4.2% | -9.9% | -13.2% | 129% | 4227% |
|  |  |  |  |  |  |  |  |  |
|  | **All Intra** | | | | | | | |
|  | **BD-rate Over NNVC-7.1 VTM** | | | | | | | |
|  | Y-PSNR | U-PSNR | V-PSNR | Y-MSIM | U-MSIM | V-MSIM | EncT | DecT CPU |
| Class A1 | -8.6% | -12.7% | -12.3% | -9.0% | -14.3% | -12.6% | 187% | 6908% |
| Class A2 | -7.1% | -12.7% | -11.3% | -7.5% | -12.3% | -9.2% | 186% | 5880% |
| Class B | -7.3% | -13.0% | -13.5% | -7.4% | -13.3% | -13.4% | 181% | 5701% |
| Class C | -7.5% | -13.8% | -14.5% | -7.9% | -14.3% | -14.6% | 168% | 4342% |
| Class E | -10.7% | -14.1% | -15.1% | -10.9% | -13.6% | -14.1% | 176% | 6176% |
| **Overall** | **-8.1%** | **-13.3%** | **-13.4%** | **-8.4%** | **-13.6%** | **-13.0%** | 179% | 5644% |
| Class D | -7.7% | -12.7% | -15.0% | -7.5% | -13.6% | -15.4% | 160% | 4159% |
| Class F | -5.3% | -10.8% | -10.4% | -5.1% | -11.3% | -11.8% | 141% | 4847% |

Summary **of all test results**

Summary of all EE1 tests results is shown in Table 2.

The key aspects of each EE1 test are described below.

HOP filter category:

* EE1-1.0 is retraining of existing unified HOP filter architecture with better Luma-Chroma performance balance. As agreed during AhG11/AhG14 teleconference ([JVET-AG0041](https://jvet-experts.org/doc_end_user/current_document.php?id=13594)) it became new NNVC-7.1 HOP2 filter design and comparison point for all technologies targeting replacement HOP filter. This became the basis of all other experiments in the HOP category.
* EE1-1.1 [JVET-AG0174](https://jvet-experts.org/doc_end_user/current_document.php?id=13730) key aspects: group convolutions in residual block (JVET-AF0182), alternation of two types of residual blocks and decomposition rank reduction, i.e. C31=48 (JVET-AF0102), 1×1 convolutions instead of 3×3 over IPB and BS inputs (JVET-AF0103).
* EE1-1.2 withdrawn
* EE1-1.3 [JVET-AG0175](https://jvet-experts.org/doc_end_user/current_document.php?id=13731) key aspects: two separate models for Luma and Chroma with total complexity 473 (366 for Luma, 107 for Chroma) no changes of HOP architecture beside of output and number residual blocks.
* EE-1.4 [JVET-AG0056](https://jvet-experts.org/doc_end_user/current_document.php?id=13612) key aspects: both rotation and flipping are combined to geotransform for input / output NNLF, tested in combination with both LOP and HOP. 0.4% gain in LDB configuration.
* EE-1.5 [JVET-AG0162](https://jvet-experts.org/doc_end_user/current_document.php?id=13718) key aspects: simplified (w/o softmax and layer normalization) transformers based attention module is added to two (#8 and #15) out of 26 residual blocks (additionally “rank of decomposition” C31 is reduced to 48 and alternating BB type, similar to EE1-1.1).

LOP filter category:

* EE1-2.1 withdrawn
* EE1-2.2 [JVET-AG0111](https://jvet-experts.org/doc_end_user/current_document.php?id=13667) key aspects: content adaptivity for LOP, overfitting multiplier in activation in K layers (K depends on bit-rate overhead), only class C results provided so far (0.5% Luma gain in RA cfg). The test is based on the LOP1 architecture.
* EE1-2.3 [JVET-AG0163](https://jvet-experts.org/doc_end_user/current_document.php?id=13719) key aspects: skip connection is modified to have no start/end point between the two 1x1 convolutions and the two 1x1 conv layers could be fused into one single 1x1 convolutional layer. Training strategy (batch size and learning rate) is modified compared to anchor.

NN-Inter category:

* EE1-3.1 [JVET-AG0122](https://jvet-experts.org/doc_end_user/current_document.php?id=13678) key aspects: deep reference frame generation with down-sampled input, ‘small IFRNet’ and up-sampling resulting optical flow, reduced number of channels, removal of some convolution operation. The complexity of model is reduced from 504 kMAC/pxl to 69 kMAC/pxl during this EE. Training uses license free HAA500 data base.

Super-resolution category:

* EE1-4.1 [JVET-AG0130](https://jvet-experts.org/doc_end_user/current_document.php?id=13686) key aspects: Super-resolution filter in NNVC has 469kMAC/pxl complexity. Two variants of SR filter with Low complexity (20 kMAC/pxl) and same as existing SR filter complexity (469 kMAC/pxl), both based on unified filter architecture are tested in absence of other NNVC tools (NNVC configured as VTM).

*Table 2 Summary of results for all EE1 tests vs NNVC-7.1 default configuration* (NNLF-LOP2 & NN-Intra).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Random Access** | | | **All Intra** | | | **kMAC/pxl** | **Param** | **Source** |
| Y | U | V | Y | U | V |  |  |  |
| NNVC-7.1 [LOP] | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 25.1 | 1.6 | [JVET-AG0014](https://jvet-experts.org/doc_end_user/current_document.php?id=13597) |
| EE1-1.0 [HOP] | -7.2% | 0.8% | -2.3% | -4.8% | 2.3% | 0.5% | 485 | 3 | [JVET-AG0014](https://jvet-experts.org/doc_end_user/current_document.php?id=13597) |
| EE1-1.1 [HOP] | -7.4% | -0.9% | -2.7% | -5.0% | 2.0% | 0.5% | 474 | 2.9 | [JVET-AG0174](https://jvet-experts.org/doc_end_user/current_document.php?id=13730) |
| EE1-1.3 [HOP] | -7.1% | -1.7% | -3.5% | -4.8% | 0.5% | -0.8% | 481 | 2.9 | [JVET-AG0175](https://jvet-experts.org/doc_end_user/current_document.php?id=13731) |
| EE1-1.4 [HOP] | -7.3% | 0.7% | -2.7% |  |  |  | 485 | 3 | [JVET-AG0056](https://jvet-experts.org/doc_end_user/current_document.php?id=13612) |
| EE1-1.5 [HOP] | -7.2% | -7.0% | -8.0% | -5.5% | -3.2% | -4.2% | 483 | 2.9 | [JVET-AG0162](https://jvet-experts.org/doc_end_user/current_document.php?id=13718) |
| EE1-1.4 [LOP] | -0.1% | -0.4% | -0.4% |  |  |  | 25.1 | 1.6 | [JVET-AG0056](https://jvet-experts.org/doc_end_user/current_document.php?id=13612) |
| EE1-2.2 | - | - | - |  |  |  |  |  | [JVET-AG0111](https://jvet-experts.org/doc_end_user/current_document.php?id=13667) |
| EE1-2.3 [LOP] | -0.3% | 2.6% | 2.1% | 0.0% | 1.8% | 1.5% | 24.6 | 1.6 | [JVET-AG0163](https://jvet-experts.org/doc_end_user/current_document.php?id=13719) |
| EE1-3.1 [LOP] | -0.6% | -0.3% | -0.3% |  |  |  | 94.1 | 4.5 | [JVET-AG0122](https://jvet-experts.org/doc_end_user/current_document.php?id=13678) |

Performance and complexity for technologies targeting HOP filter architecture or inference improvements in NNVC-7.1 are summarized in Table 3. BD-rate reported relatively to NNVC-1.7- HOP (HOP2 filter and NN-Intra enabled).

*Table 3 Summary of results for HOP filter tests in EE1 vs NNVC-7.1 HOP configuration* (NNLF-HOP2 & NN-Intra).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Random Access** | | | **All Intra** | | | **kMAC/pxl** | **Param** | **Source** |
| Y | U | V | Y | U | V |
| EE1-1.0 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 485 | 3 | [JVET-AG0014](https://jvet-experts.org/doc_end_user/current_document.php?id=13597) |
| EE1-1.1 | -0.2% | -1.7% | -0.3% | -0.2% | -0.3% | 0.0% | 474 | 2.9 | [JVET-AG0174](https://jvet-experts.org/doc_end_user/current_document.php?id=13730) |
| EE1-1.3 | 0.1% | -2.4% | -1.1% | 0.1% | -1.8% | -1.3% | 481 | 2.9 | [JVET-AG0175](https://jvet-experts.org/doc_end_user/current_document.php?id=13731) |
| EE1-1.4 | -0.1% | -0.1% | -0.4% |  |  |  | 485 | 3 | [JVET-AG0056](https://jvet-experts.org/doc_end_user/current_document.php?id=13612) |
| EE1-1.5 | 0.0% | -7.6% | -5.7% | -0.7% | -5.5% | -4.7% | 483 | 2.9 | [JVET-AG0162](https://jvet-experts.org/doc_end_user/current_document.php?id=13718) |

*Table 4 Summary of results for Super-resolution technologies tested vs VTM (NNVC-7.1 all tools disabled)*.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Random Access** | | | **All Intra** | | | **kMAC/pxl** | **Param** | **Document** |
| Y | U | V | Y | U | V |
| EE1-4.1.1a | -1.6% | -0.6% | 0.1% | -1.2% | -0.2% | -1.2% | 20 | 0.08 | [JVET-AG0130](https://jvet-experts.org/doc_end_user/current_document.php?id=13686) |
| EE1-4.1.1b | -2.2% | -0.6% | 0.3% | -1.2% | -2.7% | -1.2% | 469 | 1.9 | [JVET-AG0130](https://jvet-experts.org/doc_end_user/current_document.php?id=13686) |

HOP category:

1.1 is basically a simplification, but was slightly modified such that complexity in kMAC/pix became the same as 1.0, and provides some gain in luma and chroma, run time reduction. Training by three independent parties, cross-checked. Decision: Adopt JVET-AG0174

1.3 has small loss in luma, gain in chroma. The approach of using separate models for luma and chroma could also be combined with the simplification of 1.1 Investigate this aspect in next EE.

1.4 (flipping/rotation signalled on block level) is only applied to B slices, no gain was found for I slices. Gain relatively small for RA, reported larger for LB. Encoding runtime is slightly larger, decoding run time is increased, as the filter is enabled more frequently. It was commented that this is less related to exploring NN technology, but rather giving chances of using it more frequently. The gain is relatively small, and it adds some complexity in software for encoder and decoder. It was also commented that by a more extensive training strategy this might also be implicitly done in the NN LF. No action.

1.5 has interesting gain in chroma, and also luma for AI, and it is using transformers in attention mechanisms. Further, though integerization is known to be problematic for transformers, a simplification was implemented that is quantized. Training crosscheck not done yet – further investigate in next EE.

LOP category:

2.2 (adaptive post filter) is based on LOP1 (not the newest LOP). Shows interesting gain, and latency has also been reduced by performing overfitting on segments of 1 s rather than whole sequence as in previous approach. Time to train the model was also reduced. Further investigate in EE with newest LOP, which likely will need some modification of the overfitting process. It was further commented that results are not complete yet, and it will be interesting to review those (revisit).

2.3 is a complexity reduction of the current LOP. Some gain in luma for RA, but loss in chroma. For AI, loss in chroma. A different training strategy was used, but it was reported that when using it for the base model as well, still luma gain is retained. Cross-checkers reported that the unbalance of luma and chroma performance should be better understood. Revisit (review of contribution).

NN-Inter category:

3.1 complexity was largely reduced relative to previous version, but the gain also dropped from -2.3% to -0.6% (RA luma). An alternative dataset was used for training. Proponents report that the performance with the usual (BVI) set was not satisfactory (may not be appropriate for the optical flow inherent in the network). By using yet another set (Vimeo which would not be license free), a gain of -1.3% would be possible. The previous approach also used Vimeo for training. Further investigate in EE. It was also suggested that when later adopting such an approach to NNVC, it might be good to have a higher-operation point as well.

It was commented that for tools that go more towards end-to-end optimization and need optimization for different types of motion the currently available training sets may not be sufficient.

It was suggested to issue a call for training material. Revisit, possibly BoG. Clips do not need to be long, but 65 frames (RA period) should be available.

Super-resolution category:

4.1 is testing unified solutions (LOP and HOP). HOP similar in performance to SR currently in NNVC SW, Was not tested in combination with loop filters – results are against VTM anchor, not NNVC. It was also commented that a modified encoder decision (additional RD check) was used than in current SR and RPR. The proponent commented that this was only modified for LOP in AI.

Proponents were asked to provide results on top of NNVC anchor. Revisit.

It was agreed to impose a deadline to finalization of EE1 results by limiting write access to the GIT (plus 24 hrs grace period).

[JVET-AG0041](https://jvet-experts.org/doc_end_user/current_document.php?id=13594) AhG11/AhG14 teleconference [E. Alshina, F. Galpin, D. Rusanovskyy]

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

Contributions in this area were discussed in the context of the EE summary report JVET-AG0023, or in the BoG JVET-AG0XXX unless noted otherwise.

[JVET-AG0056](https://jvet-experts.org/doc_end_user/current_document.php?id=13612) EE1-1.4: Joint design of rotation and flipping on NNLF [Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO), R. Chang, L. Wang, X. Xu, S. Liu (Tencent)]

[JVET-AG0294](https://jvet-experts.org/doc_end_user/current_document.php?id=13867) Crosscheck of JVET-AG0056 (EE1-1.4) [J. Li (Bytedance)] [late] [miss]

[JVET-AG0111](https://jvet-experts.org/doc_end_user/current_document.php?id=13667) EE1-2.2: Content-adaptive LOP filter [R. Yang, M. Santamaria, F. Cricri, M. M. Hannuksela, H. Zhang, J. Lainema, A. Hallapuro, D. Bugdayci Sansli (Nokia)]

[JVET-AG0300](https://jvet-experts.org/doc_end_user/current_document.php?id=13873) Crosscheck of JVET-AG0111 (EE1-2.2: Content-adaptive LOP filter) [S. P. Badya, A. Shyam, J. N. Shingala (Ittiam)] [late]

[JVET-AG0122](https://jvet-experts.org/doc_end_user/current_document.php?id=13678) EE1-3.1: Deep Reference Frame Generation for Inter Prediction Enhancement [X. Chen, W. Bao, J. Jia, Z. Chen (Wuhan Univ.), Z. Liu, X. Xu, S. Liu (Tencent)]

[JVET-AG0235](https://jvet-experts.org/doc_end_user/current_document.php?id=13808) Crosscheck of JVET-AG0122 (EE1-3.1: Deep Reference Frame Generation for Inter Prediction Enhancement) [Z. Xie (OPPO)] [late]

[JVET-AG0130](https://jvet-experts.org/doc_end_user/current_document.php?id=13686) EE1-4.1: Unified CNN-based super resolution for resampling-based video coding [C. Lin, Y. Li, J. Li, K. Zhang, L. Zhang (Bytedance)]

[JVET-AG0226](https://jvet-experts.org/doc_end_user/current_document.php?id=13799) Crosscheck of JVET-AG0130 (EE1-4.1: Unified CNN-based super resolution for resampling-based video coding) [J. Ye, X. Li, Y. Zhu, Q. Liu (HUST)] [late]

[JVET-AG0162](https://jvet-experts.org/doc_end_user/current_document.php?id=13718) EE1-1.5: Report on implementation of HOP In-loop filter with Transformer blocks [Y. Li, D. Rusanovskyy, M. Karczewicz (Qualcomm)]

[JVET-AG0241](https://jvet-experts.org/doc_end_user/current_document.php?id=13814) Crosscheck of JVET-AG0162 (EE1-1.5: Report on implementation of HOP In-loop filter with Transformer blocks) [D. Liu (Ericsson)] [late]

[JVET-AG0163](https://jvet-experts.org/doc_end_user/current_document.php?id=13719) EE1-2.3: Further complexity reduction on the joint LOP.2 [T. Shao, P. Yin, S. McCarthy (Dolby), J. N. Shingala, A. Shyam, A. Suneja, S. P. Badya (Ittiam)]

TBP/revisit from EE summary

[JVET-AG0161](https://jvet-experts.org/doc_end_user/current_document.php?id=13717) Crosscheck of EE1-2.3 [D. Rusanovskyy (Qualcomm)] [late]

[JVET-AG0174](https://jvet-experts.org/doc_end_user/current_document.php?id=13730) EE1-1.1: Report on training with HOP architecture change for EE1-0 (variant 1) [Y. Li, C. Lin, J. Li, K. Zhang, L. Zhang (Bytedance), D. Rusanovskyy, Y. Li, M. Karczewicz (Qualcomm), R. Chang, L. Wang, X. Xu, S. Liu (Tencent)]

[JVET-AG0175](https://jvet-experts.org/doc_end_user/current_document.php?id=13731) EE1-1.3: Separate models for HOP filter [Y. Li, C. Lin, J. Li, K. Zhang, L. Zhang (Bytedance), F. Galpin (InterDigital), D. Rusanovskyy (Qualcomm), R. Chang (Tencent)]

### EE1 related contributions: Neural network-based video coding (3)

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

[JVET-AG0155](https://jvet-experts.org/doc_end_user/current_document.php?id=13711) EE1-Related: On Low Complexity Operational Point for In-Loop Filtering [D. Rusanovskyy, Y. Li, M. Karczewicz (Qualcomm)]

[JVET-AG0156](https://jvet-experts.org/doc_end_user/current_document.php?id=13712) EE1-Related: On LOP2 training process [D. Rusanovskyy, Y. Li, M. Karczewicz (Qualcomm)]

[JVET-AG0179](https://jvet-experts.org/doc_end_user/current_document.php?id=13735) EE1-1.1-related: HOP filter complexity alignment with wider activation [Y. Li, C. Lin, J. Li, K. Zhang, L. Zhang (Bytedance)]

### Improvements of NNVC beyond EE1 (4)

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

[JVET-AG0057](https://jvet-experts.org/doc_end_user/current_document.php?id=13613) [AHG11] Study on lower-complexity NNLF [Z. Xie, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AG0069](https://jvet-experts.org/doc_end_user/current_document.php?id=13625) AhG11: LOP with inputs transformed [D. Liu, J. Ström, M. Damghanian, P. Wennersten (Ericsson)]

[JVET-AG0258](https://jvet-experts.org/doc_end_user/current_document.php?id=13831) Crosscheck of JVET-AG0069 (AhG11: LOP with inputs transformed) [Y. Li (Qualcomm)] [late]

[JVET-AG0114](https://jvet-experts.org/doc_end_user/current_document.php?id=13670) AHG11: On new input and backbone enhancement of model for super-resolution [J. Ye, X. Li, Y. Zhu, Q. Liu (HUST), C. Zhou, M. Rafie, Z. Lv (vivo)]

[JVET-AG0129](https://jvet-experts.org/doc_end_user/current_document.php?id=13685) AHG11: Unified CNN-based super resolution [C. Zhou, Z. Lv (vivo)]

### SADL implementation (3)

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

[JVET-AG0109](https://jvet-experts.org/doc_end_user/current_document.php?id=13665) AhG14 SADL update [F. Galpin, T. Dumas, P. Bordes, E. François (InterDigital)]

[JVET-AG0115](https://jvet-experts.org/doc_end_user/current_document.php?id=13671) AHG14: The extension of SADL library [X. Li, J. Ye, Y. Zhu, Q. Liu (HUST)]

[JVET-AG0219](https://jvet-experts.org/doc_end_user/current_document.php?id=13792) AHG14: The extension of SADL library [Y. Cai, W. Bao, Z. Chen (Wuhan Univ.)] [late]

## AHG6/AHG12: Enhanced compression beyond VVC capability (85+1)

### Summary and BoG reports (1)

Contributions in this area were discussed at 2330–XXXX on Wednesday 17 Jan. 2024 (chaired by JRO).

