Joint Collaborative Team on Video Coding (JCT-VC)
of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11
8th Meeting: San Jose, US, 1–10 Feb. 2012

Document: JCTVC-H1000

Title: **Meeting report of the eighth meeting of the Joint Collaborative Team on Video Coding (JCT-VC), San Jose, US, 1–10 Feb. 2012**

Status: Report Document from Chairs of JCT-VC

Purpose: Report

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Source: Chairs

Summary

The Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T WP3/16 and ISO/IEC JTC 1/ SC 29/ WG 11 held its eighth meeting during 1-10 Feb 2012 at the DoubleTree Inn in San José, US. The JCT-VC meeting was held under the chairmanship of Dr Gary Sullivan (Microsoft/USA) and 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 1.13 of this document.

The JCT-VC meeting sessions began at approximately 0900 hours on Wednesday 1 Feb 2012. Meeting sessions were held on all days (including weekend days) until the meeting was closed at approximately 1250 hours on Friday 10 Feb. Approximately 255 people attended the JCT-VC meeting, and approximately 700 input documents were discussed. The meeting took place in a co-located fashion with a meeting of ISO/IEC WG 11 – one of the two parent bodies of the JCT-VC. The subject matter of the JCT-VC meeting activities consisted of work on the new next-generation video coding standardization project known as High Efficiency Video Coding (HEVC).

The primary goals of the meeting were to review the work that was performed in the interim period since the seventh JCT-VC meeting in producing the 5th HEVC Test Model (HM5) software and text and editing the 5th HEVC specification Working Draft (WD5), review the results from interim Core Experiments (CEs), review technical input documents, establish the 6th draft of the HEVC specification (to be issued as an ISO/IEC Committee Draft – CD) and the sixth version of the HEVC Test Model (HM6), and plan a new set of Core Experiments (CEs) for further investigation of proposed technology.

The JCT-VC produced three particularly important output documents from the meeting: the HEVC Test Model 6 (HM6), the HEVC specification draft 6 a.k.a. Commitee Draft (CD), and a document specifying common conditions and software reference configurations for HEVC coding experiments. Moreover, plans were established to conduct 4 future CEs in the interim period until the next meeting.

For the organization and planning of its future work, the JCT-VC established 16 "Ad Hoc Groups" (AHGs) to progress the work on particular subject areas. The next four JCT-VC meetings are planned for 27 April – 7 May 2012 under ITU-T auspices in Geneva, CH, 11–20 July 2012 under WG 11 auspices in Stockholm, SE, 10–19 Oct 2012 under WG 11 auspices in Shanghai, CN, and 14–23 January 2013 under ITU-T auspices in Geneva, CH.

NOTE – The planned dates as listed above for the 9th meeting are the result of a change of plans that was established and announced after the 8th meeting had ended.

The document distribution site http://phenix.it-sudparis.eu/jct/ was used for distribution of all documents.

The reflector to be used for discussions by the JCT-VC and all of its AHGs is the JCT-VC reflector: jct-vc@lists.rwth-aachen.de. For subscription to this list, see http://mailman.rwth-aachen.de/mailman/listinfo/jct-vc.

1 Administrative topics

1.1 Organization

The ITU-T/ISO/IEC Joint Collaborative Team on Video Coding (JCT-VC) is a group of video coding experts from the ITU-T Study Group 16 Visual Coding Experts Group (VCEG) and the ISO/IEC JTC 1/ SC 29/ WG 11 Moving Picture Experts Group (MPEG). The parent bodies of the JCT-VC are ITU-T WP3/16 and ISO/IEC JTC 1/SC 29/WG 11.

The Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T WP3/16 and ISO/IEC JTC 1/ SC 29/ WG 11 held its eighth meeting during 1–10 Feb 2012 at the DoubleTree Inn in San José, US. The JCT-VC meeting was held under the chairmanship of Dr Gary Sullivan (Microsoft/USA) and Dr Jens-Rainer Ohm (RWTH Aachen/Germany).

1.2 Meeting logistics

The JCT-VC meeting sessions began at approximately 0900 hours on Wednesday 1 Feb 2012. Meeting sessions were held on all days (including weekend days) until the meeting was closed at approximately 1250 hours on Friday 10 Feb. Approximately 255 people attended the JCT-VC meeting, and approximately 700 input documents were discussed. The meeting took place in a co-located fashion with a meeting of WG 11 – one of the two parent bodies of the JCT-VC. The subject matter of the JCT-VC meeting activities consisted of work on the new next-generation video coding standardization project known as High Efficiency Video Coding (HEVC).

Some statistics are provided below for historical reference purposes:

- 1st "A" meeting (Dresden, 2010-04): 188 people, 40 input documents
- 2nd "B" meeting (Geneva, 2010-07): 221 people, 120 input documents
- 3rd "C" meeting (Guangzhou, 2010-10): 244 people, 300 input documents
- 4th "D" meeting (Daegu, 2011-01): 248 people, 400 input documents
- 5th "E" meeting (Geneva, 2011-03): 226 people, 500 input documents
- 6th "F" meeting (Torino, 2011-07): 254 people, 700 input documents
- 7th "G" meeting (Geneva, 2011-11) 284 people, 1000 input documents
- 8th "H" meeting (San Jose, 2012-02) 255 people, 700 input documents

Information regarding logistics arrangements for the meeting had been provided at http://registrationassistant.com/meetingplanit/2012ISO/default.asp.

1.3 Primary goals

The primary goals of the meeting were to review the work that was performed in the interim period since the seventh JCT-VC meeting in producing the 5th HEVC Test Model (HM) software and text and editing the 5th HEVC specification Working Draft (WD5), review the results from interim Core Experiments (CEs), review technical input documents, establish the 6th draft of the HEVC specification (to be issued

as an ISO/IEC Committee Draft – CD) and the sixth version of the HEVC Test Model (HM6), and plan a new set of Core Experiments (CEs) for further investigation of proposed technology.

1.4 Documents and document handling considerations

1.4.1 General

The documents of the JCT-VC meeting are listed in Annex A of this report. The documents can be found at http://phenix.it-sudparis.eu/jct/.

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

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 (rather than as contribution registration and upload times) follow the local time at the meeting facility.

Decisions made by the group that affect the normative content of the draft standard are identified in this report by prefixing the description of the decision with the string "Decision:". Decisions that affect the reference software but have no normative effect on the text are marked by the string "Decision (SW):".

This meeting report is based primarily on notes taken by the chairs and projected for real-time review by the participants during the meeting discussions. The preliminary notes were also circulated publicly by ftp during the meeting on a daily basis. Considering the high workload of this meeting and the large number of contributions, 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 discussion of 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.

1.4.2 Late and incomplete document considerations

The formal deadline for registering and uploading non-administrative contributions had been announced as Friday, 20 Jan 2012.

Non-administrative documents uploaded after 2359 hours in Paris/Geneva time Saturday Jan 21 were considered "officially late".

Most documents in this category were CE reports or cross-verification reports, which are somewhat less problematic than late proposals for new action (and especially for new normative standardization action).

At this meeting, we again had a substantial amount of late document activity, but in general the early document deadline gave us a significantly better chance for thorough study of documents that were delivered in a timely fashion. The group strived to be conservative when discussing and considering the content of late documents, although no objections were raised regarding allowing some discussion in such cases.

All contribution documents with registration numbers JCTVC-H0572 to JCTVC-H0737 were registered after the "officially late" deadline (and therefore were also uploaded late), except JCTVC-H666, JCTVC-H667, and JCTVC-H668, which were exceptionally registered out of the regular numbering sequence. However, some documents in the "H0572+" range include break-out activity reports that were generated during the meeting and are therefore considered report documents rather than 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.

The following other technical proposal contributions were registered in time but were uploaded late:

- JCTVC-H0154 (a technical proposal) [uploaded 01-26]
- JCTVC-H0247 (a technical proposal) [uploaded 01-29]
- JCTVC-H0249 (a technical proposal) [uploaded 01-31]
- JCTVC-H0259 (a technical proposal) [uploaded 02-04]
- JCTVC-H0317 (a technical proposal) [uploaded 01-31]
- JCTVC-H0499 (a technical proposal) [uploaded 01-29]
- JCTVC-H0506 (a technical proposal) [uploaded 01-22]
- JCTVC-H0508 (a technical proposal) [uploaded 01-22]
- JCTVC-H0511 (a technical proposal) [uploaded 01-22]
- JCTVC-H0514 (a technical proposal) [uploaded 01-22]
- JCTVC-H0516 (a technical proposal) [uploaded 01-22]
- JCTVC-H0517 (a technical proposal) [uploaded 01-22]
- JCTVC-H0531 (a technical proposal) [uploaded 01-27]
- JCTVC-H0533 (a technical proposal) [uploaded 01-30]
- JCTVC-H0544 (a technical proposal) [uploaded 01-22]
- JCTVC-H0547 (a technical proposal) [uploaded 01-22]
- JCTVC-H0548 (a technical proposal) [uploaded 01-22]

The following other documents not proposing normative technical content were registered in time but uploaded late:

- JCTVC-H0389 (a contribution of source video test sequences)
- JCTVC-H0486 (a contribution suggesting editorial improvement of the text with figures)

The following cross-verification reports were uploaded late:
JCTVC-H0088, JCTVC-H0102,JCTVC-H0103, JCTVC-H0104, JCTVC-H0105, JCTVC-H0106, JCTVC-H0107, JCTVC-H0110, JCTVC-H0122, JCTVC-H0127, JCTVC-H0128, JCTVC-H0134, JCTVC-H0139, JCTVC-H0142, JCTVC-H0157, JCTVC-H0162, JCTVC-H0163, JCTVC-H0167, JCTVC-H0170, JCTVC-H0173, JCTVC-H0183, JCTVC-H0185, JCTVC-H0191, JCTVC-H0192, JCTVC-H0195, JCTVC-H0206, JCTVC-H0209, JCTVC-H0218, JCTVC-H0219, JCTVC-H0220, JCTVC-H0236, JCTVC-H0241, JCTVC-H0245, JCTVC-H0246, JCTVC-H0254, JCTVC-H0258, JCTVC-H0300, JCTVC-H0301, JCTVC-H0302, JCTVC-H0318, JCTVC-H0319, JCTVC-H0320, JCTVC-H0328, JCTVC-H0329, JCTVC-H0330, JCTVC-H0331, JCTVC-H0332, JCTVC-H0334, JCTVC-H0335, JCTVC-H0337, JCTVC-H0338, JCTVC-H0339, JCTVC-H0340, JCTVC-H0341, JCTVC-H0350, JCTVC-H0351, JCTVC-H0352, JCTVC-H0353, JCTVC-H0354, JCTVC-H0355, JCTVC-H0356, JCTVC-H0357, JCTVC-H0358, JCTVC-H0359, JCTVC-H0369, JCTVC-H0373, JCTVC-H0374, JCTVC-H0377, JCTVC-H0378, JCTVC-H0408, JCTVC-H0416, JCTVC-H0421, JCTVC-H0422, JCTVC-H0439, JCTVC-H0440, JCTVC-H0446, JCTVC-H0454, JCTVC-H0469, JCTVC-H0474, JCTVC-H0479, JCTVC-H0480, JCTVC-H0484, JCTVC-H0488, JCTVC-H0493, JCTVC-H0503, JCTVC-H0509, JCTVC-H0518, JCTVC-H0519, JCTVC-H0525, JCTVC-H0527, JCTVC-H0539, JCTVC-H0542, JCTVC-H0543, JCTVC-H0558, JCTVC-H0560.

(The cross-verification report JCTVC-H0055 was uploaded on time, but was initially accidentally uploaded as an "associated resource" rather than as the contribution itself.)

The following document registrations were later cancelled or otherwise never provided or never discussed due to lack of availability or registration errors:

JCTVC-H0060, JCTVC-H0144, JCTVC-H0256, JCTVC-H0291, JCTVC-H0304, JCTVC-H0305, JCTVC-H0333, JCTVC-H0363, JCTVC-H0470, JCTVC-H0529, JCTVC-H0564, JCTVC-H0572, JCTVC-H0636, JCTVC-H0647, JCTVC-H0670, JCTVC-H0675, JCTVC-H0693.

Ad hoc group interim activity reports, CE summary results reports, break-out activity reports, and information documents containing the results of experiments requested during the meeting are not included in the above list, as these are considered administrative report documents to which the uploading deadline is not applied.

As a general policy, missing documents were not to be presented, and late documents (and substantial revisions) could only be presented when sufficient time for studying was given after the upload. Again, an exception is applied for AHG reports, CE 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 was some expression of annoyance and remarks on the difficulty of dealing with late contributions and late revisions.

It was remarked that documents that are substantially revised after the initial upload are also a problem, as this becomes confusing, interferes with study, and puts an extra burden on synchronization of the discussion. This is especially 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.

"Placeholder" contribution documents that were basically empty of content, with perhaps only a brief abstract and some expression of an intent to provide a more complete submission as a revision, were considered unacceptable and were rejected in the document management system, as has been agreed since the third meeting.

The initial uploads of the following contribution documents were rejected as "placeholders" and were not corrected until after the upload deadline:

- JCTVC-H0072 (a contribution of non-normative software and test results, but initially provided without any significant content, corrected 2012-01-23)
- JCTVC-H0189 (test results for a previously-suggested technique, corrected 2012-01-25)
- JCTVC-H0325 (a cross-check report without results, corrected 2012-01-30)
- JCTVC-H0554 (initially uploaded with the wrong document content, corrected 2012-01-24)

A few contributions had some problems relating to IPR declarations in the initial uploaded versions (missing declarations, declarations saying they were from the wrong companies, etc.). These issues were corrected by later uploaded versions in all cases (to the extent of the awareness of the chairs).

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

1.4.3 Measures to facilitate the consideration of contributions

It was agreed that, due to the continuingly high workload for this meeting, the group would try to rely more extensively on summary CE reports. For other contributions, it was agreed that generally presentations should not exceed 5 minutes to achieve a basic understanding of a proposal – with further review only if requested by the group. For cross-verification contributions, it was agreed that the group would ordinarily only review cross-checks for proposals that appear promising.

When considering cross-check contributions, it was agreed that, to the extent feasible, the following data should be collected:

- Subject (including document number).

- Whether common conditions were followed.
- Whether the results are complete.
- Whether the results match those reported by the contributor (within reasonable limits, such as minor compiler/platform differences).
- Whether the contributor studied the algorithm and software closely and has demonstrated adequate knowledge of the technology.
- Whether the contributor independently implemented the proposed technology feature, or at least compiled the software themselves.
- Any special comments and observations made by the cross-check contributor.

1.4.4 Outputs of the preceding meeting

The report documents of the previous meeting, particularly the meeting report JCTVC-G1100, the HEVC Test Model (HM) JCTVC-G1102, and the Working Draft (WD) JCTVC-G1103, were approved. The HM reference software produced by the AHG on software development and HM software technical evaluation was also approved.

The group was asked to review the prior meeting report for finalization. The meeting report was later approved without modification.

Versions of the WD, the HM document, the HM software and the CE descriptions had been made available in a reasonably timely fashion.

The chair asked if there were any issues regarding potential mismatches between perceived technical content prior to adoption and later integration efforts. It was also asked whether there was adequate clarity of precise description of the technology in the associated proposal contributions.

It was remarked that, in regard to software development efforts – for cases where "code cleanup" is a goal as well as integration of some intentional functional modification, it was emphasized that these two efforts should be conducted in separate integrations, so that it is possible to understand what is happening and to inspect the intentional functional modifications.

The need for establishing good communication with the software coordinators was also emphasized.

At previous meetings, it has previously been remarked that in some cases the software implementation of adopted proposals revealed that the description that had been the basis of the adoption apparently was not precise enough, so that the software unveiled details that were not known before (except possibly for CE participants who had studied the software). Also, there should be time to study combinations of different adopted tools with more detail prior to adoption.

CE descriptions need to be fully precise – this is intended as a method of enabling full study and testing of a specific technology.

Greater discipline in terms of what can be established as a CE may be an approach to helping with such issues. CEs should be more focused on testing just a few specific things, and the description should precisely define what is intended to be tested (available by the end of the meeting when the CE plan is approved).

It was noted that in the case of CE11, there was one design change that was to be tested that was only vaguely described in concept in the CE plan document, and there was some discussion on the reflector to resolve the situation.

It was noted that sometimes there is a problem of needing to look up other referenced documents, sometimes through multiple levels of linked references, to understand what technology is being discussed in a contribution – and that this often seems to happen with CE documents. It was emphasized that we need to have some reasonably understandable description, within a document, of what it is talking about.

Software study can be a useful and important element of adequate study; however, software availability is not a proper substitute for document clarity.

Software shared for CE purposes needs to be available with adequate time for study. Software of CEs should be available early, to enable close study by cross-checkers (not just provided shortly before the document upload deadline).

Issues of combinations between different features (e.g., different adopted features) also tend to sometimes arise in the work.

1.5 Attendance

The list of participants in the JCT-VC 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 11 (including experts who had been personally invited by the Chairs 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 Chairs.

1.6 Agenda

The agenda for the meeting was as follows:

- IPR policy reminder and declarations
- Contribution document allocation
- Reports of ad hoc group activities
- Reports of Core Experiment activities
- Review of results of previous meeting
- Consideration of contributions and communications on HEVC project guidance
- Consideration of HEVC technology proposal contributions
- Consideration of information contributions
- Coordination activities
- Future planning: Determination of next steps, discussion of working methods, communication practices, establishment of coordinated experiments, establishment of AHGs, meeting planning, refinement of expected standardization timeline, other planning issues
- Other business as appropriate for consideration

1.7 IPR policy reminder

Participants were reminded of the IPR policy established by the parent organizations of the JCT-VC 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 JCT-VC as 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/jctvc-site (JCT-VC contribution templates)
- http://www.itu.int/ITU-T/studygroups/com16/jct-vc/index.html (JCT-VC general information and founding charter)
- http://www.itu.int/ITU-T/dbase/patent/index.html (ITU-T IPR database)
- http://www.itscj.ipsj.or.jp/sc29/29w7proc.htm (JTC 1/ SC 29 Procedures)

It is noted that the ITU TSB director's AHG on IPR had issued a clarification of the IPR reporting process for ITU-T standards, as follows, per SG 16 TD 327 (GEN/16):

> "TSB has reported to the TSB Director's IPR Ad Hoc Group that they are receiving Patent Statement and Licensing Declaration forms regarding technology submitted in Contributions that may not yet be incorporated in a draft new or revised Recommendation. The IPR Ad Hoc Group observes that, while disclosure of patent information is strongly encouraged as early as possible, the premature submission of Patent Statement and Licensing Declaration forms is not an appropriate tool for such purpose.
>
> In cases where a contributor wishes to disclose patents related to technology in Contributions, this can be done in the Contributions themselves, or informed verbally or otherwise in written form to the technical group (e.g. a Rapporteur's group), disclosure which should then be duly noted in the meeting report for future reference and record keeping.
>
> It should be noted that the TSB may not be able to meaningfully classify Patent Statement and Licensing Declaration forms for technology in Contributions, since sometimes there are no means to identify the exact work item to which the disclosure applies, or there is no way to ascertain whether the proposal in a Contribution would be adopted into a draft Recommendation.
>
> Therefore, patent holders should submit the Patent Statement and Licensing Declaration form at the time the patent holder believes that the patent is essential to the implementation of a draft or approved Recommendation."