[JVET-AG0024](https://jvet-experts.org/doc_end_user/current_document.php?id=13791) EE2: Summary report of exploration experiment on enhanced compression beyond VVC capability [V. Seregin, J. Chen, R. Chernyak, K. Naser, J. Ström, F. Wang, M. Winken, X. Xiu, K. Zhang (EE coordinators)]

This document provides a summary report of Exploration Experiment on Enhanced Compression beyond VVC capability. The tests are categorized as intra prediction, inter prediction, transform and coefficient coding, in-loop filtering, and entropy coding.

The software basis for this EE is ECM-10.0, released at <https://vcgit.hhi.fraunhofer.de/ecm/ECM/-/tags/ECM-11.0>. ECM-11.0 is used as an anchor in the tests.

Software for EE tests is released in the corresponding branches at <https://vcgit.hhi.fraunhofer.de/ecm/jvet-af-ee2/ECM/-/branches>.

Test results can be found in input JVET contributions, cross-check results are uploaded to <https://vcgit.hhi.fraunhofer.de/ecm/jvet-af-ee2/simulation-results> if cross-check reports are not submitted as they are optional for EE tests.

**List** of **tests**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Intra prediction** | | | |
| 1.1a | Decoder derived CCP mode | Y.-J. Chang (Qualcomm)  [JVET-AG0154](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0154-v1.zip) | H.-J. Jhu  (Kwai)  [JVET-AG0269](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0269-v1.zip) |
| 1.1b | Test 1.1a with decoder derived CCP fusion modes | Y.-J. Chang (Qualcomm)  [JVET-AG0154](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0154-v1.zip) | J. Lainema  (Nokia)  [JVET-AG0278](https://jvet-experts.org/doc_end_user/current_document.php?id=13851) |
| 1.2 | IntraTMP with merge candidates | K. Naser (InterDigital)  [JVET-AG0151](https://jvet-experts.org/doc_end_user/current_document.php?id=13707) | I.Zupancic (Nokia)  [JVET-AG0245](https://jvet-experts.org/doc_end_user/current_document.php?id=13818) |
| 1.3 | SGPM with IntraTMP and IBC | K. Naser  (InterDigital)  [JVET-AG0152](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0152-v1.zip) | I.Zupancic (Nokia)  [JVET-AG0245](https://jvet-experts.org/doc_end_user/current_document.php?id=13818) |
| 1.4 | IntraTMP extension to DIMD | K. Naser  (InterDigital)  [JVET-AG0146](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0146-v1.zip) | K. Cui  (Qualcomm)  [JVET-AG0170](https://jvet-experts.org/doc_end_user/current_document.php?id=13726) |
| 1.5 | IntraTMP extension to LIC | F. Le Léannec  (InterDigital)  [JVET-AG0136](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0136-v1.zip) | K. Cui  (Qualcomm)  [JVET-AG0171](https://jvet-experts.org/doc_end_user/current_document.php?id=13727) |
| 1.6 | Test 1.4 + Test 1.5 | F. Le Léannec  (InterDigital)  [JVET-AG0137](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0137-v2.zip) | M. Abdoli  (Xiaomi)  [JVET-AG0255](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0255-v1.zip) |
| 1.7a | Test 1.6 + Test 1.3 | K. Naser  (InterDigital)  [JVET-AG0137](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0137-v2.zip) | F. Wang,  L. Zhang  (OPPO)  [JVET-AG0274](https://jvet-experts.org/doc_end_user/current_document.php?id=13847) |
| 1.7b | Test 1.7a + Test 1.2 | F. Le Léannec (InterDigital)  [JVET-AG0137](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0137-v2.zip) | F. Wang,  L. Zhang  (OPPO)  [JVET-AG0274](https://jvet-experts.org/doc_end_user/current_document.php?id=13847) |
| 1.8a | The length of the auto-relocated BVP trace path is 1 (i.e, n=1) | N. Zhang  (Bytedance)  [JVET-AG0091](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0091-v1.zip) | D. Ruiz Coll, (Ofinno)  [JVET-AG0134](https://jvet-experts.org/doc_end_user/current_document.php?id=13690)  Y. Kidani,  (KDDI)  [JVET-AG0225](https://jvet-experts.org/doc_end_user/current_document.php?id=13798) |
| 1.8b | The length of the auto-relocated BVP trace path is 2 (i.e, n=2) | N. Zhang  (Bytedance)  [JVET-AG0091](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0091-v1.zip) | D. Ruiz Coll, (Ofinno)  [JVET-AG0134](https://jvet-experts.org/doc_end_user/current_document.php?id=13690)  Y. Kidani,  (KDDI)  [JVET-AG0225](https://jvet-experts.org/doc_end_user/current_document.php?id=13798) |
| 1.8c | No constraint for the length of the auto-relocated BVP trace path | N. Zhang  (Bytedance)  [JVET-AG0091](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0091-v1.zip) | D. Ruiz Coll, (Ofinno)  [JVET-AG0134](https://jvet-experts.org/doc_end_user/current_document.php?id=13690)  Y. Kidani,  (KDDI)  [JVET-AG0225](https://jvet-experts.org/doc_end_user/current_document.php?id=13798) |
| 1.9 | Intra TMP fusion probing | J.-L. Lin  (Qualcomm)  [JVET-AG0118](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0118-v1.zip) | Z. Deng  (Bytedance)  JVET-AG0236 |
| 1.10 | Bilateral filtering for intra prediction | W. Yin  (Bytedance)  [JVET-AG0123](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0123-v1.zip) | X. Li  (Alibaba)  JVET-AG0248 |
| 1.11a | IntraTMP search area extension with sampling factor proportional to CU distance | D. Ruiz Coll  (Ofinno)  [JVET-AG0131](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0131-v1.zip) | G. Verba  (Qualcomm)  [JVET-AG0229](https://jvet-experts.org/doc_end_user/current_document.php?id=13802) |
| 1.11b | IntraTMP search area extension with sampling factor proportional to search area dimension | K. Naser  (InterDigital)  [JVET-AG0131](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0131-v1.zip) | G. Verba  (Qualcomm)  [JVET-AG0229](https://jvet-experts.org/doc_end_user/current_document.php?id=13802) |
| 1.11c | Test 1.11a + Test 1.11b | D. Ruiz Coll  (Ofinno)  K. Naser  (InterDigital)  [JVET-AG0131](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0131-v1.zip) | G. Verba  (Qualcomm)  [JVET-AG0229](https://jvet-experts.org/doc_end_user/current_document.php?id=13802) |
| 1.12a | IBC with extended reference area up to the picture’s upper side boundary | Y. Kidani  (KDDI)  [JVET-AG0072](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0072-v1.zip) | N. Zhang  (Bytedance)  [JVET-AG0206](https://jvet-experts.org/doc_end_user/current_document.php?id=13762) |
| 1.12b | IBC with four CTU rows instead of two CTU rows in HD resolution or less | Y. Kidani  (KDDI)  [JVET-AG0072](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0072-v1.zip) | N. Zhang  (Bytedance)  [JVET-AG0206](https://jvet-experts.org/doc_end_user/current_document.php?id=13762) |
| 1.13a | Test 1.11c + Test 1.12a | Y. Kidani  (KDDI)  D. Ruiz Coll  (Ofinno)  K. Naser  (InterDigital)  [JVET-AG0199](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0199-v1.zip) | N. Zhang  (Bytedance)  [JVET-AG0207](https://jvet-experts.org/doc_end_user/current_document.php?id=13763) |
| 1.13b | Test 1.11c + Test 1.12b | Y. Kidani  (KDDI)  D. Ruiz Coll  (Ofinno)  K. Naser  (InterDigital)  [JVET-AG0199](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0199-v1.zip) | N. Zhang  (Bytedance)  [JVET-AG0207](https://jvet-experts.org/doc_end_user/current_document.php?id=13763) |
| 1.14a | Encoder run-time reduction methods for extrapolation filter-based intra prediction mode only | L. Xu (OPPO)  [JVET-AG0058](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0058-v1.zip) | X. Li  (Alibaba)  [JVET-AG0250](https://jvet-experts.org/doc_end_user/current_document.php?id=13823)  H.-J. Jhu  (Kwai)  [JVET-AG0265](https://jvet-experts.org/doc_end_user/current_document.php?id=13838) |
| 1.14b | Encoder run-time reduction methods for extrapolation filter-based intra prediction and its merge mode | L. Xu (OPPO)  [JVET-AG0058](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0058-v1.zip) | X. Li  (Alibaba)  [JVET-AG0250](https://jvet-experts.org/doc_end_user/current_document.php?id=13823)  H.-J. Jhu  (Kwai)  [JVET-AG0265](https://jvet-experts.org/doc_end_user/current_document.php?id=13838) |
| 1.15a | CCP merge fusion | H. Huang  (OPPO)  Z. Deng  (Bytedance)  [JVET-AG0059](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0059-v1.zip) | X. Li  (Alibaba)  [JVET-AG0249](https://jvet-experts.org/doc_end_user/current_document.php?id=13822) |
| 1.15b | Inheriting LB-CCP flag in CCP merge mode | H. Huang  (OPPO)  Z. Deng  (Bytedance)  [JVET-AG0059](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0059-v1.zip) | X. Li  (Alibaba)  [JVET-AG0249](https://jvet-experts.org/doc_end_user/current_document.php?id=13822) |
| 1.15c | Test 1.15a + Test 1.15b | H. Huang  (OPPO)  Z. Deng  (Bytedance)  [JVET-AG0059](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0059-v1.zip) | X. Li  (Alibaba)  [JVET-AG0249](https://jvet-experts.org/doc_end_user/current_document.php?id=13822) |
| 1.16 | Slope adjustment for IBC LIC | C. Ma  (Kwai)  [JVET-AG0103](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0103-v1.zip) | Y. Wang  (Bytedance)  [JVET-AG0221](https://jvet-experts.org/doc_end_user/current_document.php?id=13794) |
| 1.17a | IBC GPM with block vector difference | C. Ma  (Kwai)  [JVET-AG0104](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0104-v1.zip) | Y. Wang  (Bytedance)  [JVET-AG0222](https://jvet-experts.org/doc_end_user/current_document.php?id=13795) |
| 1.17b | IBC GPM with split mode reordering | C. Ma  (Kwai)  [JVET-AG0104](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0104-v1.zip) | Y. Wang  (Bytedance)  [JVET-AG0222](https://jvet-experts.org/doc_end_user/current_document.php?id=13795) |
| 1.17c | Test 1.17a + Test 1.17b | C. Ma  (Kwai)  [JVET-AG0104](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0104-v1.zip) | Y. Wang  (Bytedance)  [JVET-AG0222](https://jvet-experts.org/doc_end_user/current_document.php?id=13795) |
| 1.18a | DIMD mode derivation from spatial blocks | J. Huo, J. Fan  (Xidian Univ.)  M. Li  (OPPO)  [JVET-AG0076](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0076-v1.zip) |  |
| 1.18b | DIMD mode derivation with reduced complexity | J. Huo, J. Fan  (Xidian Univ.)  M. Li  (OPPO)  [JVET-AG0076](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0076-v1.zip) |  |
| 1.19 | IBC-LIC model merge mode | L. Zhang  (OPPO) | Y. Wang  (Bytedance)  [JVET-AG0220](https://jvet-experts.org/doc_end_user/current_document.php?id=13793) |
| 1.20a | TIMD fusion with non-angular predictor | P. Andrivon (Ofinno)  [JVET-AG0092](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0092-v1.zip) | M. Abdoli  (Xiaomi) |
| 1.20b | Test 1.20a + TIMD sample-based fusion | P. Andrivon (Ofinno)  [JVET-AG0092](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0092-v1.zip) | S. Blasi  (Nokia)  [JVET-AG0132](https://jvet-experts.org/doc_end_user/current_document.php?id=13688) |
| 1.21 | TIMD fusion reference line determination | C. Zhou (vivo)  [JVET-AG0128](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0128-v1.zip) | J. Chen  (Alibaba) |
| 1.22a | Test 1.20a + Test 1.21 | P. Andrivon (Ofinno)  C. Zhou  (vivo)  [JVET-AG0093](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0093-v1.zip) | M. Abdoli  (Xiaomi) |
| 1.22b | Test 1.20b + Test 1.21 | P. Andrivon (Ofinno)  C. Zhou (vivo)  [JVET-AG0094](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0094-v1.zip) | S. Blasi  (Nokia)  [JVET-AG0133](https://jvet-experts.org/doc_end_user/current_document.php?id=13689) |
| 1.22c | Test 1.20b + Test 1.21 + Test 1.4 | P. Andrivon (Ofinno)  C. Zhou (vivo)  K. Naser  (InterDigital)  [JVET-AG0095](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0095-v1.zip) | H. Qin  (TCL)  [JVET-AG0127](https://jvet-experts.org/doc_end_user/current_document.php?id=13683) |

***Intra prediction***

**Test 1.1: Decoder derived CCP mode ([JVET-AG0154](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0154-v1.zip))**

In this method, a candidate list of cross-component prediction (CCP) modes is constructed, and to select the best candidate from the list a template cost is calculated to compare the reconstructed samples and the prediction values generated by the evaluated CCP mode. The template is shown in the next figure.

A blue and black rectangle

Description automatically generated

The template adjacent to the current chroma CU

The CCP mode list is constructed from the already existed in ECM modes by single model CCLM, single model CCCM, multi-model CCCM, single model GLCCCM, single model CCCM applied with LBCCP, and multi-model CCCM applied with LBCCP.

In the second aspect of the method, various decoder-derived CCP fusion candidates are added. A fusion candidate is the combination of two CCP modes selected from the existing CCP mode lists reordered by template costs.

Mode flag and a fusion flag are signalled to indicate the mode usage.

Test 1.1a: Decoder derived CCP mode

Test 1.1b: Test 1.1a with decoder derived CCP fusion mode

**Test 1.2: IntraTMP with merge candidates ([JVET-AG0151](https://jvet-experts.org/doc_end_user/current_document.php?id=13707))**

In the test, new candidates, consisting of block vectors from neighbouring PUs coded in IBC or IntraTMP mode, are added into IntraTMP search process. There are up to 25 local and non-local PUs that may be checked during the selection of the neighbouring candidates, those candidates are evaluated together with other candidates, and 30 best candidates (same as in ECM) are selected for further refinement.

The neighbouring candidates may come from outside of IntraTMP search area and such outside candidates are prioritized.

**Test 1.3: SGPM with IntraTMP and IBC ([JVET-AG0152](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0152-v1.zip))**

In the test, spatial GPM (SGPM) mode is extended to additionally consider BVs from IBC and IntraTMP to form a predictor. In the extended SGPM, the predictor may be IBC, IntraTMP or regular intra prediction.

BV are selected as follows:

1. Obtain block vectors of all merge candidates
2. Select the best block vector according to SATD template cost
3. Test up to 6 best block vectors (if available) inside SGPM candidate list construction.



Identifiers intra\_pred\_0 and intra\_pred\_1 correspond to be regular or BV based prediction.

**Test 1.4: IntraTMP extension to DIMD ([JVET-AG0146](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0146-v1.zip))**

The method consists in adaptively selecting between planar or block vector based prediction obtained from IntraTMP or IBC mode of neighboring blocks for the blending with an angular intra prediction in DIMD (up to five predictors and the planar mode predictor with the weights derived from the histogram of gradients can be used). The selection is based on the SAD template cost, where the planar mode is compared to all block vector based prediction. The mode with the minimum cost is selected.

**Test 1.5: IntraTMP extension to LIC ([JVET-AG0136](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0136-v1.zip))**

In the test, LIC usage is extended to IntraTMP mode. A CU-level flag is signalled to indicate the use of LIC. For screen content coding, the IntraTMP LIC mode is extended to support top-only and left-only templates to compute LIC model parameters, while for camera-captured coding, only the top-left template is employed. MMLM is also supported for IntraTMP LIC mode in screen content coding, similar to IBC LIC.

When LIC is used for a given CU, the IntraTMP search process employs MRSAD rather than SAD distortion function to search for block vector.

A restricted version of IntraTMP LIC is also tested. The restriction consists in a reduced IntraTMP search process for both LIC and non-LIC IntraTMP coding units. That is, a SAD-based search is performed for non-LIC blocks and a MRSAD-based search is performed for IntraTMP CUs coded in LIC mode.

To limit the amount of BV search process, the sampling of the IntraTMP search area is increased from 3 to 4.

**Tests 1.6-1.7: Combination of IntraTMP related tests ([JVET-AG0137](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0137-v2.zip))**

Test 1.6: Test 1.4 + Test 1.5 (restricted)

Test 1.7a: Test 1.3 + Test 1.4 + Test 1.5 (restricted)

Test 1.7b: Test 1.2 + Test 1.3 + Test 1.4 + Test 1.5 (restricted)

Test 1.7c: Test 1.2 + Test 1.3 + Test 1.4

**Test 1.8: Auto-relocated block vector prediction ([JVET-AF0079](https://jvet-experts.org/doc_end_user/documents/32_Hannover/wg11/JVET-AF0079-v1.zip))**

In the test, auto-relocated BV is introduced to IBC merge and AMVP candidate list construction. As shown in the next figure, a guiding block vector BV0,1 associated with the current block B0 points to a reference block B1. If B1 has a BV denoted as BV1,2 pointing to a reference block B2, then BV0,2,given by BV0,2 = BV0,1 +BV1,2, is defined as the auto-relocated BVP, guided by BV0,1. Similarly, BV0,n+1 can be derived by

BV0,n+1 =BV0,n+BVn,n+1 = BV0,1+BV1,2 +…+BVn-1,n +BVn,n+1.