The chairs invited participants to make any necessary verbal reports of previously-unreported IPR in draft standards under preparation, and opened the floor for such reports: No such verbal reports were made.

1.8 Software copyright disclaimer header reminder

It was noted that, as had been agreed at the 5th meeting of the JCT-VC and approved by both parent bodies at their collocated meetings at that time, the HEVC reference software copyright license header language is the BSD license with preceding sentence declaring that contributor or third party rights are not granted, as recorded in N10791 of the 89th meeting of ISO/IEC JTC 1/ SC 29/ WG 11. Both ITU and ISO/IEC will be identified in the <OWNER> and <ORGANIZATION> tags in the header. This software is used in the process of designing the new HEVC standard and for evaluating proposals for technology to be included in this design. Additionally, after development of the coding technology, the software will be published by ITU-T and ISO/IEC as an example implementation of the HEVC standard and for use as the basis of products to promote adoption of the 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.

1.9 Communication practices

The documents for the meeting can be found at http://phenix.it-sudparis.eu/jct/. For the first two JCT-VC meetings, the JCT-VC documents had been made available at http://ftp3.itu.int/av-arch/jctvc-site, and documents for the first two JCT-VC meetings remain archived there. That site was also used for distribution of the contribution document template and circulation of drafts of this meeting report.

JCT-VC email lists are managed through the site http://mailman.rwth-aachen.de/mailman/options/jct-vc, and to send email to the reflector, the email address is jct-vc@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 JCT-VC participants.

It was emphasized that reflector subscriptions and email sent to the reflector must use their real names when subscribing and sending messages and must respond to inquiries regarding their type of interest in the work.

It was emphasized that usually discussions concerning CEs and AHGs should be performed using the reflector. CE internal discussions should primarily be concerned with organizational issues. Substantial technical issues that are not reflected by the original CE plan should be openly discussed on the reflector. Any new developments that are result of private communication cannot be considered to be the result of the CE.

For the case of CE documents and AHG reports, email addresses of participants and contributors may be obscured or absent (and will be on request), although these will be available (in human readable format – possibly with some "obscurification") for primary CE coordinators and AHG chairs.

1.10 Terminology

Some terminology used in this report is explained below:

- **AHG**: Ad hoc group.
- **AI**: All-intra.
- **AIF**: Adaptive interpolation filtering.
- **AIS**: Adaptive intra smoothing.
- **ALF**: Adaptive loop filter.
- **AMP**: Asymmetric motion partitioning.
- **AMVP**: Adaptive motion vector prediction.
- **AMVR**: Adaptive motion vector resolution.
- **APS**: Adaptation parameter set.
- **ARC**: Adaptive resolution coding.
- **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.
- **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).
- **BoG**: Break-out group.

- **BR**: Bit rate.
- **CABAC**: Context-adaptive binary arithmetic coding.
- **CBF**: Coded block flag(s).
- **CD**: Committee draft – the first formal ballot stage of the approval process in ISO/IEC.
- **CE**: Core experiment – a coordinated experiment conducted after the 3rd or subsequent JCT-VC meeting and approved to be considered a CE by the group.
- **Consent**: A step taken in ITU-T to formally consider a text as a candidate for final approval (the primary stage of the ITU-T "alternative approval process").
- **CTC**: Common test conditions.
- **CVS**: Coded video sequence.
- **DCT**: Discrete cosine transform (sometimes used loosely to refer to other transforms with conceptually similar characteristics).
- **DCTIF**: DCT-derived interpolation filter.
- **DIS**: Draft international standard – the second formal ballot stage of the approval process in ISO/IEC.
- **DF**: Deblocking filter.
- **DT**: Decoding time.
- **EPB**: Emulation prevention byte (as in the emulation_prevention_byte syntax element).
- **ET**: Encoding time.
- **GPB**: Generalized P/B – a not-particularly-well-chosen name for B pictures in which the two reference picture lists are identical.
- **HE**: High efficiency – a set of coding capabilities designed for enhanced compression performance (contrast with LC). Often loosely associated with RA.
- **HEVC**: High Efficiency Video Coding – the video coding standardization initiative under way in the JCT-VC.
- **HLS**: High-level syntax.
- **HM**: HEVC Test Model – a video coding design containing selected coding tools that constitutes our draft standard design – now also used especially in reference to the (non-normative) encoder algorithms (see WD and TM).
- **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).
- **IPCM**: Intra pulse-code modulation (similar in spirit to IPCM in AVC).
- **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.
- **LB** or **LDB**: Low-delay B – the variant of the LD conditions that uses B pictures.
- **LC**: Low complexity – a set of coding capabilities designed for reduced implementation complexity (contrast with HE). Often loosely associated with LD.

- **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). Often loosely associated with LC. Typically refers to LB, although also applies to LP.
- **LM**: Linear model.
- **LP** or **LDP**: Low-delay P – the variant of the LD conditions that uses P frames.
- **LUT**: Look-up table.
- **MANE**: Media-aware network elements.
- **MC**: Motion compensation.
- **MPEG**: Moving picture experts group (WG 11, the parent body working group in ISO/IEC JTC 1/ SC 29, one of the two parent bodies of the JCT-VC).
- **MV**: Motion vector.
- **NAL**: Network abstraction layer (as in AVC).
- **NB**: National body (usually used in reference to NBs of the WG 11 parent body).
- **NSQT**: Non-square quadtree.
- **NUT**: NAL unit type (as in AVC).
- **OBMC**: Overlapped block motion compensation.
- **PCP**: Parallelization of context processing.
- **PIPE**: Probability interval partitioning entropy coding (roughly synonymous with V2V for most discussion purposes, although the term PIPE tends to be more closely associated with proposals from Fraunhofer HHI while the term V2V tends to be more closely associated with proposals from RIM).
- **POC**: Picture order count.
- **PPS**: Picture parameter set (as in AVC).
- QM: Quantization matrix (as in AVC).
- **QP**: Quantization parameter (as in AVC, 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). Often loosely associated with HE.
- **R-D**: Rate-distortion.
- **RDO**: Rate-distortion optimization.
- **RDOQ**: Rate-distortion optimized quantization.
- **ROT**: Rotation operation for low-frequency transform coefficients.
- **RQT**: Residual quadtree.
- **RRU**: Reduced-resolution update (e.g. as in H.263 Annex Q).
- **RVM**: Rate variation measure.
- **SAO**: Sample-adaptive offset.
- **SDIP**: Short-distance intra prediction.
- **SEI**: Supplemental enhancement information (as in AVC).

- **SD**: Slice data; alternatively, standard-definition.
- **SH**: Slice header.
- **SPS**: Sequence parameter set (as in AVC).
- **TE**: Tool Experiment – a coordinated experiment conducted between the 1st and 2nd or 2nd and 3rd JCT-VC meeting.
- **TM**: Test Model – a video coding design containing selected coding tools; as contrasted with the TMuC, see HM.
- **TMuC**: Test Model under Consideration – a video coding design containing selected proposed coding tools that are under study by the JCT-VC for potential inclusion in the HEVC standard.
- **Unit types**:
    - CTB: code tree block (synonymous with LCU or TB).
    - **CU**: coding unit.
    - **LCU**: (formerly LCTU) largest coding unit (synonymous with CTB or TB).
    - **PU**: prediction unit, with four shape possibilities.
        - **2Nx2N**: having the full width and height of the CU.
        - **2NxN**: having two areas that each have the full width and half the height of the CU.
        - **Nx2N**: 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.
    - **TB**: tree block (synonymous with LCU – LCU seems preferred).
    - **TU**: transform unit.
- **V2V**: variable-length to variable-length prefix coding (roughly synonymous with PIPE for most discussion purposes, although the term PIPE tends to be more closely associated with proposals from Fraunhofer HHI while the term V2V tends to be more closely associated with proposals from RIM).
- **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 JCT-VC).
- **WD**: Working draft – the draft HEVC standard corresponding to the HM.
- **WG**: Working group (usually used in reference to WG 11, a.k.a. MPEG).
- **WPP**: Wavefront parallel processing.

1.11 Liaison activity

The JCT-VC did not send or receive formal liaison communications at this meeting.

1.12 Opening remarks

No particular non-routine opening remarks were recorded.

1.13 Contribution topic overview

The approximate subject categories and quantity of contributions per category for the meeting were summarized and categorized into "tracks" (A, B, or P) for "parallel session A", "parallel session B", or

"Plenary" review, as follows. Discussions on topics categorized as "Track A" were primarily chaired by Gary Sullivan, and discussions on topic categorized as "Track B" were primarily chaired by Jens-Rainer Ohm.

- AHG reports (22) Track P (section 2)
- Project development, status, and guidance (0) Track P (section 3)
- CE1: Entropy coding investigation (19) Track B (section 4.1)
- CE2: Chroma RQT depth (9) Track B (section 4.2)
- CE3: Chroma interpolation filter (4) Track A (section 4.3)
- CE4: Quantization (27) Track B (section 4.4)
- CE5: Transform skipping (15) Track B (section 4.5)
- CE6: Intra prediction improvement (24) Track B (section 4.6)
- CE7: Additional transforms (10) Track B (section 4.7)
- CE8: Non-deblocking loop filtering (33) Track A (section 4.8)
- CE9: MV coding and skip/merge operation (10) Track A (section 4.9)
- CE10: Deblocking filter (31) Track A (section 4.10)
- CE11: Coefficient scanning and coding (27) Track B (section 4.11)
- Clarifications and bug fix issues (1) Track P (section 5.1)
- HM settings and common test conditions (0) Track P (section 5.2)
- HM coding performance (3) Track P (section 5.3)
- Profile/level definitions (5) Track P (section 5.4)
- Source video test material (2) Track P (section 0)
- Functionalities (8) Track A (section 5.6)
- Deblocking filter (10) Track A (section 5.7)
- Non-deblocking loop filters (32) Track A (section 5.8)
- NSQT/SDIP harmonization (8) Track B (section 5.9)
- Block structures and partitioning (6) Track B (section 5.10)
- Motion compensation operation and interpolation filters (8) Track A (section 5.11)
- Motion and mode coding (53) Track A (section 5.12)
- High-level syntax and tile/slice/wavefront structures (66) Track A (section 5.13)
- Quantization (25) Track B (section 5.14)
- Entropy coding (18) Track B (section 5.15)
- Transform coefficient coding (49) Track B (section 5.16)
- Intra prediction and mode coding (46) Track B (section 5.17)
- Transforms (4) Track B (section 5.18)
- Memory bandwidth reduction (11) Track B (section 5.19)

- Alternative coding modes (27) Track B (section 5.20)
- Encoder optimization (2) Track A (section 5.21)

NOTE – The number of contributions noted in each category, as shown in parenthesis above, may not be 100% precise.

Overall approximate contribution allocations: Track P: 33; Track A: 287; Track B: 299.

2 AHG reports

The activities of *ad hoc* groups that had been established at the prior meeting are discussed in this section.

JCTVC-H0001 JCT-VC AHG Report: JCT-VC Project Management (AHG1) [G. J. Sullivan, J.-R. Ohm (AHG chairs)]

This report was discussed verbally prior to upload. All documents had been delivered. No critical issues were identified.

JCTVC-H0002 JCT-VC AHG report: HEVC Draft and Test Model editing (AHG2) [B. Bross, K. McCann, W.-J. Han, J.-R. Ohm, S. Sekiguchi, G. J. Sullivan, T. Wiegand]

The fifth High Efficiency Video Coding (HEVC) test model (HM5) was developed from the fourth HEVC test model (HM4), following the decisions taken at the 7th JCT-VC meeting in Geneva (21-30 November, 2011).

Two editorial teams were formed to work on the two documents that were to be produced:

JCTVC-G1102 HEVC Test Model 5 (HM 5) Encoder Description

- Il-Koo Kim
- Shun-ichi Sekiguchi
- Benjamin Bros
- Woo-Jin Han
- Ken McCann

JCTVC-G1103 WD5: Working Draft 5 of High Efficiency Video Coding [2]

- Benjamin Bross
- Woo-Jin Han
- Jens-Rainer Ohm
- Gary J. Sullivan
- Thomas Wiegand

Editing JCTVC-G1103 was assigned a higher priority than editing JCTVC-G1102.

An issue tracker (http://hevc.kw.bbc.co.uk/trac) was created in order to facilitate the reporting issues on the text of both documents.

One draft of JCTVC-G1102 and nine drafts of JCTVC-G1103 were published by the Editing AHG between the 7th JCT-VC Meeting in Geneva (21-30 November, 2011) and the 8th JCT-VC Meeting in San José (1-10 February, 2012). JCTVC-G1102 still needs further improvement, whilst the final draft of JCTVC-G1103 is reasonably complete.

The recommendations of the HEVC Draft and Test Model Editing AHG were to:

- Approve the edited JCTVC-G1102 and JCTVC-G1103 documents as JCT-VC outputs.
- Continue to edit both documents to ensure that all agreed elements of HEVC are fully described.
- Encourage the use of the issue tracker (http://hevc.kw.bbc.co.uk/trac) to facilitate the reporting of issues with the text of either document.
- Compare the HEVC documents with the HEVC software and resolve any discrepancies that may exist, in collaboration with the Software AHG.
- Continue to improve the overall editorial quality of the HEVC WD, to allow it to proceed to CD ballot shortly after the San José meeting.
- Ensure that, when considering the addition of new tools to HEVC, properly drafted text for addition to both the HEVC Draft and the HM Test Model (if appropriate) is made available in a timely manner.

It was suggested that the WG11 parent body issue an abbreviated (2 month) CD ballot at this meeting.

The group had a discussion about the suggested timeline: There was a suggestion to target having a short CD ballot with an option to issue DIS in May. This would allow a longer editing period for DIS, and also have the advantage that the DIS ballot would arrive in advance to the January 2013 meeting. This requires a short editing period for CD (just a few days after the current Feb 2012 meeting).

Regarding the HRD, although its specification may not be complete in the current text, in concept it is intended to be essentially the same as in AVC at this point. The SEI message status, in principle, has been previously documented. Byte stream formatting is already documented, except perhaps for mentioning APS start codes, which should be handled the same way as PPS and SPS start codes. This was agreed. Editing work during the meeting to improve the text was encouraged.

JCTVC-H0003 JCT-VC AHG report: Software development and HM software technical evaluation (AHG3) [F. Bossen, D. Flynn, K. Suehring]

This was discussed verbally prior to upload.

More items needed to be integrated than ever before, nevertheless HM5.0 was issued before Christmas, and HM5.1 two weeks prior to the meeting. All adoptions had been integrated. The comparison against previous HM4 performance in case of LC was highly influenced by removal of CAVLC; for HE, losses were expected due to the removal of 10 bit precision from the default condition; in test cases where 10 bit processing was retained, there was still gain observed (roughly 1%). Post-integration testing of single tools was done, but not strictly evaluated.

Regarding retesting of individual tools, this was not always done to the extent that it was intended to have been done.

In one case there was actually an accidental benefit in coding efficiency that occurred. However, the overall results seemed to be about what were expected.

One issue to be observed is that even if every tool implementation is OK under common test conditions, crashes and other issues may occur when tested under non-common conditions (e.g. slice implementation). Investigation has been started to identify such phenomena in more detail. It is important to avoid problems in cases outside the common conditions, such as when slices are used.

The use of so-called Hungarian notation for variable names in the software is now discouraged.

Difficult areas of the software were suggested to include aspects related to the high-level basic structuring of information (i.e. slices, entropy slices, tiles, and wavefronts), and ALF (which was the subject of work on AHG6, resulting in a software attachment to the AHG report). General cleanup of unnecessary macro-dependent software was requested (e.g. remnants of CAVLC).

It was requested for software modifications to be supplied as patch/difference files rather than as copies of the whole codebase, to make it easier to find and inspect the changes.

JCTVC-H0004 JCT-VC AHG report: Picture Partitioning and LCU scan order (AHG4) [R. Sjöberg (AHG chair), Y. Chen, F. Henry, M. Horowitz, K. Kazui, A. Segall, W. Wan (vice chairs)]

The slice coding implementation was broken in HM5.0, but had been fixed in 5.1.

WD tickets #263 and #264 reported a number of issues with tiles and wavefronts. Those were discussed on the reflector, in particular restrictions on the entropy_coding_synchro syntax element. The conclusion was to discuss this further at the meeting; input documents JCTVC-H0349 and JCTVC-H0517 are related.

HM software slice support was broken in HM-5.0 which caused problems for some JCT-VC sub-groups, e.g. CE8 and AHG21. Tickets #225, #256, #257, #258 and #286 describe the problems. These tickets were all addressed, and slices reportedly work fine in HM-5.1.

The coding efficiency of 1500 byte slices was tested for HM-5.0-dev-bugfix. The overhead of 1500 byte slices was reported in the AHG report as being similar to earlier HM versions.

A substantial number of contributions related to this AHG were noted.

JCTVC-H0005 JCT-VC AHG Report: Spatial Transforms (AHG5) [P. Topiwala (AHG Chair), M. Budagavi, R. Cohen, R. Joshi (vice chairs)]

The purpose of AhG was to investigate the design and application of transforms in HEVC. This included architectural improvements of the conventional block integer DCT-like transforms, as well as alternative transforms proposed for use in intra coding. This AhG addresses the design of transforms that achieve high performance, but with reasonable complexity. Complexity is measured not only in terms of operations count, but memory access impact and software and hardware implementation convenience.

The following tasks were performed in this AhG:

- Specify the software platform, common software configurations and common test conditions for these experiments;
- Evaluate compression efficiency vs. complexity of proposed designs according to test conditions;
- Analyse complexity in terms of operations, memory access, and hardware implementability ease;
- Report the results and conclusions of these experiments.

The activity in this AhG was mainly focused on the CE7 work on additional primary and secondary transforms. Only one document, not yet uploaded, was on the topic of core transforms. The additional transform work is covered in detail in the CE7 Summary Report. Several discussions took place via email among CE7 participants regarding how these transforms worked, along with updates and corrections to documents being submitted for this JCT-VC meeting. An overview of transform-related documents for CE7 is provided in the tables below.