A black background with blue lines and squares

Description automatically generated

When deriving BVn,n+1 guided by BV0,n, all five positions shown in the next figure including top-left, top-right, center, bottom-left, and bottom-right positions of Bn are checked to find BVn,n+1.

Auto-relocated BV candidates are inserted after the HBVP candidates. The IBC merge and AMVP candidate list sizes are kept unchanged.

A screen shot of a computer

Description automatically generated

Three tests are conducted varying the length of the trace path, n=1, n=2, and unrestricted.

Test 1.8a: Auto-relocated BV with trace path 1.

Test 1.8b: Auto-relocated BV with trace path 2.

Test 1.8c: Auto-relocated BV with unrestricted trace path.

**Test 1.9: IntraTMP fusion probing ([JVET-AG0118](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0118-v1.zip))**

In ECM, IntraTMP candidate list is constructed from candidates derived by L-shape, left or above template based on the template matching cost which is calculated as the SAD between the template of the reference block and the template of current block. For IntraTMP fusion mode, multiple IntraTMP candidates are linearly combined according to the fusion weights derived from the template matching costs or derived by the MSE minimization method. A flag intra\_tmp\_fusion\_weight\_typeis signalled to indicate which weight derivation method is used and an index intra\_tmp\_fusion\_idx is signalled to indicate which candidate set is selected for IntraTMP fusion.

In the tested method, a fusion candidate with the minimum probing cost is selected from a fusion candidate list without signalling the intra\_tmp\_fusion\_weight\_typeand intra\_tmp\_fusion\_idx. The probing cost is derived as the SAD between the samples in the probing line of the fused template and the current block’s template. The fusion weights derivation is the same as in ECM-11.0, but the samples in probing line are excluded.



A flag is signalled to indicate the IntraTMP fusion probing mode.

**Test 1.10: Bilateral filtering for intra prediction ([JVET-AG0123](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0123-v1.zip))**

In this test, the generated intra prediction samples are further filtered by bilateral filter to reduce the noise level. The filter is similar to BIF used in the loop-filtering stage. The filter length is kept as 2.

**Test 1.11: IntraTMP search range extension with adaptive sampling ([JVET-AG0131](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0131-v1.zip))**

In ECM, the IBC search region comprises the reconstructed samples of a fixed number of CTUs based on the CTU dimension. This region encompasses all left neighbor CTUs within the same row as the current CTU and extends to two CTU rows above the current CTU.



In the test, IntraTMP search region is extended to align with the one of IBC. To cover the whole IBC reference region, the number of IntraTMP regions is increased by one compared to ECM-11, and exclusively, the boundaries of the farthest original regions (R1, R2, and R3) have been modified to cover the whole IBC search region, as it is depicted in next figure.



The ‘*regular search area’* maintains the exact dimensions as in ECM-11 constrained by the *SearchRangeWidth* and *SearchRangeHeight* parameters, and the same sample rate of 3.

The searching process in the further away regions (R1 and R7) is subject to pruning if the normalized TM cost of the last BV candidate in the sparse list is less than a threshold, which depends on the current block's horizontal and vertical size (W, H). Furthermore, the search regions R1 and R6 are scanned in the inverse direction, from left to right, checking before the most probable candidates, and the scanning pattern is shifted by one pixel per row. Lastly, for block sizes of 64 samples, the factor parameter ‘a’ is set to 4, preventing the regular search region from exceeding the IBC search region.

Two methods are tested adapting the sampling rate beyond the regular search area to reduce the complexity of the search extension.

In Test 1.11a, sampling rate is adjusted based on stepwise function stored as lookup table based on the block distance ranging from 3 within the regular search region (a\*W, a\*H) to a maximum sampling factor of 80.

In Test 1.11b, sampling rate is based on IntraTMP regions dimension, where a new subsampling factor is determined for each region () according to the region dimensions as follows:

where F is the constant that controls the gain/complexity trade-off. The new sampling rate factors are only applied at the extended region locations.

Test 1.11c is a combination of Test 1.11a and Test 1.11b:

* The multifactor parameter 'a' for block sizes of 8 and 4 pixels is unified to 5.
* The sampling factor rate for both methods is calculated as described in Test 1.11b.
* The most significant sampling factor is selected for the current location:

**Test 1.12: IBC with upward-extended reference area ([JVET-AG0072](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0072-v1.zip))**

In the ECM, the current IBC reference area is shown in the next figure.



In Test 1.12a, IBC reference area is extended to the whole causal area of a picture (to the top picture boundary).

In Test 1.12b, IBC search area is increased from 2 to 4 CTU rows above the current CTU for HD resolution or less.

**Test 1.13: Combination of IBC and IntraTMP search area related tests ([JVET-AG0199](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0199-v1.zip))**

Test 1.13a: Test 1.11c + Test 1.12a.

Test 1.13b: Test 1.11c + Test 1.12b.

**Test 1.14: Extrapolation filter-based intra prediction mode ([JVET-AG0058](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0058-v1.zip))**

The extrapolation filter-based intra prediction mode consists of three steps:

1. The extrapolation filter coefficients are derived from a neighbouring reconstructed area of the current block or filter shape and coefficients are inherited from a previous block coded with this mode. For the latter, a mode flag is signalled, and candidate list is constructed using spatial and non-adjacent blocks coded with this mode, initial list of 12 candidates is reduced to 6 after reordering based on SAD cost measured on the L-shape template of size 1. An index is further signalled to identify a candidate from the list.
2. The extrapolation process generates predicted signals from the top-left to bottom-right corner within the current block.
3. An intra prediction angle using DIMD process is derived by analyzing the gradient of the predicted block, and then the corresponding intra mode is used to select MTS, NSPT, and LFNST kernels for transform.

The mode is restricted to blocks with sizes not greater than 32x32 and luma component only.

Three filer shapes are used in this method, a choice of reconstructed area and filter shape shown in the next figure is signalled.

A black and white grid

Description automatically generated

A black screen with white squares

Description automatically generated

The selected filter shape moves in the selected reconstructed area with a one-sample step either horizontally or vertically to collect input samples and output samples, then the filter coefficients are derived using CCCM solver.

The merge mode is also introduced, where the filter shape and the filter coefficients are inherited from the previous decoded blocks that are coded with the tested extrapolation filter-based intra prediction mode or the merge mode based on this mode. In the merge mode, the positions and inclusion order of the spatial adjacent, temporal, non-adjacent, shifted temporal, and history candidates are the same as those defined in ECM-11.0 for the CCP merge prediction candidates. In addition, the merge candidates are reordered by comparing the SAD cost on an L-shape template with column width and row height equal to 1. In the SAD calculation, predictions of the template area by the mode filters are generated only from reconstructed (neighbouring and template) samples, allowing the filters to be applied in parallel rather than sequentially.

In the current block, the recursive predictor is derived from the top-left to the bottom-right position by a diagonal prediction order as shown in the next figure, where the predicted results of the previous diagonal are used.

A diagram of a graph

Description automatically generated

The predicted samples are calculated as follows,

where is the predicted value at (x, y) in the current block, is the coefficient of the selected filter, the index of the coefficients is from 0 to 14, is a reconstructed or a predicted value used for the current position’s prediction, and are the position offsets to the current position along x and y directions, respectively.

At encoder side, SATD is used to compare the costs for the added modes to update the list for full RDO, the number of total RDs is not increased. Additionally, the encoder will conditionally reduce one mode with the worst SATD cost in the full RDO cost when extrapolation-based prediction mode is already included in the full RDO list.

Test 1.14a: Encoder run-time reduction methods for extrapolation filter-based intra prediction mode only

Test 1.14b: Encoder run-time reduction methods for extrapolation filter-based intra prediction and its merge mode

**Test 1.15: Enhancements on CCP merge for chroma intra coding ([JVET-AG0059](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0059-v1.zip))**

In the CCP merge mode of ECM, a candidate list is created, which includes CCP models collected from the previous blocks coded by CCLM, MMLM, CCCM, GLM, chroma fusion, and CCP merge modes. Then one candidate in the list is selected as the CCP model for the current block.

In the test, two aspects are evaluated.

Aspect #1: CCP-merge fusion method is introduced where a fused prediction is generated by a weighted sum of the CCP-merge prediction and either the MM-CCCM prediction or the DIMD prediction. A CCP-merge fusion flag is signalled conditionally under the CCP-merge flag, to indicate whether the fusion mode is applied. A CCP-merge fusion type flag is further signalled if the CCP-merge fusion flag is true, to indicate whether the MM-CCCM prediction or the DIMD prediction is selected and fused with the CCP-merge prediction.

Aspect #2: The local-boosting CCP mode flag is inherited from a CCP candidate in the CCP merge candidate list.

Test 1.15a: CCP merge fusion

Test 1.15b: Inheriting LB-CCP flag in CCP merge mode

Test 1.15c: Test 1.15a + Test 1.15b

**Test 1.16: IBC LIC with slope adjustment ([JVET-AG0103](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0103-v1.zip))**

In this test, the slope adjustment of IBC LIC is introduced, where an offset parameter chosen from the set {-1/2, -1/4, -1/8, -1/16, 1/16, 1/8, 1/4, 1/2} is signalled to update the slope parameter of IBC LIC. The proposed method is only applied in IBC AMVP mode and luma component. In addition, the slope adjustment is not applied to the CUs that apply multi-mode IBC LIC.

**Test 1.17:  IBC GPM with block vector difference and split mode reordering ([JVET-AG0104](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0104-v1.zip))**

In Test 1.17a, IBC GPM with block vector difference is introduced, where one additional BVD, which is selected from the set {1/4-pel, 1/2-pel, 1-pel, 2-pel, 4-pel, 8-pel, 16-pel, 32-pel}, is allowed to be added on top of the BV of one IBC GPM partition which is based on regular IBC merge. A flag is signalled for each IBC partition to indicate whether additional BVD is applied. When the flag is true, the corresponding BVD index is further signalled.

In Test 1.17b, the split modes of IBC GPM with template matching are reordered, the reordering is only applied to the first set of IBC GPM split modes.

Test 1.17c: Test 1.17a + Test 1.17b.

**Test 1.18: DIMD mode derivation from spatial blocks ([JVET-AG0076](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0076-v1.zip))**

In this test, DIMD mode is derived by spatial blocks including non-adjacent spatial candidates. When neighbouring blocks are coded with DIMD mode, the DIMD histograms are combined to form a new DIMD merge histogram for the current block. DIMD merge modes and weights are computed based on this merged histogram.

As shown in the below figure, the distances between non-adjacent candidates and current block are defined based on the width and height of current coding block. When using DIMD merge, the DIMD information extracted from neighbouring blocks and non-adjacent spatial blocks is used to compute the intra prediction for the current block.



In Test 1.18a, when more than one neighbouring block encoded with DIMD or DIMD merge are available, all the spatial blocks are used to generate the DIMD merge mode.

In Test 1.18b, when more than one neighbouring block encoded with DIMD or DIMD merge are available, only the non-adjacent spatial candidates are used to derive the DIMD merge mode.

**Test 1.19: IBC-LIC model merge mode ([JVET-AG0060](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0060-v1.zip))**

In the test, IBC-LIC model parameters are inherited from spatial adjacent and non-adjacent neighbours, history candidates, or default models as follows.

1. Construct a model candidate list which consists of model parameters from spatial adjacent and non-adjacent neighbors, history candidates, and default models. The size of the candidate list is 12.

If the list is not full, a default model and the scaled models are then added to the list. To avoid redundant models, a pruning operation is also applied.

1. Select an IBC-LIC model from the candidate list and signal its index.

The IBC-LIC model merge mode can be applied to both IBC-merge mode and IBC-AMVP mode. In IBC-merge mode, the selected LIC model is applied to the reference template during merge list reordering. Then the IBC merge list is further sorted by the inherited IBC LIC flags. In the IBC-AMVP mode, the selected LIC model is applied to the reference template during BVD prediction.

A flag is signalled to indicate whether the IBC-LIC merge mode is applied or not. If this flag is true, an index is further signaled to indicate which candidate model is used by the current block.

**Test 1.20: TIMD fusion with non-angular predictor ([JVET-AG0092](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0092-v1.zip))**

In TIMD of ECM, two intra modes providing the smallest template cost are selected from the list of candidates and blended in a fusion process according to their respective template costs.

In Test 1.20a, a third non-angular intra prediction mode (among DC and planar) with the smallest SATD cost is added in TIMD fusion process, the fusion weights are computed based on the SATD costs.

In Test 1.20b, additionally location-dependent sample-based blending of the DIMD fusion process is re-used but the location-dependent criterion applying to amplitudes of the selected predictors is replaced by a SATD cost-based criteria. The location-dependent criterion is determined from a ratio of the normalized SATD of the selected TIMD predictors computed in ABOVE and LEFT templates area.

**Test 1.21: TIMD fusion reference line determination ([JVET-AG0128](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0128-v1.zip))**

For TIMD mode with blending in ECM-11.0, the first mode uses reference line . While for the second mode, whether to use reference line or +1 depends on the following conditions:

* If all of the following conditions are true, is chosen.
* the current block is not ISP block
* the second mode is angular prediction mode
* the second mode does not represent non-fractional angles
* Otherwise, is chosen.

In this test, for the second mode, the modified (underscored) conditions of reference line determination are as follows:

* If all of the following conditions are true, is chosen.
* the current block is not ISP block
* both the first mode and second mode are angular prediction mode
* all of the following conditions are false
* abs(predModeIntra1 – predModeIntra2) is greater than *Threshold*. The value of *Threshold* is set to 8 or 4.
* (predModeIntra1 - EXT\_HOR\_IDX) \* (predModeIntra2 - EXT\_HOR\_IDX) is less than 0.
* (predModeIntra1 - EXT\_VER\_IDX) \* (predModeIntra2 - EXT\_VER\_IDX) is less than 0.
* Otherwise, is chosen.

**Test 1.22: Combination test of TIMD related tests**

Test 1.22a: Test 1.20a + Test 1.21 ([JVET-AG0093](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0093-v1.zip))

Test 1.22b: Test 1.20b + Test 1.21 ([JVET-AG0094](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0094-v1.zip))

Test 1.22c: Test 1.20b + Test 1.21 + Test 1.4 ([JVET-AG0095](https://jvet-experts.org/doc_end_user/documents/33_Teleconference/wg11/JVET-AG0095-v1.zip))

* TIMD/DIMD intra prediction modes may select IntraTMP/IBC BV (Test 1.22b + Test 1.4)
* a non-angular intra prediction mode (among DC, Planar or the best IntraTMP/IBC BV for TIMD/DIMD modes) is conditionally introduced (Test 1.20a + Test 1.4)
* location sample-based blending for TIMD is used similarly to DIMD (Test 1.20b and Test 1.22b)
* reference lines for TIMD are adjusted (Test 1.21 and Test 1.22b)



1.1: It was asked what the benefit of 1.1a would be, why not the fusion mode from 1.1b could be used without 1.1a? A proponent commented that 1.1a provides gain for luma, and 1.1b adds up gain for chroma. It was asserted that the fusion mode is a superset and cannot be operated standalone. 1.1b provides a reasonable tradeoff, runtimes also confirmed by crosscheck.

Decision: Adopt JVET-AG0154 test 1.1b.

1.2…1.7 are related to each other. It is observed that in the combinations the gain is in most cases more than additive from the different standalone tools (1.2…1.5). A possible explanation may be that all the tools use information from neighboring blocks, and it might be the case that a more frequent usage of intra TMP provides this benefit.

The test 1.7c was not originally planned, and RA results were not made available, and does not have a cross-check. From AI results, 1.7b and 1.7c are providing most attractive tradeoff, where 1.7b has higher gain (0.21% in AI, 0.12% in RA, but also has an encoder runtime increase of 2% in AI. All results except 1.7c are confirmed by crosschecks.

Decision: Adopt JVET-AG0137 test 1.7b.

1.8x is introducing additional candidates. 1.8a is most restricting the number of possible BVs to be traced and confirmed to be straightforward to implement by crosscheckers. In terms of gain, the different versions are not much different (small gain in AI, no gain in RA).

It was asked if effectively the search range / reference area of IBC was increased? It was confirmed by the proponent and a crosschecker that this was not the case.

Decision: Adopt JVET-AG0091 test 1.8a

1.9 has reasonable tradeoff in terms of encoder runtime vs. benefit, but probably introduces some additional processing in intra TMP: According to proponents, the decoder runtime increase is mostly caused by the more frequent usage of intra TMP mode itself rather than the additional processing steps. This is an additional mode which needs to be signalled. According to crosschecker, the mode should be simpler to process than the current Intra TMP mode.

Except for crosschecker, no support was expressed by other experts.

1.10 applies a bilateral filter on the intra prediction blocks (not in DC mode, and somewhat different in case of PDPC). Though there is almost no gain for RA, 0.12% luma gain in AI vs. 1% encoder run time increase would be a reasonable tradeoff. Crosschecker however reports an increase of 2-3% encoding run time. May not be accurate, though.

Gain is higher than reported in last meeting, due to some modifications of the filter.

It was commented that encoding run time might be reduced if the filtering would be omitted in the pre-checks for the RD decision.

It was commented that the bilateral filter when proposed to VVC was originally operating for intra priediction, but was moved into the loop filter stage for complexity considerations.

Revisit: Clarify deviation of encoder run time between proponent and crosschecker. 1% would be reasonable tradeoff for adoption.