Relevant contributions were noted, and tables were provided in the report to describe their subject matter, show which were cross-checks of others, etc.

JCTVC-H0006 JCT-VC AHG report: In-loop filtering (AHG6) [T. Yamakage (AHG chair), K. Chono, Y. J. Chiu, I. S. Chong, M. Narroschke, A. Norkin (vice chairs)]

Mandate 1, studying simplification and harmonization of in-loop filtering technologies, had been mainly studied in the context of CE8 and a couple of non-CE8 contributions were input to this meeting.

There were email exchanges on the JCT-VC reflector about Mandate 2 (studying the relationship between IPCM and deblocking filtering behaviour). The following two on the IPCM issues (specifically, the QP derivation issue for IPCM block boundary) were discussed in the third week of December:

- AVC-style qp derivation was discussed and integrated into HM-5.0.
- Two cases below on top of HM-5.0 were recommended to be studied:
    - Case (1) pcm_sample_loop_filter_disable_flag is set to 0.
    - Case (2) pcm_sample_loop_filter_disable_flag is set to 1 and only one side of block boundary is IPCM coded.

As for Mandate 3 (to clean up and stabilize the HM software, the WD text and the HM encoder description on non-deblocking in-loop filtering), some volunteers (MediaTek, Qualcomm, Sharp and Toshiba) had cleaned up the HM software. The first cleanup was committed to branch/HM-4.1-dev-sao-alf of the SVN server on Dec 12 2011 (r1583 + the fix by r1608), which was integrated into HM 5.0. The second cleanup on HM 5.1 was attached to the AHG report for experts' review. During the cleanup, one bug fix about 1/2 pass encoding was reported as ticket #298. Additional patches were provided with a revision of the AHG report after this was requested in discussions.

There were noted to be 38 technical contributions and 15 cross-checks related to this AHG.

Code cleanup work was a significant focus.

It was remarked that the decoder software still seems to need a lot of work, whereas this AHG was focused primarily on the encoder software.

There was an investigation on one-pass coding – however, this had resulted in a substantial loss (1.6%) compared to 14-pass.

JCTVC-H0007 JCT-VC AHG report: Memory bandwidth restrictions in motion compensation (AHG7) [T. Suzuki (Sony)]

This AHG was established in Geneva to study memory bandwidth issues in HEVC. The relevant contributions were outlined in the report.

The proposed constraints to limit MC memory bandwidth can be classified as follows.

- Defining a VMV (Virtual Bandwidth Verifier) and requiring the encoder to ensure not to exceed VMV. The constraint is proposed to be applied at picture level (JCTVC-H0089).
- Specific constraints on prediction mode, 2D interpolation, the number of MVs
    - Restricting bi-pred for 4x8, 8x4 and/or 8x8 depending on PU/MinCUSize (JCTVC-H0096).
    - Restricting to uni-pred only for 4x8 and 8x4 rather than restricting on the number of MVs (JCTVC-H0441).
    - Replacing bi-pred of merge candidate with uni-pred for 4x4, 4x8, 8x4 and 8x8 (JCTV-H0221).
    - One MV for L0/L1 being restricted to integer pel for 4x8 and 8x4 (JCTVC-H0181).
    - Restricting the number of MVs per LCU rather than block size based mode restrictions (JCTVC-H0267).
    - Restricting both the number of MVs and uni/bi-pred (JCTVC-H0600)

The impact on coding efficiency and complexity should be considered as well as reduction level of MC memory bandwidth. Good trade off should be identified.

Some proposals would specify an encoder-side constraint, while others would specify modifications of the decoder operation.

JCTVC-H0008 JCT-VC AHG report: Profile and level definitions (AHG8) [M. Horowitz, K. McCann (co-chairs), T. Suzuki, T. K. Tan, W. Wan, Y.-K. Wang (vice chairs)]

Relevant input contributions were reviewed.

Specification of a "Main" profile was discussed in the report. Contribution JCTVC-H0168 suggested the following constraints for such a Main Profile:

- LCU size: Max 64x64, Min 16x16
- Slice constraints: Min slice granularity of LCU size and each slice starts from LCU boundary
- Max number of reference frames: max value of 4 (maybe 5, if necessary)
- Number of PS: Max SPS of 8, Max PPS of 16, Max APS of 8
- Parallel processing: Constraints on tiles

An alternative approach would be to define two profiles to cover mainstream requirements, such as a "Baseline" and "High" as proposed in JCTVC-H0353.

JCTVC-H0116 was noted to be rich in analysis, particularly focused on RDOQ, ALF, SAO, LMChroma, AMP, and NSQT.

It was noted that we may not want profiles exactly corresponding to what seemed to be envisioned in the original requirements documents that emphasized one "high efficiency" and one "low complexity" operational point.

JCTVC-H0009 JCT-VC AHG report: Entropy Coding Architecture (AHG9) [K. McCann (chair), J. Lainema, D. Marpe, A. Segall, K. Sugimoto, V. Sze, W. Wan, X. Wang (vice chairs)]

There were 4 email messages relating to the work of AHG9 exchanged on the reflector.

The difficulty of measuring throughput was identified. One option is to count the coded bins per pixel, but it was recognised that this does not take into account differences in the binarization schemes.

No better measurement was identified, so expert judgement probably remains the most important criterion for characterizing throughput.

It was suggested that this AHG may not need to be re-established for the next meeting cycle.

JCTVC-H0010 JCT-VC AHG report: Parallel merge/skip (AHG10) [M. Zhou (chair), H. Y. Kim, P. Onno, X. Wen (vice chairs)]

The general understanding of underlying motion estimation throughput issues due to sequential merge was reported as follows:

- There is motion estimation throughput issue on the encoder side due to dependency of merge/skip MVP list (MCL) derivation on the regular motion estimation, if an encoder chooses to leverage full quality potential of HEVC merge/skip mode.
- Excessive amount of MCL derivation required for motion estimation worsens the motion estimation throughput issue.

General design goals of parallel merge/skip are:

- Decouple the merge/skip MVP list derivation process and merge motion estimation from the regular motion estimation, so that both threads can run fully parallel
- Reduce the number of merge/skip MVP list derivation

- Remove remaining dependency at CU and SCU level
- Configurability to enable flexible coding efficiency and throughput trade-offs on the encoder side.

The relevant issues were explained and analysed to a significant degree in the report, and the relevant contributions were noted.

JCTVC-H0011 JCT-VC AHG Report: Video test material selection (AHG11) [T. Suzuki]

A problem of the current class E test sequences was reported in JCTVC-G732 in Geneva. "De-interlace" artefacts were observed in the current class E. The effort to generate new class E test materials was continued. The AHG suggested that when the materials are ready, they should be checked during JCT-VC San Jose meeting and should be studied under the common test conditions. It was remarked that JCTVC-H0389 is relevant.

It was also remarked that JCTVC-H0294 is relevant (describing 4:4:4 video for screen content coding).

There were two contributions on test material at the meeting (see section 5.5).

JCTVC-H0012 JCT-VC AHG report: Objective quality metric and alternative methods for measuring coding efficiency (AHG12) [K. Minoo, G. Sullivan (co-chairs)]

For the first two mandates, on objective quality metrics, there were some discussions on the reflector. These discussions mainly considered the suitability of different colour spaces for the purpose of objective quality assessment and how a mean squared error metric should be modified by effective sub-sampling in different colour components.

On the last two mandates (on error/quality pooling for the purpose of reporting a single coding efficiency value) there was an email message sent to the reflector by the AHG12 chairs. The message (quoted in the report) described computing a multi-component (weighted or unweighted) average MSE in the YUV domain and converting this to the PSNR domain, rather than using our historical practice of computing single-component PSNR values and then averaging these together in the PSNR domain.

In response, various issues had been discussed on the e-mail thread. These included the following:

- Adjustments for 4:2:0 versus 4:4:4 or 4:2:2 sampling
- Potentially measuring error in the RGB domain rather than the YUV domain (and the extent to which these may be equivalent, and clipping effects).
- How to select MSE weighting values for individual components (e.g. weighting G more in an RGB measurement, picking weights based on perceptual importance, or picking weights based on slopes of rate-distortion curves)

One relevant input document was noted, JCTVC-H0063.

During the discussion of the AHG report, one suggestion was to pipe the output of the decoder to a separate tool that computes one or more quality metrics.

The idea of adding an additional column of combined YUV metric information to the usual reported statistics had some support in the discussion.

JCTVC-H0013 JCT-VC AHG report: Interlace indication (AHG13) [K. Chono (chair), C. Fogg, K. Sato, S. Sekiguchi, W. Wan (vice chairs)]

A SEI message based on H.263 Annex W had been defined according to the last meeting's decisions. The starting text specifying the VUI flag and SEI message had been distributed to the JCTVC main reflector on December 22. The text was uploaded in a revision of the AHG report.

The following opinions were expressed on the starting text (or interlace indication):

- To move the VUI flag to SPS in order to simplify the signalling of the type of a coded sequence;
- To reserve more bits of the field of the SEI message to indicate other ways of interpreting the decoded arrays in addition to interlace;
- That perhaps we need to define some stronger means than an SEI message to convey this kind of information to avoid "external hacks". The file format, for example, needs to specify the presence of the SEI message;
- That an AVC style indication (conditional signalling of bottom_field_flag in slice headers) can be such a stronger means but it uses normative bits.

In discussion of the draft, one question was why a value was identified as "unspecified" rather than "reserved". This seemed to be an error.

The AHG report also described some of the remarks made in email on the JCT-VC reflector discussing suggestions beyond interlace indication:

- A suggestion to define an unified sequence level SEI message that contains information at a sequence level about characteristics of the sequence (e.g., colour space, progressive/interlace, etc). In the meeting discussion, it seemed that VUI is equivalent to this.
- A suggestion to define an unified picture level SEI message that contains information at a picture level about characteristics of the picture (e.g., top/bottom indication for interlaced video, stereoscopic side-by-side/mono indication for frame-compatible stereo video, etc).
- A suggestion to define a picture-level signalling means other than SEI message to indicate dynamically changing source material properties.

The AHG report discussed the relevant input contributions.

JCTVC-H0014 JCT-VC AHG Report: Loss robustness (AHG14) [S. Wenger (chair), M. Coban, Y. W. Huang, P. Onno, Y.-K. Wang (vice chairs)]

There was reportedly no directly-related AHG activity. Some relative input contributions were listed. The most directly-related identified contributions were described as follows:

- JCTVC-H0072 (late) provides loss simulation software.
- JCTVC-H0132 includes simulation results for a lost APS, and proposes an optimization method JCTVC-to deal with such losses.
- JCTVC-H0520 appears to propose an FMO-like picture segmentation mechanism on the tile level, facilitating error concealment.
- JCTVC-H0570 proposes a bit in the slice header to signal temporal MV prediction, which is claimed to be beneficial for error resilience.

Other related contributions were described as:

- JCTVC-H0168 advocates, among many other things, that slices need to start at LCU boundaries (no FG slices) (which may create overhead when matching MTU size), and that tiles be independent (which may be advantageous from an error resilience viewpoint).
- JCTVC-H0345 advocates, among other things, independent tiles (only) through profiling, which may be good for error resilience.
- JCTVC-H0348 proposes slices local to tiles only, which may make MTU size matching harder for some slices.
- JCTVC-H0463 advocates, through profiling, restrictions to tiles, especially number of columns (max 2), slices local to tiles, independent tiles only, and other modifications.

- JCTVC-H0472 appears to advocate the use of tiles with limited column width (level dependent) to reduce line buffer requirements.
- JCTVC-H0449 and JCTVC-H0501 relate to error resilient derivation of POC values.
- JCTVC-H0668 advocates, among other things, "no more than 4 coded slices" per picture with non-empty slice headers, which may make sending a sufficient number of redundant copies impossible.
- Various documents on (partial) APS updates were noted, including JCTVC-H0069, JCTVC-H0070, JCTVC-H0255, JCTVC-H0381, JCTVC-H0505, JCTVC-H0512.
- Scalability related contributions were noted, including JCTVC-H0386, JCTVC-H0388, JCTVC-H0410, JCTVC-H0423).

JCTVC-H0015 JCT-VC AHG report: High-level syntax (AHG15) [Y. K. Wang (chair), J. Boyce, Y. Chen, M. Hannuksela, K. Kazui, T. Schierl, R. Sjöberg, T. K. Tan, W. Wan, P. Wu (vice chairs)]

One recommendation made by this AHG was on signalling of picture size, as suggested through mailing list discussions. The recommendation was to leave the signalling of the decoded picture width and height as they are in the SPS in the latest HEVC WD, in units of luma samples, but to add a cropping process before a decoded picture is stored into the DPB, to make sure that the decoded picture size is exactly the same as signalled in the SPS. Review of relevant input contributions was desired before making a decision on this by the JCT-VC.

On the LCU concept, there was no clear conclusion. Among those who were involved in the discussion, more were inclined to add some clarification to the draft HEVC specification, such that an LCU can be incomplete, in terms that some pixels in the LCU may be outside the boundary of the decoded picture. This way, even when the picture width or height is not an integer number of LCU sizes, tiles, which are defined as consisting of an integer number of LCUs, may still be applied.

Related contributions and relevant work in other AHGs were listed.

JCTVC-H0485 advocates for the internal decoding process to operate with the granularity of the minimum CU size – and then for a cropping window to be applied outside the coding loop for output only (e.g. as in AVC). Decision: Agreed.

In discussion, it was suggested to constrain the syntax-expressed width and height parameters (which express the width and height prior to application of the cropping window) to be an integer multiple of the minimum CU size. Decision: Agreed. (Note that this is a constraint, not a description of the units in which the width and height are expressed.)

In discussion, it was suggested for the profile/level constraints to apply to the full DPB-stored width and height. Decision: Agreed.

In discussion, the cropping was suggested to have the same type of flexibility of the cropping window as in AVC. Decision: Agreed.

In discussion, it was suggested for the motion compensation padding to apply to the minimum CU size granularity boundary (e.g. as AVC). Decision: Agreed.

In principle, there may be LCUs at the right and bottom boundaries that are not fully occupied by samples in the decoded picture that is stored in the DPB. Decision: Agreed.

It was noted that these agreements, at least to some extent, express what was already intended and is already reflected in the software operation.

JCTVC-H0016 JCT-VC AHG report: Unification of NSQT and SDIP (AHG16) [X. Zheng (chair), J. Xu, X. Wang, A. Tabatabai, J. Lim (vice chairs)]

This AHG report summarized the issues and the content of the contributions relating to unification of NSQT and SDIP.

(Discussed in Track B – NSQT/SDIP harmonization – see section 5.9.)

JCTVC-H0017 JCT-VC AHG Report: Hooks for scalable coding (AHG17) [J. Boyce (chair), J. Kang, J. Samuelsson, W. Wan, Y.-K. Wang (vice chairs)]

The AHG report listed the contributions relevant to providing "hooks" for scalable coding extensions.

(Discussed in Track A – Functionalities – see section 5.6.2.)

JCTVC-H0018 JCT-VC AHG report: Resolution adaption (AHG18) [T. Davies (chair), P. Topiwala, P. Wu (Vice-chairs)]

A kick-off email was sent on 4 January 2012. A brief discussion on the relationship between resolution adaption and reduced resolution update took place on the reflector. Related contributions were listed in the report.

(Discussed in Track A – Functionalities – see section 5.6.3.)

JCTVC-H0019 JCT-VC AHG Report: Lossless coding (AHG19) [W. Gao (chair), K. Chono, J. Xu, M. Zhou, P. Topiwala (vice chairs)]

The AHG report described the relevant contributions as follows:

- TI proposed to install a high-level flag in PPS to enable lossless coding mode by bypassing inverse quantization, inverse transform, de-blocking filter, SAO and ALF, and to use sample-based angular intra prediction (SAP) in lossless coding mode for better coding efficiency (JCTVC-H0083).
- Huawei proposed a QP-based enabling method for lossless coding in HEVC without change to the HEVC syntax specification. This is done by using QP to signal a HEVC video codec whether a CU employs lossless coding (JCTVC-H0528).
- TI and Huawei submitted a joint proposal that combines the sample-based angular intra prediction (SAP) as proposed in JCTVC-H0083 and the lossless coding signaling method as proposed in JCTVC-H0528 to form a simple and efficient lossless coding solution for HEVC. The HM5.0 software and HEVC WD (JCTVC-G1103_d8) have been modified to incorporate this lossless coding solution (JCTVC-H0530).
- Sharp introduced a modified CABAC structure without last position coding, which requires significantly reduced number of context models and also achieves better coding efficiency in lossless coding condition (JCTVC-H0499).

(Discussed in Track B – Alternative coding modes – see section 5.20.3.)

JCTVC-H0020 JCT-VC AHG report: Chroma format support (AHG20) [D. Flynn (chair), D. Hoang, K. McCann, P. Topiwala (vice chairs)]

Related topics and contributions included the following topics

- Hybrid coding (JCTVC-H0065, JCTVC-H0073)
- Sub-sampling filters (JCTVC-H0394)
- Current issues affecting 4:2:0 (JCTVC-H0177)

- Syntax for monochrome (JCTVC-H0457)
- Modifications for 4:2:2 (JCTVC-H0650)

(Discussed in Track A – Functionalities – see section 5.6.4.)

JCTVC-H0021 JCT-VC AHG report: Reference picture buffering and list construction (AHG21) [R. Sjöberg (chair), Y. Chen, Hendry, T. K. Tan, W. Wan, Y.-K. Wang (vice chairs)]

The d6 version of the HEVC working draft 5 (JCTVC-G1103) was reportedly the first version to contain reference picture sets. It was reportedly made available on January 19. Fixes that had been made to the related sections of HM software were described in the AHG report.

The specification text for reference picture buffering and list construction proposals was finalized and uploaded on January 4. It consists of seven "random access" test cases and four "low-delay" test cases. Short descriptions of these test cases were provided in the AHG report.

Anchor source code supporting all G1036 test cases was made available on January 21 in the HM-5.0-dev-misc-ahg21 branch. The code was later moved to HM-5.1-dev-ahg21. A config file for each test case is available in HM-5.1-dev-ahg21/cfg/JCTVC-G1036/. Most test cases are supported by only config file changes but cases 2.6, 3.3 and 3.4 required source code changes as well.

Due to lack of time, anchors were not generated.

Bit counting functionality was added to the HM-5.1-dev-ahg21 source code. It reports the number of bits spent on reference picture set and reference picture lists in a sequence. This includes SPS, PPS and slice header syntax. The slice header syntax elements that are included in the count are listed in the AHG report.