### EE2 contributions: Enhanced compression beyond VVC capability (41)

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-AG0058](https://jvet-experts.org/doc_end_user/current_document.php?id=13614) EE2-1.14: An extrapolation filter-based intra prediction mode [L. Xu, Y. Yu, H. Yu, J. Gan, D. Wang (OPPO)]

[JVET-AG0250](https://jvet-experts.org/doc_end_user/current_document.php?id=13823) Crosscheck of JVET-AG0058 (EE2-1.14: An extrapolation filter-based intra prediction mode) [X. Li (Alibaba)] [late]

[JVET-AG0265](https://jvet-experts.org/doc_end_user/current_document.php?id=13838) Crosscheck of JVET-AG0058 (EE2-1.14: An extrapolation filter-based intra prediction mode) [H.-J. Jhu (Kwai)] [late]

[JVET-AG0059](https://jvet-experts.org/doc_end_user/current_document.php?id=13615) EE2-1.15: Enhancements on CCP merge for chroma intra coding [H. Huang, Y. Yu, H. Yu, D. Wang (OPPO), Z. Deng, K. Zhang, L. Zhang (Bytedance)]

[JVET-AG0249](https://jvet-experts.org/doc_end_user/current_document.php?id=13822) Crosscheck of JVET-AG0059 (EE2-1.15: Enhancements on CCP merge for chroma intra coding) [X. Li (Alibaba)] [late]

[JVET-AG0060](https://jvet-experts.org/doc_end_user/current_document.php?id=13616) EE2-1.19: IBC-LIC Model Merge mode [L. Zhang, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AG0220](https://jvet-experts.org/doc_end_user/current_document.php?id=13793) Crosscheck of JVET-AG0060 (EE2-1.19: IBC-LIC Model Merge mode) [Y. Wang (Bytedance)] [late]

[JVET-AG0061](https://jvet-experts.org/doc_end_user/current_document.php?id=13617) EE2-3.3: Utilizing LFNST/NSPT for inter coding [F. Wang, J. Gan, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AG0211](https://jvet-experts.org/doc_end_user/current_document.php?id=13767) Crosscheck of JVET-AG0061 (EE2-3.3: Utilizing LFNST/NSPT for inter coding) [M. Koo (LGE)] [late]

[JVET-AG0067](https://jvet-experts.org/doc_end_user/current_document.php?id=13623) EE2-2.8: On DMVR Extensions [M. Salehifar, Y. He, K. Zhang, L. Zhang (Bytedance)]

[JVET-AG0267](https://jvet-experts.org/doc_end_user/current_document.php?id=13840) Crosscheck of JVET-AG0067 (EE2-2.8: On DMVR Extensions) [H.-J. Jhu, X. Xiu (Kwai)] [late]

[JVET-AG0301](https://jvet-experts.org/doc_end_user/current_document.php?id=13874) Crosscheck of JVET-AG0067 (EE2: test 2.8a - DMVR extension) [P. Le Guyadec (InterDigital)] [late]

[JVET-AG0259](https://jvet-experts.org/doc_end_user/current_document.php?id=13832) Crosscheck report of JVET-AG0061: EE2-3.3: Utilizing LFNST/NSPT for inter coding [K. Naser, S. Puri (InterDigital)] [late]

[JVET-AG0072](https://jvet-experts.org/doc_end_user/current_document.php?id=13628) EE2-1.12: IBC with upward-extended reference area [Y. Kidani, H. Kato, K. Kawamura (KDDI)]

[JVET-AG0206](https://jvet-experts.org/doc_end_user/current_document.php?id=13762) Crosscheck of JVET-AG0072 (EE2-1.12: IBC with upward-extended reference area) [N. Zhang (Bytedance)] [late]

[JVET-AG0076](https://jvet-experts.org/doc_end_user/current_document.php?id=13632) EE2-1.18 DIMD mode derivation from spatial blocks [J. Huo, J. Fan, Z. Zhang, Y. Ma, F. Yang (Xidian Univ.), M. Li (OPPO)]

[JVET-AG0251](https://jvet-experts.org/doc_end_user/current_document.php?id=13824) Crosscheck of JVET-AG0076 (EE2-1.18 DIMD mode derivation from spatial blocks) [X. Li (Alibaba)] [late]

[JVET-AG0091](https://jvet-experts.org/doc_end_user/current_document.php?id=13647) EE2-1.8: Auto-relocated block vector prediction [N. Zhang, K. Zhang, L. Zhang (Bytedance)]

[JVET-AG0134](https://jvet-experts.org/doc_end_user/current_document.php?id=13690) Crosscheck of JVET-AG0091 (EE2-1.8: Auto-relocated block vector prediction) [D. Ruiz Coll (Ofinno)] [late]

[JVET-AG0225](https://jvet-experts.org/doc_end_user/current_document.php?id=13798) Crosscheck of JVET-AG0091 (EE2-1.8: Auto-relocated block vector prediction) [Y. Kidani, K. Kawamura (KDDI)] [late]

[JVET-AG0092](https://jvet-experts.org/doc_end_user/current_document.php?id=13648) EE2-1.20: TIMD fusion with non-angular predictor [P. Andrivon, M. Blestel (Ofinno)]

[JVET-AG0252](https://jvet-experts.org/doc_end_user/current_document.php?id=13825) Crosscheck of JVET-AE0092 (EE2-1.20: TIMD fusion with non-angular predictor) [M. Abdoli, R. G. Youvalari (Xiaomi)] [late]

[JVET-AG0132](https://jvet-experts.org/doc_end_user/current_document.php?id=13688) Crosscheck of EE2-Test 1.20b: TIMD fusion with non angular predictor and sample-based fusion [S. Blasi (Nokia)] [late]

[JVET-AG0093](https://jvet-experts.org/doc_end_user/current_document.php?id=13649) EE2-1.22a: Combination of EE2-1.20a and EE2-1.21 [P. Andrivon, M. Blestel (Ofinno), [C. Zhou](mailto:chuan.zhou@vivo.com), Z. Lv (vivo)]

[JVET-AG0253](https://jvet-experts.org/doc_end_user/current_document.php?id=13826) Crosscheck of JVET-AG0093 (EE2-1.22a: Combination of EE2-1.20a and EE2-1.21) [M. Abdoli, R. G. Youvalari (Xiaomi)] [late]

[JVET-AG0094](https://jvet-experts.org/doc_end_user/current_document.php?id=13650) EE2-1.22b: Combination of EE2-1.20b and EE2-1.21 [P. Andrivon, M. Blestel (Ofinno), C. Zhou, Z. Lv (vivo)]

[JVET-AG0133](https://jvet-experts.org/doc_end_user/current_document.php?id=13689) Crosscheck of JVET-AG0094 (EE2-1.22b: Combination of EE2-1.20b and EE2-1.21) [S. Blasi (Nokia)] [late]

[JVET-AG0095](https://jvet-experts.org/doc_end_user/current_document.php?id=13651) EE2-1.22c: Combination of EE2-1.22b and EE2-1.4 [P. Andrivon, M. Blestel (Ofinno), C. Zhou, Z. Lv (vivo), K. Naser, F. Le Léannec (InterDigital)]

[JVET-AG0127](https://jvet-experts.org/doc_end_user/current_document.php?id=13683) Crosscheck of JVET-AG0095 (EE2-1.22c: Combination of EE2-1.22b and EE2-1.4) [H. Qin (TCL)] [late]

[JVET-AG0097](https://jvet-experts.org/doc_end_user/current_document.php?id=13653) EE2-2.12: Adjusting out-of-boundary prediction samples [P. Astola, J. Lainema (Nokia)]

[JVET-AG0205](https://jvet-experts.org/doc_end_user/current_document.php?id=13761) Crosscheck of JVET-AG0097 (EE2-2.12: Adjusting out-of-boundary prediction samples) [Y. Wang (Bytedance)] [late]

[JVET-AG0098](https://jvet-experts.org/doc_end_user/current_document.php?id=13654) EE2-2.7: AMVP with SbTMVP mode [R.-L. Liao, J. Chen, Y. Ye, X. Li (Alibaba)]

[JVET-AG0234](https://jvet-experts.org/doc_end_user/current_document.php?id=13807) Crosscheck of JVET-AG0098 (EE2-2.7: AMVP with SbTMVP mode) [L. Zhao (Bytedance)] [late]

[JVET-AG0288](https://jvet-experts.org/doc_end_user/current_document.php?id=13861) Crosscheck of JVET-AG0098 (EE2-2.7: AMVP with SbTMVP mode) [F. Pu (Dolby)] [late]

[JVET-AG0099](https://jvet-experts.org/doc_end_user/current_document.php?id=13655) EE2 Test 2.3, 2.4, 2.6b: LIC with multiple templates and slope adjustment [Y. Wang, K. Zhang, Y. He, H. Liu, L. Zhang (Bytedance), X. Xiu, C. Ma, N. Yan, H.-J. Jhu, C.-W. Kuo, W. Chen, X. Wang (Kwai)]

[JVET-AG0214](https://jvet-experts.org/doc_end_user/current_document.php?id=13770) Crosscheck of JVET-AG0099 (EE2-2.4: LIC with slope adjustment) [P. Astola (Nokia)] [late]

[JVET-AG0262](https://jvet-experts.org/doc_end_user/current_document.php?id=13835) Crosscheck of JVET-AG0099 (EE2 Test 2.3, 2.6b: LIC with multiple templates and slope adjustment) [L. Zhang (OPPO)] [late]

[JVET-AG0100](https://jvet-experts.org/doc_end_user/current_document.php?id=13656) EE2-3.2: Transform coefficient coding [P. Nikitin, M. Coban, M. Karczewicz, P. Garus, V. Seregin (Qualcomm)]

[JVET-AG0159](https://jvet-experts.org/doc_end_user/current_document.php?id=13715) Crosscheck of JVET-AG0100 EE2-3.2: Transform coefficient coding [F. Lo Bianco, F. Galpin (Interdigital)] [late]

[JVET-AG0103](https://jvet-experts.org/doc_end_user/current_document.php?id=13659) EE2-1.16: IBC LIC with slope adjustment [C. Ma, X. Xiu, W. Chen, H.-J. Jhu, C.-W. Kuo, N. Yan, X. Wang (Kwai)]

[JVET-AG0221](https://jvet-experts.org/doc_end_user/current_document.php?id=13794) Crosscheck of JVET-AG0103 (EE2-1.16: IBC LIC with slope adjustment) [Y. Wang (Bytedance)] [late]

[JVET-AG0104](https://jvet-experts.org/doc_end_user/current_document.php?id=13660) EE2-1.17: IBC GPM with block vector difference and split mode reordering [C. Ma, X. Xiu, W. Chen, H.-J. Jhu, C.-W. Kuo, N. Yan, X. Wang (Kwai)]

[JVET-AG0222](https://jvet-experts.org/doc_end_user/current_document.php?id=13795) Crosscheck of JVET-AG0104 (EE2-1.17: IBC GPM with block vector difference and split mode reordering) [Y. Wang (Bytedance)] [late]

[JVET-AG0112](https://jvet-experts.org/doc_end_user/current_document.php?id=13668) EE2-2.11: Regression-based GPM blending (tests a,b,c) [P. Bordes, K. Reuzé, F. Galpin, F. Urban, K. Naser, F. Le Léannec, E. François (InterDigital)]

[JVET-AG0285](https://jvet-experts.org/doc_end_user/current_document.php?id=13858) Crosscheck of Test-2.11a from JVET-AG0112 (EE2-2.11: Regression-based GPM blending (tests a,b,c)) [L. Zhao (Bytedance)] [late]

[JVET-AG0117](https://jvet-experts.org/doc_end_user/current_document.php?id=13673) EE2-5.3: Spatial CABAC tuning [J. Lainema, A. Aminlou, P. Astola, D. B. Sansli (Nokia)]

[JVET-AG0119](https://jvet-experts.org/doc_end_user/current_document.php?id=13675) Crosscheck of EE2-Test 5.1 and 5.3 (JVET-AG0117 Spatial CABAC tuning in combination with retrained context initialization for inter slices) [K. Andersson (Ericsson)]

[JVET-AG0124](https://jvet-experts.org/doc_end_user/current_document.php?id=13680) Crosscheck of EE2-Test 5.3 (Spatial CABAC tuning) [P. Nikitin (Qualcomm)] [late] [miss]

[JVET-AG0118](https://jvet-experts.org/doc_end_user/current_document.php?id=13674) EE2-1.9: Intra TMP fusion probing [J.-L. Lin, P.-H. Lin, H. Wang, Y.-J. Chang, Z. Zhang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AG0236](https://jvet-experts.org/doc_end_user/current_document.php?id=13809) Crosscheck of JVET-AG0118 (EE2-1.9: Intra TMP fusion probing) Z. Deng (Bytedance) [late]

[JVET-AG0123](https://jvet-experts.org/doc_end_user/current_document.php?id=13679) EE2-1.10: Bilateral Filtering for Intra Prediction [W. Yin, K. Zhang, Y. Wang, Z. Deng, L. Zhao, N. Zhang, M. Salehifar, L. Zhang (Bytedance)]

[JVET-AG0248](https://jvet-experts.org/doc_end_user/current_document.php?id=13821) Crosscheck of JVET-AG0123 (EE2-1.10: Bilateral Filtering for Intra Prediction) [X. Li (Alibaba)] [late]

[JVET-AG0128](https://jvet-experts.org/doc_end_user/current_document.php?id=13684) EE2-1.21: TIMD fusion reference line determination [C. Zhou, Z. Lv (vivo)]

[JVET-AG0275](https://jvet-experts.org/doc_end_user/current_document.php?id=13848) Crosscheck of JVET-AG0128 (EE2-1.21: TIMD fusion reference line determination) [J. Chen (Alibaba)] [late] [miss]

[JVET-AG0131](https://jvet-experts.org/doc_end_user/current_document.php?id=13687) EE2-1.11: IntraTMP search range extension with adaptive sampling [D. Ruiz Coll (Ofinno), K. Naser, P. Bordes, F. Le Léannec, F. Galpin (InterDigital)]

[JVET-AG0229](https://jvet-experts.org/doc_end_user/current_document.php?id=13802) Crosscheck of JVET-AG0131 (EE2-1.11: IntraTMP search range extension with adaptive sampling) [G. Verba (Qualcomm)] [late]

[JVET-AG0135](https://jvet-experts.org/doc_end_user/current_document.php?id=13691) EE2-2.9: CIIP with subblock-based motion compensation [L. Zhao, K. Zhang, L. Zhang (Bytedance)]

[JVET-AG0271](https://jvet-experts.org/doc_end_user/current_document.php?id=13844) Crosscheck of JVET-AG0135 (EE2-2.9: CIIP with subblock-based motion compensation) [W. Chen (Kwai)] [late]

[JVET-AG0136](https://jvet-experts.org/doc_end_user/current_document.php?id=13692) EE2-1.5: IntraTMP extension to LIC [F. Le Léannec, T. Dumas, K. Naser, Y. Chen, M. Radosavljević (InterDigital)]

[JVET-AG0171](https://jvet-experts.org/doc_end_user/current_document.php?id=13727) Crosscheck of JVET-AG0136 (EE2-1.5: IntraTMP extension to LIC) [K. Cui (Qualcomm)] [late] [miss]

[JVET-AG0137](https://jvet-experts.org/doc_end_user/current_document.php?id=13693) EE2-1.6/1.7a/1.7b: combinations of tests 1.2, 1.3, 1.4 and 1.5 [F. Le Léannec, K. Naser, T. Dumas, Y. Chen, M. Radosavljević, T. Poirier (InterDigital)

[JVET-AG0255](https://jvet-experts.org/doc_end_user/current_document.php?id=13828) Crosscheck of JVET-AG0137 (EE2-1.6 combinations of tests 1.4 and 1.5) [R. G. Youvalari, M. Abdoli (Xiaomi)] [late] [miss]

[JVET-AG0274](https://jvet-experts.org/doc_end_user/current_document.php?id=13847) Crosscheck of JVET-AG0137 EE2-1.7a/b [F. Wang, L. Zhang (OPPO)] [late] [miss]

[JVET-AG0142](https://jvet-experts.org/doc_end_user/current_document.php?id=13698) EE2-2.11d/e/f: Combination of Test 2.9, Test 2.10 and Test 2.11a [L. Zhao, K. Zhang, L. Zhang (Bytedance), P. Bordes, K. Reuzé (InterDigital)]

[JVET-AG0223](https://jvet-experts.org/doc_end_user/current_document.php?id=13796) Crosscheck of EE2-2.11d from JVET-AG0142 (EE2-2.11d/e/f: Combination of Test 2.9, Test 2.10 and Test 2.11a) [M. Blestel (Ofinno)] [late]

[JVET-AG0297](https://jvet-experts.org/doc_end_user/current_document.php?id=13870) Crosscheck of JVET-AG0142 (EE2-2.11d/e/f: Combination of Test 2.9, Test 2.10 and Test 2.11a) [C. Ma (Kwai)] [late] [miss]

[JVET-AG0143](https://jvet-experts.org/doc_end_user/current_document.php?id=13699) EE2-3.1 CABAC inter/intra model switch for residual coding [F. Lo Bianco, F. Galpin, C. Salmon-Legagneur (InterDigital)]

[JVET-AG0147](https://jvet-experts.org/doc_end_user/current_document.php?id=13703) Crosscheck of EE2-3.1 CABAC inter/intra model switch for residual coding [P. Nikitin (Qualcomm)] [late] [miss]

[JVET-AG0145](https://jvet-experts.org/doc_end_user/current_document.php?id=13701) EE2-4.1: Adaptive clipping with signalled lower and upper bounds [K. Cui, Z. Zhang, H. Huang, V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AG0246](https://jvet-experts.org/doc_end_user/current_document.php?id=13819) Cross-check of JVET-AG0145 (EE2-4.1: Adaptive clipping with signalled lower and upper bounds) [F. Le Léannec (InterDigital)] [late]

[JVET-AG0146](https://jvet-experts.org/doc_end_user/current_document.php?id=13702) EE2-1.4: IntraTMP extension to DIMD [K. Naser, T. Poirier, F. Le Léannec, T. Dumas, Y. Chen, M. Radosavljević (InterDigital)]

[JVET-AG0170](https://jvet-experts.org/doc_end_user/current_document.php?id=13726) Crosscheck of JVET-AG0146 (EE2-1.4: IntraTMP extension to DIMD) [K. Cui (Qualcomm)] [late]

[JVET-AG0151](https://jvet-experts.org/doc_end_user/current_document.php?id=13707) EE2-1.2: IntraTMP with Merge Candidates [K. Naser, M. Radosavljević, F. Le Léannec, Y. Chen, T. Dumas, T. Poirier (InterDigital)]

[JVET-AG0244](https://jvet-experts.org/doc_end_user/current_document.php?id=13817) Crosscheck of JVET-AG0151 (EE2-1.2: IntraTMP with Merge Candidates) [I. Zupancic (Nokia)] [late]