An RPS cost analysis in the report shows the average percentage of bits that are spent on RPS-related syntax. The numbers were calculated by first running each test case on the common condition sequences. The RA sequence set was used for the 2.x test cases and the LD sequence set was used for the 3.x test cases. For each sequence, fixed QPs 23, 27, 32, 37 was used. 1500 byte slices were turned on for the 3.x test cases. The HM-5.1-dev-ahg21 decoder reports "RPS related bits in total: "; this number was divided by the bitstream file size and averaged for all bitstreams in each test case.

(Discussed in DPB/RPS BoG in Track A – High-level syntax – see section 5.13 and JCTVC-H0715.)

JCTVC-H0022 JCT-VC AHG report: HM subjective quality investigation (AHG22) [G. Sullivan, J.-R. Ohm (co-chairs), F. Bossen, T. Wiegand (vice chairs)]

(Discussed in Plenary on the first day of the meeting.)

The goal of this AHG work was to quantify, to the extent feasible, the rate savings for which similar subjective quality is achieved for the current HM5 when compared to a similarly-configured JM encoder/decoder.

It was considered to be important to conduct the subjective tests with non-expert viewers. Due to the limited resources that were available for this purpose, tests were restricted to the RA-HE settings of the HM (ref JCTVC-G1200) and to classes B and C. A modified version of the JM encoder was used in the test, which includes some non-normative improvements as described previously in JCTVC-G399 and updated in JCTVC-H0360. The release of a new version of the JM is planned to support these non-normative modifications.

By negotiation with the test coordinator, Vittorio Baroncini, the maximum number of cases that could be tested was set to 72. With 9 sequences in classes B and C and two codecs, it was possible to test four rate points for each. Instead of testing pre-defined rate points, it was considered to try finding points of similar subjective quality, and run both codecs with fixed QP. In terms of subjective quality that would provide reasonable results when assessed by non-expert viewers, QP settings 27, 30, 33 and 36 were selected for

the JM codec, with confirmation by the test coordinator. Several experts involved in the preparation performed pre-assessment in comparing the JM versus the HM codec, and the overall opinion unveiled that with same QP settings, the HM would provide substantially better visual quality than the JM, which in fact can also be confirmed by PSNR numbers. Finally, it was decided to use QPHM= QPJM+4 settings for the HM encoded cases. Though PSNR numbers are slightly worse for this case, the experts involved in pre-viewing came to the opinion that this gave a quality which is approximately equal to the JM quality in most cases. It was therefore decided to run the tests with QP settings of 31, 34, 37 and 40 for the HM (and QP settings of 27, 30, 33 and 36 for the JM).

Subjective tests were performed using a Double Stimulus Impairment Scale (DSIS) method equivalent to the approach described in JCTVC-A204. A revision of the report was provided after the meeting had begun which provided further detail and scores for the tests that had been performed.

The HM bitstreams were generated using the HM reference software from https://hevc.hhi.fraunhofer.de/svn/svn_HEVCSoftware/tags/HM-5.0/.

The simulations were run using the configuration file cfg/encoder_randomaccess.cfg from that version of the reference software. The HM encoder was run with this configuration file and command line parameters adapted for each sequence. An example for encoding a particular test sequence was provided in the report.

The sequences of Class B and Class C were encoded. The command line parameters used in the simulations were listed in the report. The simulations were run for QP = {31, 34, 37, 40}.

Results of the test (MOS, standard deviation and confidence intervals) were made available in an attached Excel spreadsheet. As the subjective tests did not unveil exactly the same quality of HM and JM for the different test cases, linear interpolation was performed on RD graphs (MOS over rate). Such an approach was reported to appear appropriate since the QP differences between the various test points are relatively close, such that a fairly precise estimate of the rate difference between the two codecs at same quality could be achieved. Rate differences had been computed for all cases where an MOS point for one of the codecs has a matching point (i.e. in the range where the two plots overlap on the MOS axis). By that, a gross average bit rate reduction of 67% for class B sequences, 49% for class C sequences and 58% overall was reported for equivalent video quality. These preliminary results appear to confirm that substantial progress has been achieved in the work.

3 Project development, status, and guidance

No particular contributions noted in this area. See AHG reports for relevant discussions.

4 Core experiments

4.1 CE1: Entropy coding investigation

4.1.1 Summary

JCTVC-H0031 CE1: Summary report of core experiment on entropy coding [R. Joshi]

The purpose of Core Experiment 1 (CE1) was to evaluate changes to the existing entropy coding. The core experiment was divided into 4 subtests. In subtest A, a proposal for modification of the existing arithmetic coding engine was investigated. In subtest B, different methods for 8-bit initialization of the CABAC context models were evaluated. In subtest C, alternatives to the arithmetic coding probability model update were explored. In subtest D, methods for increasing the throughput of CABAC were studied. This report provided a summary of the activities and results for this core experiment.

4.1.2 Contributions

Subtest A

JCTVC-H0444 CE1: Modified LPS range and state transition tables for BAC [J. Sole, L. Guo, M. Karczewicz (Qualcomm)]

Test results summary (BD bit rate difference is averaged across AI, RA, LD(B) for HE, LC and HE-10 respectively, class F is not included):

Proponent	Description	BD bit rate for HE			BD bit rate for LC			BD bit rate for HE-10		
		Y	U	V	Y	U	V	Y	U	V
Qualcomm JCTVC-H0444	64x4 range rescaling table	-0.2%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.1%	0.1%
	32x4 range rescaling table	-0.2%	-0.6%	-0.6%	-0.2%	-0.4%	-0.5%	-0.3%	-0.1%	-0.3%

Reduces range table but increases state transition table.

Number of bits in context memory increases

Subtest A: No clear advantage in terms of complexity/efficiency tradeoff

JCTVC-H0210 CE1: Crosscheck of Test A Modified LPS range and state transition tables for BAC (G324, Qualcomm) by Cisco [T. Davies (Cisco)]

Subtest B

B1/B3

Test results summary (BD bit rate difference is averaged across AI, RA, LD(B) for HE, LC and HE-10 respectively, class F is not included) for QPs = {22, 27, 32, 37} in common condition.

Proponent	Description	BD bit rate for HE			BD bit rate for LC			BD bit rate for HE-10		
		Y	U	V	Y	U	V	Y	U	V
Qualcomm, I2R JCTVC-H0535	Formula 1	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%
	Formula 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%

Test results summary (BD bit rate difference is averaged across AI, RA, LD(B) for HE, LC and HE-10 respectively, class F is not included) for low QPs = {17, 22, 27, 32}.

Proponent	Description	BD bit rate for HE			BD bit rate for LC			BD bit rate for HE-10		
		Y	U	V	Y	U	V	Y	U	V
Qualcomm, I2R JCTVC-H0535	Formula 1	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
	Formula 2	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%

Test results summary (BD bit rate difference is averaged across AI, RA, LD(B) for HE, LC and HE-10 respectively, class F is not included) for high QPs = {27, 32, 37, 42}.

Proponent	Description	BD bit rate for HE			BD bit rate for LC			BD bit rate for HE-10		
		Y	U	V	Y	U	V	Y	U	V
Qualcomm, I2R JCTVC-H0535	Formula 1	0.0%	-0.1%	-0.1%	0.0%	0.0%	-0.1%	0.0%	0.2%	0.0%

B2

Test results summary (BD bit rate difference is averaged across AI, RA, LD(B) for HE, LC and HE-10 respectively, class F is not included).
For low QPs = {17, 22, 27, 32}.

Proponent	Description	BD bit rate for HE			BD bit rate for LC			BD bit rate for HE-10		
		Y	U	V	Y	U	V	Y	U	V
HHI JCTVC-H0266	Test1: 'linear' mapping	0,0%	0,1%	0,1%	0,0%	0,2%	0,1%	0,0%	-0,1%	0,0%
	Test3: 'disabled' mapping	0,0%	0,0%	0,0%	0,0%	0,2%	0,1%	0,0%	0,0%	0,0%

For common QPs = {22, 27, 32, 37}.

Proponent	Description	BD bit rate for HE			BD bit rate for LC			BD bit rate for HE-10		
		Y	U	V	Y	U	V	Y	U	V
HHI JCTVC-H0266	Test1: 'linear' mapping	0,0%	0,1%	0,1%	0,0%	0,2%	0,1%	0,0%	-0,1%	0,1%
	Test3: 'disabled' mapping	0,0%	0,0%	0,0%	0,0%	0,2%	0,1%	0,0%	0,0%	0,1%

For high QPs = {27, 32, 37, 42}.

Proponent	Description	BD bit rate for HE			BD bit rate for LC			BD bit rate for HE-10		
		Y	U	V	Y	U	V	Y	U	V
HHI JCTVC-H0266	Test1: 'linear' mapping	0,0%	0,0%	-0,1%	0,0%	0,0%	0,0%	0,0%	0,0%	0,3%
	Test3: 'disabled' mapping	0,0%	-0,1%	-0,1%	0,0%	0,0%	0,0%	0,0%	0,1%	0,1%

B4

Test results summary (BD bit rate difference is averaged across AI, RA, LD(B) for HE, LC and HE-10 respectively, class F is not included) for QPs = {22, 27, 32, 37} in common condition.

Proponent	Description	BD bit rate for HE			BD bit rate for LC			BD bit rate for HE-10		
		Y	U	V	Y	U	V	Y	U	V
Sharp JCTVC-H0540	CABAC init.									

Test results summary (BD bit rate difference is averaged across AI, RA, LD(B) for HE, LC and HE-10 respectively, class F is not included) for low QPs = {17, 22, 27, 32}.