[JVET-AG0152](https://jvet-experts.org/doc_end_user/current_document.php?id=13708) EE2-1.3: SGPM with IntraTMP and IBC [K. Naser, Y. Chen, F. Le Léannec (InterDigital)]

[JVET-AG0245](https://jvet-experts.org/doc_end_user/current_document.php?id=13818) Crosscheck of JVET-AG0152 (EE2-1.3: SGPM with IntraTMP and IBC) [I. Zupancic (Nokia)] [late]

[JVET-AG0154](https://jvet-experts.org/doc_end_user/current_document.php?id=13710) EE2-1.1: Decoder Derived Cross-Component Prediction [Y.-J. Chang, P.-H. Lin, V. Seregin, J.-L. Lin, M. Karczewicz (Qualcomm)]

[JVET-AG0269](https://jvet-experts.org/doc_end_user/current_document.php?id=13842) Crosscheck of JVET-AG0154 (EE2-1.1: Decoder Derived Cross-Component Prediction) [H.-J. Jhu (Kwai)] [late]

[JVET-AG0278](https://jvet-experts.org/doc_end_user/current_document.php?id=13851) Crosscheck of EE2-1.1b (Decoder Derived Cross-Component Prediction) [J. Lainema (Nokia)] [late] [miss]

[JVET-AG0157](https://jvet-experts.org/doc_end_user/current_document.php?id=13713) EE2-4.2: Fixed filter for Chroma ALF [N. Hu, M. Karczewicz, H. Wang, V. Seregin (Qualcomm)]

[JVET-AG0272](https://jvet-experts.org/doc_end_user/current_document.php?id=13845) Crosscheck of JVET-AG0157 (EE2-4.2: Fixed filter for Chroma ALF) [C.-W. Kuo, H.-J. Jhu (Kwai)] [late] [miss]

[JVET-AG0158](https://jvet-experts.org/doc_end_user/current_document.php?id=13714) EE2.4-3: Adaptive precision for luma ALF coefficients [N. Hu, M. Karczewicz, H. Wang, V. Seregin (Qualcomm), W. Yin, K. Zhang, L. Zhang (Bytedance)]

[JVET-AG0279](https://jvet-experts.org/doc_end_user/current_document.php?id=13852) Crosscheck of JVET-AG0158 (EE2.4-3: Adaptive precision for luma ALF coefficients) [N. Song (OPPO)] [late] [miss]

[JVET-AG0164](https://jvet-experts.org/doc_end_user/current_document.php?id=13720) EE2-2.10: GPM with affine prediction [K. Zhang, Z. Deng, L. Zhang (Bytedance)]

[JVET-AG0247](https://jvet-experts.org/doc_end_user/current_document.php?id=13820) Crosscheck of JVET-AG0164 (EE2-2.10 GPM with affine prediction) [P. Bordes (InterDigital)] [late]

[JVET-AG0176](https://jvet-experts.org/doc_end_user/current_document.php?id=13732) EE2: Test 2.1, 2.2, 2.5, 2.6a, 2.6e and 2.6f on LIC improvement [Y. Zhang, C.- C. Chen, H. Huang, Z. Zhang, V. Seregin, H. Wang, M. Karczewicz (Qualcomm), X. Xiu, C. Ma, N. Yan, H. -J. Jhu, C.-W. Kuo, W. Chen, X. Wang (Kwai)]

[JVET-AG0177](https://jvet-experts.org/doc_end_user/current_document.php?id=13733) Crosscheck JVET-AG0176 EE2 2.2 [A. Robert, F. Galpin (InterDigital)] [late]

[JVET-AG0270](https://jvet-experts.org/doc_end_user/current_document.php?id=13843) Crosscheck EE2-2.1, 2.2 and 2.6a (LIC improvements) [X. Xiu (Kwai)] [late]

[JVET-AG0260](https://jvet-experts.org/doc_end_user/current_document.php?id=13833) Crosscheck report of JVET-AG0176: EE2: 2.6e and 2.6f on LIC improvement [Y. Yu, Z. Xie (OPPO)] [late]

[JVET-AG0283](https://jvet-experts.org/doc_end_user/current_document.php?id=13856) Crosscheck of JVET-AG0176 EE2: Test 2.1, 2.2, 2.5, 2.6a, 2.6e and 2.6f on LIC improvement (cross-check for 2.1 and 2.6a) [K. Reuzé (InterDigital)] [late]

[JVET-AG0286](https://jvet-experts.org/doc_end_user/current_document.php?id=13859) Crosscheck of EE2-2.5 (LIC improvements) [Y. Zhang (Qualcomm)] [late] [miss]

[JVET-AG0196](https://jvet-experts.org/doc_end_user/current_document.php?id=13752) EE2-5.1/2: CABAC context initialization retraining and slice type based window offsets [F. Galpin, F. Lo Bianco, C. Salmon-Legagneur, K. Naser (InterDigital), V. Seregin, M. Karczewicz (Qualcomm)]

[JVET-AG0210](https://jvet-experts.org/doc_end_user/current_document.php?id=13766) Crosscheck of EE2-5.1 and EE2-5.2 (CABAC context initialization retraining and slice type based window offsets) [D. Bugdayci Sansli, J. Lainema (Nokia)]

[JVET-AG0199](https://jvet-experts.org/doc_end_user/current_document.php?id=13755) EE2-1.13: Combination tests of IntraTMP search range extension with adaptive sampling and IBC with upward-extended area [Y. Kidani, H. Kato, K. Kawamura (KDDI), D. Ruiz Coll (Ofinno), K. Naser, P. Bordes, F. Le Léannec, F. Galpin (InterDigital)]

[JVET-AG0207](https://jvet-experts.org/doc_end_user/current_document.php?id=13763) Crosscheck of JVET-AG0199 (EE2-1.13: Combination tests of IntraTMP search range extension with adaptive sampling and IBC with upward-extended area) [N. Zhang (Bytedance)] [late]

[JVET-AG0276](https://jvet-experts.org/doc_end_user/current_document.php?id=13849) EE2 Test 2.6g, 2.6h, 2.6i, 2.6j: Combination of tests on LIC improvement [Y. Wang, K. Zhang, Y. He, H. Liu, L. Zhang (Bytedance), Y. Zhang, C.- C. Chen, H. Huang, Z. Zhang, V. Seregin, H. Wang, M. Karczewicz (Qualcomm), X. Xiu, C. Ma, N. Yan, H.-J. Jhu, C.-W. Kuo, W. Chen, X. Wang (Kwai)] [late]

[JVET-AG0292](https://jvet-experts.org/doc_end_user/current_document.php?id=13865) Crosscheck of JVET-AG0276 (EE2-2.6: Test 2.6i and Test 2.6j) [Z. Lv (vivo)] [late] [miss]

[JVET-AG0296](https://jvet-experts.org/doc_end_user/current_document.php?id=13869) Crosscheck of JVET-AG0276 (EE2-2.6: Test 2.6g and Test 2.6h) [L. Zhang (OPPO)] [late] [miss]

### EE2 related contributions (11)

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

[JVET-AG0063](https://jvet-experts.org/doc_end_user/current_document.php?id=13619) EE2-1.2 related: AR-BVP for IntraTMP merge candidates [L. Zhang, Y. Yu, F. Wang, H. Yu, D. Wang (OPPO)]

[JVET-AG0256](https://jvet-experts.org/doc_end_user/current_document.php?id=13829) Crosscheck report of JVET-AG0063: EE2-1.2 related: AR-BVP for IntraTMP merge candidates [K. Naser (InterDigital)] [late] [miss]

[JVET-AG0066](https://jvet-experts.org/doc_end_user/current_document.php?id=13622) EE2-3.2 related: On Regular Residual Coding [Y. Yu, L. Xu, J. Gan, H. Yu, L. Zhang, H. Huang, F. Wang, Z. Xie, N. Song, D. Wang (OPPO)]

[JVET-AG0266](https://jvet-experts.org/doc_end_user/current_document.php?id=13839) Crosscheck of JVET-AG0066 (EE2-3.2 related: On Regular Residual Coding) [H.-J. Jhu (Kwai)] [late] [miss]

[JVET-AG0068](https://jvet-experts.org/doc_end_user/current_document.php?id=13624) EE2-3.2 related: On CABAC bin budget [J. Gan, Y. Yu, H. Yu (OPPO)]

[JVET-AG0261](https://jvet-experts.org/doc_end_user/current_document.php?id=13834) Crosscheck of JVET-AG0068 on CABAC bin budget [X. Li (Google)] [late] [miss]

[JVET-AG0268](https://jvet-experts.org/doc_end_user/current_document.php?id=13841) Crosscheck of JVET-AG0068 (EE2-3.2 related: On CABAC bin budget) [H.-J. Jhu (Kwai)] [late] [miss]

[JVET-AG0080](https://jvet-experts.org/doc_end_user/current_document.php?id=13636) EE2-related: Extend block vector prediction for IntraTMP merge candidates [N. Qiu, J. Huo, Y. Ma, F. Yang (Xidian Univ.)]

[JVET-AG0298](https://jvet-experts.org/doc_end_user/current_document.php?id=13871) Crosscheck of JVET-AG0080 (EE2-related: Extend block vector prediction for IntraTMP merge candidates) [X. Li (Alibaba)] [late] [miss]

[JVET-AG0150](https://jvet-experts.org/doc_end_user/current_document.php?id=13706) EE2-related: Adaptive GPM blending [L. Zhao, K. Zhang, L. Zhang (Bytedance)]

[JVET-AG0172](https://jvet-experts.org/doc_end_user/current_document.php?id=13728) EE2-related: Chroma LIC derivation with template costs [T. M. Bae, S. Deshpande (Sharp)]

[JVET-AG0208](https://jvet-experts.org/doc_end_user/current_document.php?id=13764) EE2-related: On LFNST/NSPT index signalling [M. Koo, J. Zhao, J. Lim, S. Kim (LGE)]

[JVET-AG0227](https://jvet-experts.org/doc_end_user/current_document.php?id=13800) Crosscheck of JVET-AG0208 (EE2-related: On LFNST/NSPT index signalling) [F. Wang (OPPO)] [late] [miss]

[JVET-AG0230](https://jvet-experts.org/doc_end_user/current_document.php?id=13803) EE2-3.3 related: On Inter-LFNST [S. Puri, K. Naser, C. Bonnineau, F. Le Leannec (InterDigital)] [late]

[JVET-AG0231](https://jvet-experts.org/doc_end_user/current_document.php?id=13804) EE2-1.7b related: unrestricted 1.7b performances [F. Le Léannec, K. Naser, T. Dumas, Y. Chen, M. Radosavljević, T. Poirier (InterDigital)] [late]

[JVET-AG0233](https://jvet-experts.org/doc_end_user/current_document.php?id=13806) EE2-related: Adaptive precision for CCALF coefficients [N. Hu, M. Karczewicz, V. Seregin, H. Wang (Qualcomm)] [late]

[JVET-AG0237](https://jvet-experts.org/doc_end_user/current_document.php?id=13810) EE2-3.3 related: Fix on LFNST/NSPT index signalling [M. Koo, J. Zhao, J. Lim, S. Kim (LGE)] [late]

### ECM modifications and software improvements beyond EE2 (33)

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

#### General (2)

[JVET-AG0096](https://jvet-experts.org/doc_end_user/current_document.php?id=13652) Non-EE2: On temporal buffer handling [Z. Deng, K. Zhang, L. Zhao, L. Zhang (Bytedance)]

[JVET-AG0291](https://jvet-experts.org/doc_end_user/current_document.php?id=13864) Crosscheck of JVET-AG0096 (Non-EE2: On temporal buffer handling) [[Z. Lv (vivo)](mailto:zhuoyi.lv@vivo.com)] [late] [miss]

[JVET-AG0120](https://jvet-experts.org/doc_end_user/current_document.php?id=13676) Non-EE2: On line buffer restriction [Z. Deng, K. Zhang, L. Zhang (Bytedance)]

[JVET-AG0263](https://jvet-experts.org/doc_end_user/current_document.php?id=13836) Crosscheck of JVET-AG0120 (Non-EE2: On line buffer restriction) [H. Huang (OPPO)] [late] [miss]

#### Intra and CIIP (13)

[JVET-AG0075](https://jvet-experts.org/doc_end_user/current_document.php?id=13631) AHG12: Adaptive MRL Fusion [S. Blasi, J. Lainema (Nokia)]

[JVET-AG0078](https://jvet-experts.org/doc_end_user/current_document.php?id=13634) AHG12: Intra-prediction using Merged Histogram of Gradients [S. Blasi, I. Zupancic, P. Astola, J. Lainema (Nokia)]

[JVET-AG0084](https://jvet-experts.org/doc_end_user/current_document.php?id=13640) AHG12: DIMD Merge List [M. Blestel, P. Andrivon (Ofinno)]

[JVET-AG0254](https://jvet-experts.org/doc_end_user/current_document.php?id=13827) Crosscheck of JVET-AG0084 (AHG12: DIMD Merge List) [R. G. Youvalari, M. Abdoli (Xiaomi)] [late]

[JVET-AG0106](https://jvet-experts.org/doc_end_user/current_document.php?id=13662) AHG12: TIMD merge mode [R. G. Youvalari, M. Abdoli (Xiaomi)] [late]

[JVET-AG0113](https://jvet-experts.org/doc_end_user/current_document.php?id=13669) Non-EE2: FIBC Extension [J. Kim, J. Kang, H. Han, H. Choi (HNU), W. Lim, S.-C. Lim (ETRI)]

[JVET-AG0293](https://jvet-experts.org/doc_end_user/current_document.php?id=13866) Crosscheck of JVET-AG0113 (Non-EE2: FIBC Extension) [H.-J. Jhu (Kwai)] [late] [miss]

[JVET-AG0121](https://jvet-experts.org/doc_end_user/current_document.php?id=13677) Non-EE2: Block vector guided LUT for chroma prediction [J. Huo, X. Hao, M. Chen, N. Qiu, Z. Zhang, Y. Ma, F. Yang (Xidian Univ.), M. Li, F. Wang, J. Ren (OPPO)]

[JVET-AG0299](https://jvet-experts.org/doc_end_user/current_document.php?id=13872) Crosscheck of JVET-AG0121 (Non-EE2: Block vector guided LUT for chroma prediction) [X. Li (Alibaba)] [late] [miss]

[JVET-AG0138](https://jvet-experts.org/doc_end_user/current_document.php?id=13694) Non-EE2: Chroma intra prediction mode reordering [X. Li, R.-L. Liao, J. Chen, Y. Ye (Alibaba)]

[JVET-AG0273](https://jvet-experts.org/doc_end_user/current_document.php?id=13846) Crosscheck of JVET-AG0138 (Non-EE2: Chroma intra prediction mode reordering) [Z. Deng (Bytedance)] [late] [miss]

[JVET-AG0141](https://jvet-experts.org/doc_end_user/current_document.php?id=13697) AHG12: Occurrence-Based Intra Coding (OBIC) [R. G. Youvalari, M. Abdoli (Xiaomi)] [late]

[JVET-AG0186](https://jvet-experts.org/doc_end_user/current_document.php?id=13742) Non-EE2: FIBC Extension [H.-J. Jhu, X. Xiu, W. Chen, C.-W. Kuo, N. Yan, C. Ma, X. Wang (Kwai)]

[JVET-AG0193](https://jvet-experts.org/doc_end_user/current_document.php?id=13749) Non-EE2: Enhancements on IntraTMP [W. Chen, X. Xiu, C. Ma, H.-J. Jhu, C.-W. Kuo, N. Yan, X. Wang (Kwai)]

[JVET-AG0197](https://jvet-experts.org/doc_end_user/current_document.php?id=13753) Non-EE2: Matrix based intra prediction replacing conventional intra modes [B. Ray, H. Wang, V. Seregin, M. Karczewicz, P. Garus (Qualcomm)]

[JVET-AG0202](https://jvet-experts.org/doc_end_user/current_document.php?id=13758) Non-EE2: Geometry partitioning mode with inter prediction and intra block copy Y. Wang, K. Zhang, L. Zhang (Bytedance)

[JVET-AG0243](https://jvet-experts.org/doc_end_user/current_document.php?id=13816) AHG12: Additional Metric for IntraTMP [K. Naser, F. Le Léannec, T. Poirier, H. Guermoud, T. Dumas (InterDigital)] [late]

#### Inter (7)

[JVET-AG0073](https://jvet-experts.org/doc_end_user/current_document.php?id=13629) Non-EE2: Chained motion vector prediction [Y. Kidani, H. Kato, K. Kawamura (KDDI)]

[JVET-AG0240](https://jvet-experts.org/doc_end_user/current_document.php?id=13813) Crosscheck of JVET-AG0073 (Non-EE2: Chained motion vector prediction) [N. Zhang (Bytedance)] [late]

[JVET-AG0257](https://jvet-experts.org/doc_end_user/current_document.php?id=13830) Crosscheck report of JVET-AG0073: Non-EE2: Chained motion vector prediction [K. Naser (InterDigital)] [late] [miss]

[JVET-AG0074](https://jvet-experts.org/doc_end_user/current_document.php?id=13630) Non-EE2: IntraTMP with HMVP Candidates [C. Zhu, G. Li, T. Tang, L. Luo, H. Guo (UESTC), Y. Huo, Y. Liu (Transsion)]

[JVET-AG0281](https://jvet-experts.org/doc_end_user/current_document.php?id=13854) Crosscheck of JVET-AG0074 (Non-EE2: IntraTMP with HMVP Candidates) [M. Radosavljević (InterDigital)] [late] [miss]

[JVET-AG0125](https://jvet-experts.org/doc_end_user/current_document.php?id=13681) AHG12: Parallel friendly use of boundary distortion for DMVR [K. Andersson, R. Yu (Ericsson)]

[JVET-AG0126](https://jvet-experts.org/doc_end_user/current_document.php?id=13682) AhG12: On ECM temporal partitioning prediction [G. Laroche, P. Onno (Canon)]

[JVET-AG0149](https://jvet-experts.org/doc_end_user/current_document.php?id=13705) Non-EE2: Improvements to subblock merge mode [J. Chen, R.-L. Liao, Y. Zheng, X. Li, Y. Ye (Alibaba)]

[JVET-AG0282](https://jvet-experts.org/doc_end_user/current_document.php?id=13855) Crosscheck of JVET-AG0149 (Non-EE2: Improvements to subblock merge mode) [L. Zhao (Bytedance)] [late] [miss]

[JVET-AG0194](https://jvet-experts.org/doc_end_user/current_document.php?id=13750) Non-EE2: Reference filtering for inter-prediction [A. Filippov, V. Rufitskiy, K. Suverov (Ofinno)]

[JVET-AG0195](https://jvet-experts.org/doc_end_user/current_document.php?id=13751) Non-EE2: LIC model parameter inheritance for merge modes [C.-C. Chen, H. Huang, V. Seregin, M. Karczewicz (Qualcomm)]

#### Cross Component Prediction (1)

[JVET-AG0200](https://jvet-experts.org/doc_end_user/current_document.php?id=13756) Non-EE2: Inter CCP merge mode with zero luma CBF [Z. Deng, K. Zhang, L. Zhang (Bytedance)]

#### In-Loop Filters (2)

[JVET-AG0065](https://jvet-experts.org/doc_end_user/current_document.php?id=13621) Non-EE2: Adaptive coefficient precision for CCALF [N. Song, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AG0264](https://jvet-experts.org/doc_end_user/current_document.php?id=13837) Crosscheck of JVET-AG0065 (Non-EE2: Adaptive coefficient precision for CCALF) [W. Yin (Bytedance)] [late] [miss]

[JVET-AG0289](https://jvet-experts.org/doc_end_user/current_document.php?id=13862) Crosscheck of JVET-AG0065 (Non-EE2: Adaptive Coefficient Precision for CCALF) [N. Hu (Qualcomm)] [late] [miss]

[JVET-AG0198](https://jvet-experts.org/doc_end_user/current_document.php?id=13754) Non-EE2: Coding Information based ALF Classification [W. Yin, K. Zhang, Y. Wang, Z. Deng, L. Zhao, N. Zhang, M. Salehifar, L. Zhang (Bytedance)]

#### Entropy coding, transforms, and transform coefficient coding (7)

[JVET-AG0062](https://jvet-experts.org/doc_end_user/current_document.php?id=13618) Non-EE2: Multiple Transform Sets Selection for LFNST/NSPT [F. Wang, Y. Yu, H. Yu, D. Wang (OPPO)]

[JVET-AG0064](https://jvet-experts.org/doc_end_user/current_document.php?id=13620) AHG12: On Context modeling in Chroma Coefficient Coding [L. Xu, H. Yu, Y. Yu, D. Wang (OPPO)]

[JVET-AG0284](https://jvet-experts.org/doc_end_user/current_document.php?id=13857) Crosscheck of JVET-AG0064 (AHG12: On Context modeling in Chroma Coefficient Coding) [P. Nikitin (Qualcomm)] [late] [miss]

[JVET-AG0102](https://jvet-experts.org/doc_end_user/current_document.php?id=13658) AHG12: New context model parameters for low delay B condition [R.-L. Liao, Y. Ye, J. Chen, X. Li (Alibaba)]

[JVET-AG0108](https://jvet-experts.org/doc_end_user/current_document.php?id=13664) AhG12 Entropy coding extension [F. Galpin, F. Lo Bianco, C. Salmon-Legagneur, M. Balcilar (InterDigital)]

[JVET-AG0110](https://jvet-experts.org/doc_end_user/current_document.php?id=13666) AHG12: 16 States TCQ with State Exchange [M. Balcilar, K. Naser, Y. Chen, F. Galpin, F. Le Léannec (InterDigital)]

[JVET-AG0185](https://jvet-experts.org/doc_end_user/current_document.php?id=13741) Non-EE2: Slice based Rice parameter selection for transform skip residual coding [H.-J. Jhu, X. Xiu, W. Chen, C.-W. Kuo, N. Yan, C. Ma, X. Wang (Kwai)]

[JVET-AG0277](https://jvet-experts.org/doc_end_user/current_document.php?id=13850) Crosscheck of JVET-AG0185 (Non-EE2: Slice based Rice parameter selection for transform skip residual coding) [L. Xu (OPPO)] [late] [miss]

[JVET-AG0287](https://jvet-experts.org/doc_end_user/current_document.php?id=13860) Non-EE2: Rice parameter derivation for transform skip residual coding [M. Coban, M. Karczewicz (Qualcomm)] [late]

#### RPR (1)

[JVET-AG0116](https://jvet-experts.org/doc_end_user/current_document.php?id=13672) AHG12: GOP-based RPR encoder control for ECM [K. Andersson, J. Ström, P. Wennersten, R. Yu, W. Ahmad (Ericsson)]

### CTC for EE2/ECM and general ECM improvements (0)

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

# High-level syntax (HLS) and related proposals (41)

## AHG9: SEI messages on NNPF aspects other than grouping (2)

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

[JVET-AG0089](https://jvet-experts.org/doc_end_user/current_document.php?id=13645) AHG9: Temporal extrapolation purpose for the neural-network post-filter characteristics SEI message [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

[JVET-AG0192](https://jvet-experts.org/doc_end_user/current_document.php?id=13748) AHG9: Miscellaneous NNPF items related to VUI [J. Xu, Y.-K. Wang (Bytedance)]

## AHG9: Aspects of NNPF grouping (2)

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

[JVET-AG0052](https://jvet-experts.org/doc_end_user/current_document.php?id=13608) AHG9: On using SEI processing order for NNPF grouping [Hendry, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-AG0180](https://jvet-experts.org/doc_end_user/current_document.php?id=13736) AHG9: On the SEI processing order SEI message [Y. Sanchez, R. Skupin, C. Hellge, T. Schierl (HHI)]

## AHG9: SEI processing order and processing order nesting SEI message aspects other than PPF grouping (7)

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

[JVET-AG0053](https://jvet-experts.org/doc_end_user/current_document.php?id=13609) AHG9: On activation and cancelling persistence of SEI message included in a processing order nesting SEI message [Hendry, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-AG0054](https://jvet-experts.org/doc_end_user/current_document.php?id=13610) AHG9: On the case an SEI message included in multiple sei processing order SEI messages [Hendry, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-AG0105](https://jvet-experts.org/doc_end_user/current_document.php?id=13661) AHG9: On the SEI processing order SEI message [Y. Gao, Y.-X. Bai, S.-W. Xie, M.-H. Jia, C. Huang, P. Wu (ZTE)]

[JVET-AG0165](https://jvet-experts.org/doc_end_user/current_document.php?id=13721) AHG9: On the processing order nesting SEI message [L. Chen, O. Chubach, Y. Huang, S. Lei (MediaTek)]

[JVET-AG0166](https://jvet-experts.org/doc_end_user/current_document.php?id=13722) AHG9: On grouping the SEI prefix data as a new SEI message [L. Chen, O. Chubach, Y. Huang, S. Lei (MediaTek)]

[JVET-AG0168](https://jvet-experts.org/doc_end_user/current_document.php?id=13724) AHG9: Proposed update for the SEI processing order SEI message [L. Chen, O. Chubach, Y. Huang, S. Lei (MediaTek)]

[JVET-AG0169](https://jvet-experts.org/doc_end_user/current_document.php?id=13725) AHG9: Comments on use of NNPF SEI messages in the SEI processing order SEI message [L. Chen, O. Chubach, Y. Huang, S. Lei (MediaTek)]

## AHG9: SEI messages related to generative face video (3)

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

[JVET-AG0087](https://jvet-experts.org/doc_end_user/current_document.php?id=13643) AHG9: On the generative face video SEI message [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

[JVET-AG0088](https://jvet-experts.org/doc_end_user/current_document.php?id=13644) AHG9: Usage of the neural-network post-filter characteristics SEI message to define the generator NN of the generative face video SEI message [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

[JVET-AG0203](https://jvet-experts.org/doc_end_user/current_document.php?id=13759) AHG9/AHG16: Common text for proposed generative face video SEI message [J. Chen, B. Chen, Y. Ye (Alibaba), S. Yin, S. Wang (CityU), S. McCarthy, P. Yin, G.-M. Su, A. K. Choudhury, W. Husak, G. J. Sullivan (Dolby)]

## AHG9: Source picture timing information SEI message aspects (4)

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

[JVET-AG0070](https://jvet-experts.org/doc_end_user/current_document.php?id=13626) AHG9: Comments on Source Picture Timing Information Message [S. Deshpande, J. Samuelsson-Allendes (Sharp)]

[JVET-AG0082](https://jvet-experts.org/doc_end_user/current_document.php?id=13638) AHG9: On Source Picture Timing SEI message [J. Samuelsson-Allendes, S. Deshpande (Sharp)]

[JVET-AG0188](https://jvet-experts.org/doc_end_user/current_document.php?id=13744) AHG9: On source picture timing information SEI message specification text [J. R. Arumugam, L. Jawale (Ittiam), P. Yin, G. J. Sullivan, S. McCarthy (Dolby)]

[JVET-AG0191](https://jvet-experts.org/doc_end_user/current_document.php?id=13747) AHG9: Reference software for source picture timing information SEI message [J. R. Arumugam, L. Jawale (Ittiam), P. Yin, S. McCarthy (Dolby)]

## AHG9: Encoder optimization information SEI message aspects (3)

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

[JVET-AG0083](https://jvet-experts.org/doc_end_user/current_document.php?id=13639) AHG9: On feature-based optimization type [C. Kim, Hendry, J. Lim, S. Kim (LGE)]

[JVET-AG0086](https://jvet-experts.org/doc_end_user/current_document.php?id=13642) AHG9: On the encoder optimization information SEI message [M. M. Hannuksela, F. Cricri, H. Zhang (Nokia)]

[JVET-AG0213](https://jvet-experts.org/doc_end_user/current_document.php?id=13769) AHG1/AHG2/AHG8: On project management related to the encoder optimization information SEI message [M. M. Hannuksela, A. Aminlou, F. Cricri, H. Zhang (Nokia)]

## AHG9: Object mask information SEI message aspects (1)

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

[JVET-AG0148](https://jvet-experts.org/doc_end_user/current_document.php?id=13704) AHG9: On object mask information SEI message [J. Chen, Y. Ye, S. Wang (Alibaba)]

## AHG9: SEI message aspects related to film grain (4)

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

[JVET-AG0101](https://jvet-experts.org/doc_end_user/current_document.php?id=13657) AHG9: Film grain adaptive SEI message [Y. Gao, S.-W. Xie, Y.-X. Bai, M.-H. Jia, C. Huang, P. Wu (ZTE)]

[JVET-AG0140](https://jvet-experts.org/doc_end_user/current_document.php?id=13696) AHG9/AHG13: FGS Extension SEI message for spatial adaptation [G. Teniou, S. Wenger, A. Hinds (Tencent)]

[JVET-AG0160](https://jvet-experts.org/doc_end_user/current_document.php?id=13716) AHG9/AHG13: FGS Extension SEI message useful descriptors [G. Teniou, S. Wenger, A. Hinds (Tencent)]

[JVET-AG0215](https://jvet-experts.org/doc_end_user/current_document.php?id=13771) AHG9/AHG13: Region-dependent film grain characteristics [P. de Lagrange, E. François, M. Le Pendu, C. Salmon-Legagneur (InterDigital)] [late] [miss]

## AHG9: Other SEI topics (11)

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

[JVET-AG0044](https://jvet-experts.org/doc_end_user/current_document.php?id=13598) AHG9: Copyright SEI message [S. Wenger, A. Hinds, G. Teniou (Tencent)]

[JVET-AG0045](https://jvet-experts.org/doc_end_user/current_document.php?id=13599) AHG9: AI marking SEI [S. Wenger, A. Hinds, G. Teniou (Tencent]

[JVET-AG0049](https://jvet-experts.org/doc_end_user/current_document.php?id=13603) AHG9: SEI message extension of VVC for computer-generated hologram use [H. Kojima, K. Nonaka, R. Koiso, K. Kawamura, H. Kato (KDDI)]

[JVET-AG0051](https://jvet-experts.org/doc_end_user/current_document.php?id=13607) AHG9: On design for new SEI RBSP and SEI message [Hendry, J. Nam, S. Kim, J. Lim (LGE)]

[JVET-AG0081](https://jvet-experts.org/doc_end_user/current_document.php?id=13637) AHG9: On signalling privacy protection information in SEI message [C. Kim, Hendry, J. Lim, S. Kim (LGE)]

[JVET-AG0107](https://jvet-experts.org/doc_end_user/current_document.php?id=13663) AHG9: On phase indication SEI message [T. Chujoh, T. Ikai (Sharp), K. Kawamura (KDDI)]

[JVET-AG0167](https://jvet-experts.org/doc_end_user/current_document.php?id=13723) AHG9: Text prompt for generative AI SEI [A. Hinds, G. Teniou, S. Wenger (Tencent)]

[JVET-AG0182](https://jvet-experts.org/doc_end_user/current_document.php?id=13738) AHG9: JPEG segments SEI message [P. de Lagrange, D. Doyen, E. François, F. Urban, C. Salmon-Legagneur (InterDigital)]

[JVET-AG0183](https://jvet-experts.org/doc_end_user/current_document.php?id=13739) AHG9: TIFF data SEI message [P. de Lagrange, D. Doyen, E. François, F. Urban, C. Salmon-Legagneur (InterDigital)]

[JVET-AG0184](https://jvet-experts.org/doc_end_user/current_document.php?id=13740) AHG9: Text comment SEI message [P. de Lagrange, D. Doyen, E. François, F. Urban, C. Salmon-Legagneur (InterDigital)]

[JVET-AG0232](https://www.jvet-experts.org/doc_end_user/current_document.php?id=13805) AHG9: Support of non-parallel MPI layers in the MPII SEI message [Y. Li (SJTU), Y.-K. Wang (Bytedance), Y. Xu, K. Yang (SJTU)] [late]

## Non-SEI HLS aspects (4)

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

[JVET-AG0046](https://jvet-experts.org/doc_end_user/current_document.php?id=13600) Application-required NAL Units [G. Teniou, S. Wenger (Tencent)]

[JVET-AG0077](https://jvet-experts.org/doc_end_user/current_document.php?id=13633) AHG9: On Picture Modality Information [J. Gao, H.-B. Teo, C.-S. Lim, K. Abe, V. Drugeon (Panasonic)]

[JVET-AG0079](https://jvet-experts.org/doc_end_user/current_document.php?id=13635) AHG2/AHG9: VUI extension mechanism and picture modality information for AVC and HEVC [J. Gao, H.-B. Teo, C.-S. Lim, K. Abe, V. Drugeon (Panasonic)]

[JVET-AG0144](https://jvet-experts.org/doc_end_user/current_document.php?id=13700) AHG9: Carriage of depth and alpha maps as HEVC single-layer bitstreams [E. Thomas, E. Potetsianakis, E. Alexiou, R. Ghaznavi-Youvalari, M. Abdoli, M.-L. Champel (Xiaomi)]

# Plenary meetings, joint meetings, BoG reports, and liaison communications

## JVET plenaries

An intermediate plenary was held on XXday XX Jan. XXXX. The following items were discussed:

* …

Further detail on scheduling is recorded in section 2.15.

Joint meetings involving JVET were held as follows:

* JVET, XXX on XXX, on XXday XX Jan. at XXXX–XXXX
* …

Further detail about these sessions with other groups is provided in the other subsections of this section.

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. 0600–XXXX, Wednesday 24 Jan. 0600–XXXX, and Friday 26 Jan. 2100–XXXX.

The status and plans for the work in the MPEG WGs and AGs was reviewed at these information sharing sessions.

## Joint session XXXX XXday XX Jan on XXXX: WG X XXXX, WG 5 / JVET, VCEG

(The notes for this session were recorded by XXX.)

Session ended XX:XX.

## BoGs (1)

The following break-out groups were established at this meeting to conduct discussion and develop recommendations on particular subjects.

## Liaison communications (2)

XXXX liaison mxxxx provided …

A reply was drafted as WG 5 N XXX. It provided …

The liaison responses were reviewed in JVET on XXday XX Jan. at XXXX-XXXX. The draft replies were also presented in the MPEG AG 3 Communication meeting XXday XX Jan. at XXXX.

# Project planning

## Software timeline (update)

ECM 11 software (including all adoptions) was planned to be available 3 weeks after the meeting.

The NNVC 7.0 codebase software was planned to be available 2 weeks after the meeting. An update 7.1 (including potentially the reduced-complexity intra prediction, and an update ofHOP) was planned to be available 5 weeks after the meeting.

VTM23.0 software was planned to be available on 2023-11-24. (Note that further updates may be released later)

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-AG2023.

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-AG2024.

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 Jan. 2024 at XXXX.

|  |  |  |
| --- | --- | --- |
| **Title and Email Reflector** | **Chairs** | **Mtg** |
| **Project Management (AHG1)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Coordinate overall JVET interim efforts. * Supervise AHG and experiment studies. * Report on project status to JVET reflector. * Provide a report to the next meeting on project coordination status. * Supervise processing and delivery of output documents | J.-R. Ohm (chair), G. J. Sullivan (vice‑chair) | N |
| **Draft text and test model algorithm description editing (AHG2)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Produce and finalize draft text outputs of the meeting (JVET-AF1006, JVET-AF1016, and JVET-AF2027. * Collect reports of errata for the VVC, VSEI, HEVC, AVC, CICP, and the published related technical reports and produce the JVET-AF1004 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. * Prepare availability of viewing equipment and facilities arrangements for future meetings. | V. Baroncini, T. Suzuki, M. Wien (co-chairs), W. Husak, S. Iwamura, P. de Lagrange, S. Liu, X. Meng, S. Puri, A. Segall, S. Wenger (vice-chairs) | Y (tel., 2 weeks notice) |
| **Conformance testing (AHG5)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study 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-11.0 software version and the reference configuration encodings according to the ECM common test conditions. * Investigate encoder speedup and other software optimization such as reduction of memory consumption. * Coordinate with ECM algorithm description editors to identify any mismatches between software and text, make further updates and cleanups to the software as appropriate. | V. Seregin (chair), J. Chen, R. Chernyak, F. Le Léannec, K. Zhang (vice-chairs) | N |
| **ECM tool assessment (AHG7)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Investigate methodology of tool assessment. * 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 draft technical report JVET-AE2030 on optimization of encoders and receiving systems for machine analysis of coded video content. * Study the potentials of using SEI messages for the purpose of machine analysis in coordination with AHG9. * Coordinate with WG 4 VCM AHG on aspects such as common test conditions, evaluation metrics, test and training materials, usage of SEI messages, and on studying characteristics and requirements of targeted 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 the document for technologies under consideration for VSEI JVET-AF2032, and propose improvements as appropriate. * Collect software and showcase information for SEI messages, including encoder and decoder implementations and bitstreams for demonstration and testing. * Identify potential needs for additional SEI messages, including the study of SEI messages defined in HEVC and AVC for potential use in the VVC context. * Study the alignments of the same SEI messages in different standards * Coordinate with AHG8 and WG 4 to study mechanisms for signalling metadata in the context of machine analysis of coded video content. * Coordinate with AHG3 for software support of SEI messages. | 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) | N |
| **Encoding algorithm optimization (AHG10)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study the impact of using techniques such as tool adaptation and configuration, and perceptually optimized adaptive quantization for encoder optimization. * Study the impact of non-normative techniques of preprocessing for the benefit of encoder optimization. * Study encoding techniques of optimization for objective quality metrics and their relationship to subjective quality. * Study optimized encoding for reference picture resampling and scalability modes in VTM. * 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. * Coordinate with other groups, including SC29/AG5 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 Nov. 16 |
| **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 ECM11 algorithm description JVET-AF2025. * 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-AF2024 in coordination with the EE coordinators. * Coordinate with AHG11 to study the interaction with neural network-based coding tools. | M. Karczewicz, Y. Ye, L. Zhang (co-chairs), B. Bross, R. Chernyak, X. Li, K. Naser, Y. Yu (vice-chairs) | N |
| **Film grain technologies (AHG13)**  ([jvet@lists.rwth-aachen.de](mailto:jvet@lists.rwth-aachen.de))   * Study the benefits and characteristics of film grain technologies, including autoregressive and frequency-filtering technologies. * Study alternative film grain models and their associated documentation. * 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-AD2022, 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-7.0 and NNVC-7.1 software versions and the 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-AF2019) 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. | 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))   * Establish testing conditions for evaluating the compression performance of generative face video compression (GFVC). * Identify and develop software tools for experimentation on GFVC, and make a software package available. * Study interoperability requirements, including study of the compression performance impact due to GFVC parameter translation. * Study compression performance using the VVC Main 10 profile. * Develop a document summarizing GFVC technologies. | 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 XXX) 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 XXX, as noted in section 9.

[JVET-AF1000](https://jvet-experts.org/doc_end_user/current_document.php?id=13582) Meeting Report of the 32nd JVET Meeting [J.-R. Ohm] [WG 5 N 239] (2023-11-17)

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] (2023-06-30)

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.

Post-meeting note: Expected *de facto* primary editor for ITU consent text: G. J. Sullivan.

[JVET-AF1004](https://jvet-experts.org/doc_end_user/current_document.php?id=13583) Errata report items for VVC, VSEI, HEVC, AVC, and Video CICP [Y.-K. Wang, B. Bross, I. Moccagatta, C. Rosewarne, G. J. Sullivan] (2024-01-10, near next meeting)

Post-meeting note: *De facto* primary editor: Y.-K. Wang.

Errata from JVET-AF0064, and one item on VSEI that was brought up by FNB in the context of ballot comments on AVC and HEVC (missing parenthesis):

1. (no SW change needed) All 4 items from JVET-AF0064 [Bytedance/Dolby]
2. (no SW change needed) A clarification of semantics for the existing SEI manifest and SEI prefix messages, appending “in decoding order” after “in the first access unit of the CVS”, from JVET-AF0189 [Dolby]

These items should also be included into the AVC DIS and the HEVC DAM1 texts and their corresponding JVET output documents, when applicable.

Remains valid – not updated: [JVET-Z1005](https://jvet-experts.org/doc_end_user/current_document.php?id=11707) New levels for HEVC (Draft 3) [T. Suzuki, A. Tourapis, Y.-K. Wang]

The content of this document (along with some errata corrections from JVET-AD1004) was included in a new edition of HEVC submitted for ITU consent (and had previously been included in the FDIS submitted as WG 5 N 179 issued from the January 2023 meeting).

Post-meeting note: *De facto* primary editor for ITU consent text: Y.-K. Wang.

(JVET-Z1005 can be removed after publication of the new edition of ISO/IEC 23008-2.)

[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] (2023-11-10)

Primary editor for this document and WG 5 N 244: Y.-K. Wang.

Text updates from JVET-AF0063 (except those relating to the MV profile structure), and some errata fixes:

1. (no SW change needed) 3 bug fixes from JVET-AF0063-v2 and CDAM1 ballot comments US005, US006 (see the DoCR). [Bytedance/US]
   1. Replacing an “and” with “or”
   2. Changing the constraint for the multiview monochrome profiles requiring chroma\_format\_idc to be equal to 1 to requiring chroma\_format\_idc to be equal to 0
   3. Adding the constraint requiring colour\_mapping\_enabled\_flag to be equal to 0 only for the Multiview Main 10 profile.
2. (no SW change needed) 1 bug fix from CDAM1 ballot comment FR008, on a missing ‘}’ in Eqn. D-15 (see the DoCR in WG5 N0243). [France]

A DoCR on ISO/IEC 23008-2/CDAM1 was issued as WG 5 N 243 (reviewed Thursday 19 Oct 1530).

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]

Remains valid – not updated: [JVET-AD1008](https://jvet-experts.org/doc_end_user/current_document.php?id=12972) Additional colour type identifiers for AVC and HEVC (Draft 4) [G. J. Sullivan, W. Husak, A. Tourapis] [WG 5 Preliminary WD N 200] (2023-06-30)

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]

Remains valid – not updated: [JVET-AE1011](https://jvet-experts.org/doc_end_user/current_document.php?id=13267) HEVC multiview profiles supporting extended bit depth (draft 2) [S. Paluri, W. Husak, A. Tourapis] [2023-08-11]

From JVET-AE0296. The specification of these profiles was also included in [JVET-AE1006](https://jvet-experts.org/doc_end_user/current_document.php?id=13266) and WG 5 N 226. This document, basically duplicating part of JVET-AE1006, was not issued as a separate WG 5 N document. See JVET-AE1006 for editorship note.

Draft 1 had been issued as preliminary WD WG 5 N 143.

(Number 1011 can be re-used when JVET-AE1006 progresses.)

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] (2023-05-19)

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] [2023-09-01]

New licensing available from JVET-AE0179. Other owners had not responded, therefore it was assumed that they don’t have a problem that the sequences are used.

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]

This requires an update, as the previous version referred to an outdated location of test sequences.

[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] [2023-11-10]

Primary editor of this document and WG 5 N 241: B. Bross.

Target 15th edition of ITU-T H.264 in April 2024.

Changes from JVET-AF0045, and some errata item fixes:

1. (SW changes likely not needed) All 4 items from JVET-AF0045, with the some of the items also covered by DE008 from the CD ballot comments [Nokia/DE] (see the DoCR in WG5 N0240)
   1. Regarding nuh\_layer\_id, which does not exist in AVC
   2. Regarding output\_flag, which is present only in the NAL unit header SVC extension
   3. Regarding picture unit, which is not defined in AVC
   4. Typo corrections of fp\_arrangement\_type 🡪 frame\_packing\_arrangement\_type and SliceQpY 🡪 SliceQPY
2. (no SW change needed) Bug fixes and editorial improvements from CD ballot comments (see the DoCR in WG5 N0240):
   1. US002: Avoid using “should” in NOTEs. Further check at least Annex F onwards. Either use phrases like “is expected to” or convert the NOTE to not be a NOTE. [US]
   2. US003: Avoid using “may” in NOTEs. Either replace “may” with “can” or convert the NOTE to not be a NOTE. Generally avoid using “could”, “might” and “would”. [US]
   3. US006: Add a left curly bracket after “if( sii\_sub\_layer\_idx = = 0 )” and another one after “if( shutter\_interval\_info\_present\_flag )”; rephrase the semantics for fixed\_shutter\_interval\_within\_cvs\_flag and shutter\_interval\_info\_present\_flag to introduce an “If” case to correspond with each “Otherwise” case; and express the observations of the condition in which the “Otherwise” cases apply inside of parentheses. [US]
   4. FR009: On a missing ‘}’ in Eqn. D-26 [France]

A DoCR on ISO/IEC CD 14496-10 was issued as WG 5 N 240 (reviewed Thursday 19 Oct 1610).

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**

[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] (2024-01-12, near next meeting)

New elements from notes elsewhere in this report:

* Decision (SW): Adopt the new threshold in JVET-AF0111 to the next releases of ECM, VTM and VTM-11ecm.
* Decision (SW): Adopt JVET-AF0122 to the next release of VTM, turned off by default in CTC.

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-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] (2023-08-18)

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] (2023-08-18)

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] (2023-05-26)

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]

[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] (2023-10-26)

This includes some editorial updates.

[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] (2023-11-03)

This is to include a modified Excel sheet, and mention the requirement of documenting decoder memory consumption (see discussion under JVET-AF0201).

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-AF2019](https://jvet-experts.org/doc_end_user/current_document.php?id=13580) Description of algorithms and software in neural network-based video coding (NNVC) version 5 [F. Galpin, Y. Li, D. Rusanovskyy, J. Ström, L. Wang] [WG 5 N 248] (2023-12-15)

New elements from notes elsewhere in this report:

* Decision: Adopt JVET-AF0043 LOP 2.3 architecture, and inference interface. This will become part of the NNVC7.0 anchor. Configuration files for training shall also become part of NNVC7.0.
* Adoption to NNVC-7.0
  + Decision (software): Adopt [JVET-AF0085](about:blank) (EE1-1.2.1), enable by default for LOP and HOP;
  + Decision (software fix): Adopt [JVET-AF0172](about:blank) (redundant signalling removal);
  + Decision (software, encoder only): Adopt JVET-AF0193 (disable by default);
  + Decision (training): Adopt [JVET-AF0180](about:blank) and [JVET-AF0155](about:blank) (12:1:1 distortion weight in HOP training)
  + Decision (CTC): Adopt [JVET-AF0155](about:blank) (Chroma QP offset +1 for HOP inference)
* Decision: Adopt JVET-AF0205 (decided Thu 19 Oct. at 1630, after confirmation of successful completion of the crosscheck).

Remains valid – not updated: [JVET-AE2020](https://jvet-experts.org/doc_end_user/current_document.php?id=13275) Film grain synthesis technology for video applications (Draft 5) [D. Grois, Y. He, W. Husak, P. de Lagrange, A. Norkin, M. Radosavljević, A. Tourapis, W. Wan] [WG 5 DTR N 223] (2023-09-08)

[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] (2023-12-22)

See notes under JVET-AF0311 for updates.

Remains valid – not updated: [JVET-AD2022](https://jvet-experts.org/doc_end_user/current_document.php?id=12982) Draft plan for subjective quality testing of FGC SEI message [P. de Lagrange, W. Husak, M. Radosavljević, M. Wien] (2023-06-16)

According to discussions under section 4.12, more investigations are necessary on the new sequences. An update of this document was agreed to be postponed.

[JVET-AF2023](https://jvet-experts.org/doc_end_user/current_document.php?id=13578) 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 247] (2023-11-03)

An initial draft of this document was reviewed and approved at 0900-0925 on Friday 20 Oct.

This round of EE1 tests will include:

* EE1-1: HOP
  + EE1-1.0: HOP re-training and luma/chroma balance changes ([JVET-AF0155](about:blank), [JVET-AF0180](about:blank)), possible tuning from JVET-AF0150, JVET-AF0296
  + EE1-1.1: EE1-0 with architecture change variant 1 (JVET-AF0102, JVET-AF0103, JVET-AF0182), as defined in [JVET-AF0307](https://jvet-experts.org/doc_end_user/current_document.php?id=13571).
  + EE1-1.2: EE1-0 with architecture change variant 2 (JVET-AF0102, JVET-AF0103, JVET-AF0153), as defined in [JVET-AF0307](https://jvet-experts.org/doc_end_user/current_document.php?id=13571).
  + EE1-1.3: Comparison test for HOP single model and two models (JVET-AF0183)
  + EE1-1.4: Study joint inference design of [JVET-AF0154](about:blank) (rotation) and [JVET-AF0086](about:blank) (flipping)
  + EE1-1.5: HOP In-loop filter with transformer blocks (JVET-AF0158)
* EE1-2: LOP
  + EE1-2.1: LOP/HOP fast training (JVET-AF0043, fast Stage III training)
  + EE1-2.2: LOP Content adaptive (JVET-AF0056)
  + EE1-2.3: Further complexity reduction of LOP (JVET-AF0071)
* EE1-3: inter prediction
  + EE1-3.1: Deep Reference Frame Generation for Inter Prediction Enhancement (JVET-AF0208)
* EE1-4: super-resolution
  + EE1-4.1: Unified CNN super resolution for resampling-based video coding (JVET-AF0143)

All tests in EE1 to use NNVC-7.0 as code base and to follow NNVC CTC, unless it is explicitly specified by the test description. The anchor for EE1 test is the default configuration of NNVC-7.0 as defined by AhG11/AhG14 (NN-intra and low complexity NN-filter enabled by default) in JVET-AE2016. Anchor performance and reference point for HOP NN-filters will be provided by AhG14.

All HOP tests should be done using stage 3 HOP official dataset. LOP tests uses official LOP stage 3 dataset, except EE1-2.1 which uses official HOP stage 3 dataset.

LOP-related tests will report results vs NNVC-7.0 Anchor (LOP.2 filter and NN-Intra are enabled by default). HOP-related tests to report results in comparison to HOP Anchor (HOP.1 filter and NN-Intra enabled), unless alternative anchor is specified in the test description.

[JVET-AF2024](https://jvet-experts.org/doc_end_user/current_document.php?id=13579) 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 249] (2023-11-17)

An initial draft of this document was reviewed and approved at 0925-0935 on Friday 20 Oct.

Categories and experiments are listed in the subsequent table:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Intra prediction** | | | |
| 1.1a | Decoder derived CCP mode | Y.-J. Chang (Qualcomm) |  |
| 1.1b | Test 1.1a with decoder derived CCP fusion modes | Y.-J. Chang (Qualcomm) |  |
| 1.2 | IntraTMP with merge candidates | K. Naser (InterDigital) |  |
| 1.3 | SGPM with IntraTMP and IBC | K. Naser  (InterDigital) |  |
| 1.4 | IntraTMP extension to DIMD | K. Naser  (InterDigital) |  |
| 1.5 | IntraTMP extension to LIC | F. Le Léannec  (InterDigital) |  |
| 1.6 | Test 1.4 + Test 1.5 | F. Le Léannec  (InterDigital) |  |
| 1.7 | Test 1.6 + Test 1.3 | K. Naser  (InterDigital) |  |
| 1.8a | The length of the auto-relocated BVP trace path is 1 (i.e, n=1) | N. Zhang  (Bytedance) |  |
| 1.8b | The length of the auto-relocated BVP trace path is 2 (i.e, n=2) | N. Zhang  (Bytedance) |  |
| 1.8c | No constraint for the length of the auto-relocated BVP trace path | N. Zhang  (Bytedance) |  |
| 1.9 | Intra TMP fusion probing | J.-L. Lin  (Qualcomm) |  |
| 1.10 | Bilateral filtering for intra prediction | W. Yin  (Bytedance) |  |
| 1.11a | IntraTMP search area extension with sampling factor proportional to CU distance | D. Ruiz Coll  (Ofinno) |  |
| 1.11b | IntraTMP search area extension with sampling factor proportional to search area dimension | K. Naser  (InterDigital) |  |
| 1.11c | Test 1.11a + Test 1.11b | D. Ruiz Coll  (Ofinno )  K. Naser  (InterDigital) |  |
| 1.12a | IBC with extended reference area up to the picture’s upper side boundary | Y. Kidani  (KDDI) |  |
| 1.12b | IBC with four CTU rows instead of two CTU rows in HD resolution or less | Y. Kidani  (KDDI) |  |
| 1.13a | Test 1.11c + Test 1.12a | Y. Kidani  (KDDI)  D. Ruiz Coll  (Ofinno )  K. Naser  (InterDigital) |  |
| 1.13b | Test 1.11c + Test 1.12b | Y. Kidani  (KDDI)  D. Ruiz Coll  (Ofinno )  K. Naser  (InterDigital) |  |
| 1.14a | Encoder run-time reduction methods for extrapolation filter-based intra prediction mode only | L. Xu (OPPO) |  |
| 1.14b | Encoder run-time reduction methods for extrapolation filter-based intra prediction and its merge mode | L. Xu (OPPO) |  |
| 1.15a | CCP merge fusion | H. Huang  (OPPO)  Z. Deng  (Bytedance) |  |
| 1.15b | Inheriting LB-CCP flag in CCP merge mode | H. Huang  (OPPO)  Z. Deng  (Bytedance) |  |
| 1.15c | Test1.15a + Test1.15b | H. Huang  (OPPO)  Z. Deng  (Bytedance) |  |
| 1.16 | Slope adjustment for IBC LIC | C. Ma  (Kwai) |  |
| 1.17a | IBC GPM with block vector difference | C. Ma  (Kwai) |  |
| 1.17b | IBC GPM with split mode reordering | C. Ma  (Kwai) |  |
| 1.17c | Test 1.17a + Test 1.17b | C. Ma  (Kwai) |  |
| 1.18a | DIMD mode derivation from spatial blocks | J. Huo, J. Fan  (Xidian Univ.)  M. Li  (OPPO) |  |
| 1.18b | DIMD mode derivation with reduced complexity | J. Huo, J. Fan  (Xidian Univ.)  M. Li  (OPPO) |  |
| 1.19 | IBC-LIC model merge mode | L. Zhang  (OPPO) |  |
| 1.20a | TIMD fusion with non-angular predictor | P. Andrivon (Ofinno) |  |
| 1.20b | Test 1.20a + TIMD sample-based fusion | P. Andrivon (Ofinno) |  |
| 1.21 | TIMD fusion reference line determination | C. Zhou (vivo) |  |
| 1.22a | Test 1.20a + Test 1.21 | P. Andrivon (Ofinno)  C. Zhou  (vivo) |  |
| 1.22b | Test 1.20b + Test 1.21 | P. Andrivon (Ofinno)  C. Zhou (vivo) |  |
| **2 Inter prediction** | | | |
| 2.1 | A LIC flag for inter prediction merge modes | Y. Zhang (Qualcomm) |  |
| 2.2 | Enable PU level BDMVR and BDOF for bi-predicted LIC | Y. Zhang (Qualcomm) | A. Robert (InterDigital) |
| 2.3 | LIC with multiple templates | Y. Wang  (Bytedance)  X. Xiu  (Kwai) |  |
| 2.4 | LIC with slope adjustment | Y. Wang  (Bytedance) |  |
| 2.5 | Non-local illumination compensation | X. Xiu  (Kwai) |  |
| 2.6a | Test 2.1 + Test 2.2 | Y. Zhang (Qualcomm) |  |
| 2.6b | Test 2.3 + Test 2.4 | Y. Wang  (Bytedance)  X. Xiu  (Kwai) |  |
| 2.6c | Test 2.3 + Test2.5 | X. Xiu  (Kwai)  Y. Wang  (Bytedance) |  |
| 2.7 | AMVP with SbTMVP mode | R.-L. Liao  (Alibaba) |  |
| 2.8a | DMVR for non-equal POC distance cases | M. Salehifar  (Bytedance) | P. Le Guyadec (InterDigital) |
| 2.8b | DMVR for non-equal POC distance cases with constraint | M. Salehifar  (Bytedance) |  |
| 2.8c | BDOF layer with new subblock sizes including 16×16 | M. Salehifar  (Bytedance) |  |
| 2.8d | Mean removed formula for BDOF | M. Salehifar  (Bytedance) |  |
| 2.8e | Test 2.8b + Test 2.8c + Test 2.8d | M. Salehifar  (Bytedance) |  |
| 2.9 | CIIP with subblock-based motion compensation | L. Zhao  (Bytedance) |  |
| 2.10 | GPM with affine prediction | K. Zhang  (Bytedance) |  |
| 2.11 | Regression-based GPM blending | P. Bordes  (InterDigital ) |  |
| 2.12 | Utilizing LFNST/NSPT for inter coding | F. Wang  (OPPO) | F. Le Léannec (InterDigital) |
| 2.13 | Adjusting out-of-boundary prediction samples | P. Astola  (Nokia) |  |
| **3** **Transform and coefficients coding** | | | |
| 3.1a | Intra contexts for intra CUs in inter slices | F. Lo Bianco (InterDigital) |  |
| 3.1b | Test 3.1a + inter contexts for IntraTMP/IBC CUs | F. Lo Bianco (InterDigital) |  |
| 3.1c | Test 3.1b without context switch for CBF | F. Lo Bianco (InterDigital) |  |
| 3.1d | Test 3.1 with retrained context initialization of the affected by the test contexts | F. Lo Bianco (InterDigital) |  |
| 3.2a | Transform coefficient coding | P. Nikitin  (Qualcomm) |  |
| 3.2b | Test 3.2a with retrained context retrained context initialization | P. Nikitin  (Qualcomm) |  |
| **4 In-loop filtering** | | | |
| 4.1a | Adaptive clipping with signalled min/max values from MCTF prefiltered picture | K. Cui  (Qualcomm) |  |
| 4.1b | Adaptive clipping with signalled min/max values from original picture | K. Cui  (Qualcomm) |  |
| 4.2 | Fixed filter for chroma ALF | N. Hu  (Qualcomm) |  |
| 4.3 | Coefficient precision adjustment for ALF | W. Yin  (Bytedance)  N. Hu  (Qualcomm) |  |
| **5 Entropy coding** | | | |
| 5.1 | Retrain CABAC initialization parameters for all slices | F. Galpin  (InterDigital)  V. Seregin  (Qualcomm) |  |
| 5.2 | Window slice type-dependent offsets initialization | V. Seregin  (Qualcomm)  F. Galpin (InterDigital) |  |
| 5.3a | Spatial CABAC tuning | J. Lainema  (Nokia) |  |
| 5.3b | Spatial CABAC tuning in combination with retrained context initialization for inter slices | J. Lainema  (Nokia) |  |

[JVET-AF2025](https://jvet-experts.org/doc_end_user/current_document.php?id=13581) Algorithm description of Enhanced Compression Model 11 (ECM 11) [M. Coban, R.-L. Liao, K. Naser, J. Ström, L. Zhang] [WG 5 N 250] (2023-12-15)

New elements from notes elsewhere in this report:

* Decision (SW): Adopt the new threshold in JVET-AF0111 to the next releases of ECM, VTM and VTM-11ecm.
* Decision: Adopt JVET-AF0079 test 2.6c.
* Decision: Adopt JVET-AF0066, test 2.9a.
* Decision: Adopt JVET-AF0066, test 2.9a.
* Decision: Adopt JVET-AF0073 test 3.1d.
* Decision: Adopt JVET-AF0128 test 3.2.
* Decision: Adopt JVET-AF0163 Test 3.4a.
* Decision (SW): Adopt JVET-AF0057 test 3.5b. Not enabled in CTC.
* Decision: Adopt JVET-AF0159 Test 3.6a.
* Decision: Adopt JVET-AF0190 test 4.1b.
* Decision: Adopt JVET-AF0112 Test 5.1a.
* Decision: Adopt from JVET-AF0197 the part of luma residual tap in CCALF test 5.2b.
* Decision: Adopt the CABAC initialization parameters from JVET-AF0133 Test 6.2. Also the script should be included in the ECM package, such that it can be used by other experts.
* Decision: Adopt JVET-AF0059 (fix to interpolation filters).
* Decision (SW): Adopt JVET-AF0101 (cleanup for decoder side intra prediction).
* Decision (SW): Adopt JVET-AF0177 (ECM encoder memory reduction).
* Decision (SW): Adopt JVET-AF0237 ECM encoder memory reduction).

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] (2023-04-14)

This was integrated with v1 (JVET-X2008) and delivered for ITU-T consent as H.266.1 2nd ed.

Primary editor for the ITU consent text: I. Moccagatta.

[JVET-AF2027](https://jvet-experts.org/doc_end_user/current_document.php?id=13590) SEI processing order and processing order nesting SEI messages in VVC (draft 6) [G. J. Sullivan, M. M. Hannuksela, Y.-K. Wang] [WG 5 preliminary WD 5 N 246] (2023-12-01)

Primary editor: G. J. Sullivan

Updated from JVET-AF0049, JVET-AF0062, JVET-AF0070, JVET-AF0189, JVET-AF0310. The subsequent list was provided after the meeting by Y.-K. Wang, after consultation with relevant contributors.

1. (SW change needed, Bytedance) Addition of po\_id (JVET-AF0061, JVET-AF0174, JVET-AF0067, JVET-AF0310) [Bytedance/HHI/MediaTek/Nokia/Dolby]
2. (not sure whether SW change is needed, Dolby) On the persistence scope of the SPO SEI message (JVET-AF0189, JVET-AF0049, JVET-AF0061, JVET-AF0174, JVET-AF0310) [Dolby/Nokia/Bytedance/HHI/MediaTek]
3. (SW change needed, Nokia) Addition of the processing order nesting SEI message (JVET-AF0049, JVET-AF0174, JVET-AF0310) [Nokia/HHI/Dolby/Bytedance/MediaTek]. This includes:
   1. Removing the requirement for po\_sei\_processing\_order[ i ] to be equal to 0 and the requirement for po\_sei\_processing\_order[ i ] to be no larger than po\_sei\_processing\_order[ i − 1 ] + 1 (see notes for JVET-AF0049 and item 5 of JVET-AF0310).
   2. Including a list of pon\_target\_po\_id[ i ] values in the processing order nesting SEI message to identify associated PO SEI messages (item 6 of JVET-AF0310).
4. (SW change not needed) Removal of the constraint requiring that there shall be at least two values of po\_sei\_processing\_order[ i ] that are not equal, from JVET-AF0049 and JVET-AF0062 [Nokia/Bytedance]. This was originally a redundant constraint and thus purely an editorial change, but is also part of the technical change per item 9) below.
5. (SW change needed, Dolby) The SEI prefix indications, when present, are signalled in units of bits instead of in units of bytes, same as in the SEI prefix indication SEI message, from JVET-AF0189, JVET-AF0062, and JVET-AF0049. [Dolby/Bytedance/Nokia]
6. (SW change needed, Bytedance) Move po\_sei\_prefix\_flag[ i ] from immediately before po\_sei\_payload\_type[ i ] to be immediately after po\_sei\_payload\_type[ i ], from JVET-AF0062. [Bytedance]
7. (SW change not needed) Add a NOTE to clarify the following aspects: In the semantics of the SPO SEI message, two different types of SEI messages may have the same SEI payloadType value but are differentiated by some syntax elements in the SEI payload. For example, two NNPFC SEI messages with different nnpfc\_id values are considered as having two different SEI message types. From JVET-AF0062. [Bytedance]
8. (SW change needed, Dolby) Using separate loops for the payload type and processing order information, from JVET-AF0189. [Dolby]
9. (SW change likely needed, Dolby) Removing the constraint that “The value of po\_sei\_processing\_order[ po\_num\_sei\_messages\_‌minus2 + 1 ] shall not be equal to 0”, from JVET-AF0189. [Dolby]
10. (SW change likely needed, Dolby) Modifying the use of SeiProcessingOrderSeiList such that it determines which SEI messages are allowed to appear in an SEI processing order SEI message, and update the values in the list, including disallowing the SEI payloadType value of the decoded picture hash SEI message from being included in the list, from JVET-AF0189 and JVET-AF0070. [Dolby/Sharp]

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] (2023-09-01)

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]

Remains valid – not updated: [JVET-AE2030](https://jvet-experts.org/doc_end_user/current_document.php?id=13280) Optimization of encoders and receiving systems for machine analysis of coded video content (draft 3) [J. Chen, C. Hollmann, S. Liu] [WG 5 N 224)] (2023-09-15)

Expect CDTR April 2024. Could later be defined as part of MPEG-AI, or MPEG-C

[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] (2023-11-17)

Updates: Only one anchor (VTM20 or newest VTM), and prescribe to use an RA period of 1 s in case of temporal subsampling, when comparing against an anchor without subsampling.

[JVET-AF2032](https://jvet-experts.org/doc_end_user/current_document.php?id=13592) Technologies under consideration for future extensions of VSEI (version 2) [M. M. Hannuksela, J. Chen, S. Deshpande, Hendry, S. McCarthy] [WG 5 N 242)] (2023-12-01)

The subsequent list was provided after the meeting by Y.-K. Wang, after consultation with relevant contributors which had been agreed for inclusion.

1. Changes in JVET-AF0061 other than the addition of po\_id [Bytedance]
   1. The post-processing filter (PPF) grouping concept based on po\_id in the SPO SEI message, taking into account backward compatibitiy with v3 of VVC/VSEI for the a special PPF cascading case
   2. Updates to the filtering process to apply to both NNPFs and non-NN-based PPFs and to enable the use of multiple activated PPFs from one PPF group in the cascading manner
   3. Updates to the NNPFC semantics in VSEI
   4. Updates to the NNPFC/NNPFA interface text in VVC
2. 2 items from JVET-AF0050 [Nokia]
   1. Addition of nnpfga\_no\_prev\_clvs\_flag and nnpfga\_no\_foll\_clvs\_flag
   2. Removal of the possibility to reference NNPF group identifiers from the NNPFA SEI message
3. The approach of separate SEI (applicable for any PF) from JVET-AF0051, for signalling of the gain provided by post-processing filter(s). Remove the URI, define PSNR in a bit-depth neutral. [Nokia]
4. Items 1, 2 and 3 in JVET-AF0091 [LGE]
   1. Adding the definitions of direct and indirect members of an NNPFGC
   2. Clarifying that the value of nnpfgc\_purpose in NNPFGC, when present, includes all purposes of NNPFC or NNPFGC included in the NNPFGC
   3. When nnpfgc\_grouping\_type is equal to 1 (i.e., alternative grouping) or 3 (i.e., parallel grouping), purpose information is signalled for each member of the NNPFGC.
5. On intermediary output picture(s) from activation of an NNPFGC, from JVET-AF0093 [LGE]
6. Some text clarification of the intent on activation of an NNPFGC that contains another NNPFGC could be useful, as a result from the discussion of JVET-AF0094. [LGE]
7. Some of the items on the source picture timing information (SPTI) SEI message, from JVET-AF0055 [Sharp]
   1. Item 1: Add a NOTE.
   2. Item 2: Agreed that conditioning the syntax element “spti\_max\_sublayer\_minus1” on persistence is appropriate.
   3. Item 3: Editorial action to clarify that the interval at highest layer is not necessarily 1.
   4. Item 5: Addition of text for “Use of source picture timing information” for the relevant standards.
   5. Item 6 (Syntax rearrangement is proposed such that the syntax element spti\_source\_picture\_timing\_type is signalled only when spti\_source\_timing\_equals\_output\_timing\_flag is equal to 0.): Agreed (in the context of discussing JVET-AF0069) to adopt item 6, however using the **spti\_source\_type\_present\_flag** for possible gating of the syntax element.
8. Items on the source picture timing information (SPTI) SEI message, from JVET-AF0069 [Dolby]
   1. Item 1: It was agreed that the name of the previous spti\_source\_timing\_equals\_output\_timing\_flag should not be modified into spti\_source\_timing\_info\_present\_flag. If it is zero, the spti\_source\_type shall be sent (with its gating flag).
   2. Simplify syntax element name spti\_source\_picture\_timing\_type to spti\_source\_type.
   3. Change the precision of spti\_source\_type from u(8) to u(16).
   4. Simplify the syntax element name spti\_num\_units\_in\_elemental\_source\_picture\_interval to spti\_num\_units\_in\_elemental\_interval.
   5. Simplify the syntax element name spti\_sublayer\_source\_picture\_interval\_scale\_factor[ i ] to spti\_sublayer\_interval\_scale\_factor[ i ].
   6. Change the precision of spti\_num\_units\_in\_elemental\_interval from u(32) to u(18)
   7. Add text to clarify the descriptions of the various source types, e.g., “slow motion”, “high-speed imaging”, etc.
   8. Add semantic constraints to prevent mutually exclusive timing relationships between source pictures and corresponding decoded output pictures. Specifically, prevent the combination of “high-speed imaging” and “time-lapse imaging”.
   9. Replace syntax element spti\_source\_timing\_equals\_output\_timing\_flag with spti\_source\_timing\_info\_present\_flag and add corresponding semantics.
   10. Move specification of the variable temporalReversalFlag to the semantics following spti\_sublayer\_interval\_scale\_factor[ i ].
   11. Integrate the variable temporalReversalFlag in the equation for SourcePictureInterval[ i ] and remove the equation for SourcePictureTime[ i ] (i.e., the absolute source picture time).
9. Add the following text, resulted from JVET-AF0097 item 1 [LGE]:

The information provided by the SPTI SEI message pertains only for picture(s) starting from the picture in the current layer in the access unit that contains the SPTI SEI message and all subsequent pictures of the current layer in output order based on its persistence.

1. Some of the items on the encoder optimization information (EOI) SEI message, from JVET-AF0052 [Nokia]
   1. Item 1: Editorial updates to the phrasing of the cancellation and persistence.
   2. Item 2: A syntax element eoi\_object\_based\_idc to indicate the type of object-based optimization, including blurring, quantization adjustment, and overwriting sample values of areas outside the detected objects.
   3. Item 4: Replacement of the optimization\_ prefix in the syntax element names with eoi\_ to obtain shorter syntax element names.
   4. Item 5: Sensibility constraints that when the persistence is for the current picture only, the temporal optimizations (eoi\_temporal\_subsampling\_flag and eoi\_temporal\_quality\_flag) are required to be off.
   5. Item 6: For temporal subsampling, addition of eoi\_num\_int\_pics, which is indicative of the count of pictures that the encoding systems excluded between each pair of coded pictures in output order.
   6. Item 7: For temporal quality optimization, a clarification of the semantics and addition of a related NOTE.
2. Some of the items on the EOI SEI message, from JVET-AF0107 [LGE]
   1. On re-formulation spatial/temporal resampling from subsampling/downsampling (which would also apply to upsampling).
   2. Simplification of optimization\_type table (editorial) in v2 of JVET-0107 in its section 2.1.
   3. It is further reported that in the combination with the adoption from JVET-AF0052 and JVET-AF0107, a discrepancy was found that is resolved in the green highlighted parts of v2 of JVET-0107. It was also agreed to include these changes in the updates of the EOI SEI in the TuC.
3. Items on the object mask information (OMI) SEI message, from JVET-AF0088 [Alibaba]
   1. Aspect 1: The text related to bounding box parameters was fixed and refined.
   2. Aspect 2: The binarization of bounding box parameters was changed from ue(v) to u(16)
   3. Aspect 3: A gating flag for bounding box parameters was added to give signalling flexibility to the encoder
   4. Aspect 4: The parsing dependency among different OMI SEI messages was removed by always signalling omi\_mask\_cancel[ i ][ j ][ k ]
4. SEI messages for image metadata formats EXIF, JFIF, and XMP, from JVET-AF0141, with an appropriate editor’s note on how these formats could be referenced in an ITU-T/ISO/IEC standard. [Tencent]
5. Signal picture modality type in VUI parameters, from JVET-AF0147. [Panasonic]
6. The lsei\_message( ) syntax structure for carriage of information about an SEI payload and the SEI payload itself, from JVET-AF0148 [Tencent]
7. The multiplane image information (MPII) SEI message from JVET-AF0167 [Dolby]

[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)

This includes a description of the content layering functional test conducted during the 31st meeting, and the outcome.

# 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 Wed. 17 – Wed. 24 April 2024, 34th meeting under ITU-T SG16 auspices in Rennes, FR,
* 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 January 2025, 37th meeting under ITU-T SG16 auspices, date and location t.b.d.,
* During April 2025, 38th meeting under ISO/IEC JTC 1/‌SC 29 auspices, date and location t.b.d.,
* During Thu. 26 June – Fri. 4 July 2025, 39th meeting under ISO/IEC JTC 1/‌SC 29 auspices in Daejeon, KR,
* During October 2025, 40th meeting under ITU-T SG16 auspices, date and location t.b.d.
* During January 2025, 41st meeting under ISO/IEC JTC 1/‌SC 29 auspices, date and location t.b.d.,

The agreed document deadline for the 34th JVET meeting was planned to be Wednesday 10 April 2024.

The JVET chair expressed sincere thanks to Yan Ye for chairing numerous track sessions. Without this parallelism, it might hardly have been possible to get all contributions reviewed.

Apple was thanked for providing additional test materials with synthesized film grain that can be used in assessing and developing technology in the context of film grain synthesis applications.

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 33rd JVET meeting was closed at approximately XXXX hours UTC on XXday 2X Jan. 2024.

# Annex A to JVET report: List of documents

(Dates and times in the table below are in Paris/Geneva time.)

# Annex B to JVET report: List of meeting participants

The participants of the thirty-third meeting of the JVET, according to the participation records from the Zoom teleconferencing tool used for the meeting sessions (approximately XXX people in total, not including those who attended only the joint sessions with other groups), were as follows:

# Annex C to JVET report: Recommendations of the 14th 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**