Proponent	Description	BD bit rate for HE			BD bit rate for LC			BD bit rate for HE-10		
		Y	U	V	Y	U	V	Y	U	V
Sharp JCTVC-H0540	CABAC init.									

Test results summary (BD bit rate difference is averaged across AI, RA, LD(B) for HE, LC and HE-10 respectively, class F is not included) for high QPs = {27, 32, 37, 42}.

Proponent	Description	BD bit rate for HE			BD bit rate for LC			BD bit rate for HE-10		
		Y	U	V	Y	U	V	Y	U	V
Sharp JCTVC-H0540	CABAC init.									

JCTVC-H0266 CE1: Report of test results related to subtests B2 (8-bit-init) and C3 (Alt. PMU) [H. Kirchhoffer, B. Bross, P. Helle, D. Marpe, T. Nguyen, M. Siekmann, J. Stegemann, T. Wiegand (Fraunhofer HHI)]

JCTVC-H0076 CE1: Cross-check of Subtest B2 – Test 3 (H0266) [C. Yeo, Y. H. Tan, Z. G. Li (I2R)]

JCTVC-H0161 CE1: verification of C3 sub-test from HHI (JCTVC-H0266) by Samsung and Qualcomm [E. Alshina, A. Alshin, J. H. Park (Samsung), R. Joshi, J. Sole (Qualcomm)]

JCTVC-H0535 CE1 B3: 8-bit Linear Initialization for CABAC [L. Guo, J. Sole, R. Joshi, M. Karczewicz (Qualcomm), C. Yeo, Y.H. Tan, Z. Li (I2R)]

Decision: Adopt 8-bit initialization, formula 2; the cross-checker confirmed that this is the better choice, as it is simpler implementation-wise and does not have worse results.

JCTVC-H0395 CE1: Cross-check report for Subtest B3 [P. Helle, H. Kirchhoffer (Fraunhofer HHI)]

JCTVC-H0680 Cross-check of Modified LPS range and state transition tables combined with 8-bit Linear Initialization for CABAC [N. Nguyen, T. Ji, D. He, G. Martin-Cocher (RIM)] [late]

In plenary discussion, it was asked whether this combination of H0444 and H0535 had been planned in the CE, and if yes, which document describes the combination. It was responded that this is included in H0444.

JCTVC-H0540 CE1: Subtest B4 - On cabac_init_idc [K. Misra, A. Segall (Sharp)]

Two elements: Implementation of cabac_init_idc which is specified in text but not in software

Currently, up to 7 tables (I+3P+3B) could be supported by the syntax, but the alternative tables for P and B are not specified. Three tables are used in the software, and it was suggested to align the text and software and to reduce the total number of tables to 3 (one each nominally for I, B, and P) and to allow usage of the nominally-B table for P frames and vice-versa. The proposed correction gives a small gain (0.2%) with 2-pass coding, but no gain in one-pass coding with current test set.

It was suggested to clarify with the SW coordinator what is currently used in HM5.

Other contributions were related (H0646, H0113, H0561 – see conclusions on this in other sections). The flexibility added by H0540 (allowing mutual usage of P and B tables for these two slice types) is a desirable approach from the perspective of entropy coding.

Decision: Adopt H0540.

Note: An AHG could also investigate other options such as using only init_idc without slice type dependency.

JCTVC-H0167 CE1: Cross-check report for Sharp proposal (Subtest B4) [H. Sasai, T. Nishi (Panasonic)] [late]

Subtest C

Subtest C summary: No clear advantage was shown in terms of complexity/efficiency tradeoff for any of the proposals. Multi-parameter approaches had significantly higher complexity.

(The C1 part of subtest C was withdrawn.)

C2

Test results summary (BD bit rate difference is averaged across AI, RA, LD(B) for HE, LC and HE-10 respectively, class F is not included) for QPs = {22, 27, 32, 37} in common condition.

Proponent	Description	BD bit rate for HE			BD bit rate for LC			BD bit rate for HE-10		
		Y	U	V	Y	U	V	Y	U	V
Canon JCTVC-H0140	Probability update mod	-0.7%	-0.5%	-0.4%	-0.7%	-0.7%	-0.8%	-0.8%	-0.1%	-0.1%

C3

Test results summary (BD bit rate difference is averaged across AI, RA, LD(B) for HE, LC and HE-10 respectively, class F is not included) for QPs = {22, 27, 32, 37} in common condition. The size of rangeTabLPS is 16×8 in all cases.

Proponent	Description	BD bit rate for HE			BD bit rate for LC			BD bit rate for HE-10		
		Y	U	V	Y	U	V	Y	U	V
HHI JCTVH0266	Test 4	-0.2%	-0.4%	-0.2%	-0.3%	-0.5%	-0.4%	-0.4%	-0.1%	0.1%
	new init (test 8)	-0.3%	-0.4%	-0.4%	-0.3%	-0.5%	-0.5%	-0.4%	0.0%	0.1%
	Window size 32 (test 9)	-0.3%	-0.1%	0.0%	-0.3%	-0.1%	-0.1%	-0.3%	0.2%	0.2%
	Window size 32 new init (test 10)	-0.3%	-0.2%	-0.1%	-0.3%	-0.1%	-0.2%	-0.3%	0.2%	0.1%

C4

Test results summary (BD bit rate difference is averaged across AI, RA, LD(B) for HE, LC and HE-10 respectively, class F is not included) for QPs = {22, 27, 32, 37} in common condition.

Proponent	Description	BD bit rate for HE			BD bit rate for LC			BD bit rate for HE-10		
		Y	U	V	Y	U	V	Y	U	V
Samsung JCTVC-H0112	Single parameter	-0.3%	0.1%	0.1%	-0.3%	0.1%	-0.1%	-0.3%	0.8%	0.7%
	Multi-parameter	-0.7%	-0.4%	-0.3%	-0.7%	-0.7%	-0.8%	-0.7%	-0.1%	0.0%

JCTVC-H0140 CE1: Modified probability update and table removal for multi-parameter CABAC update [C. Rosewarne, M. Maeda (Canon)]

JCTVC-H0165 CE1: verification of C2 sub-test from Canon (JCTVC-H0140) by Samsung [E. Alshina, A. Alshin, J. H. Park (Samsung)]

JCTVC-H0112 CE1, subtest C4: Multi-parameter probability estimation for CABAC [E. Alshina, A. Alshin, J. H. Park (Samsung)]

JCTVC-H0135 CE1: Cross check of Multi-parameter probability up-date for CABAC by Samsung: Sub-test C2 (H0112) [C. Rosewarne, M. Maeda (Canon)]

Subtest D

Proponent	Description	BD bit rate for HE			BD bit rate for LC			BD bit rate for HE-10		
		Y	U	V	Y	U	V	Y	U	V
Nokia JCTVC-H0232	D1: normal QPs	4.4%	2.8%	3.1%	3.8%	5.5%	5.6%	6.2%	2.0%	3.7%
	D1: low QPs (1,5,9,13)	7.7%	7.9%	8.2%	5.7%	5.4%	5.2%	9.0%	10.5%	10.1%
Qualcomm JCTVC-H0536	D2	1.3%	0.6%	0.8%	1.5%	0.3%	0.5%	1.7%	1.9%	2.2%

JCTVC-H0232 CE1.D1: Nokia report on high throughput binarization [J. Lainema, K. Ugur, A. Hallapuro (Nokia)]

Several experts expressed support for the idea of improving the throughput of CABAC; however this specific approach would, in principle, mean implementing elements of a second entropy coder for the binarization – which may not be the most desirable approach. Several other contributions (non CE) were also addressing the issue in a potentially better, more feasible way.

JCTVC-H0212 CE1: Subtest D1 - cross-verification of Nokia Single entropy coder for HEVC with a high throughput binarization mode (JCTVC-G569) by Cisco [D. Sychov, T. Davies (Cisco)]

JCTVC-H0378 CE1: Cross-check of test D1: Coding of coefficient bins in bypass mode [M. Siekmann (Fraunhofer HHI)] [late]

JCTVC-H0536 CE1 D2: Adaptive initialization for CABAC with fixed probability contexts [L. Guo, J. Sole, X. Wang, M. Karczewicz (Qualcomm)]

Loss 1.3-1.7% (see table above).

JCTVC-H0652 CE1: Cross-verification of Qualcomm Adaptive initialization for CABAC with fixed probability contexts (sub-test D2) [Gergely Korodi, Dake He RIM)] [late]

The cross-checker confirmed that this increases capability for parallel processing. It was also pointed out that the current measurement of throughput (number of bypass bins) is not optimum.

None of the suggested solutions seemed to be ideal in the way that lower complexity or a higher amount of parallelism must be "paid for" by loss of compression efficiency – and might only make sense if we would define different profiles for different levels of complexity (which may not be what we want according to AHG8 discussion).

There are other contributions that may be interesting targeting the same issues, which seemed potentially more interesting: H0233, H0458, H0510, H0554

4.2 CE2: Chroma RQT depth

4.2.1 Summary

JCTVC-H0032 CE2: Summary report of Core Experiment on Chroma RQT depth [K. Sugimoto, X. Guo, X. Wang (CE Coordinators)]

The following tools were tested:

test	Proposal Document	Proponent	Tool description	Cross-checker & Document #
4.1 JCTVC-G283	JCTVC-H0317	MediaTek PKU	- Signalling Max chroma RQT depth for intra - Chroma TU split for inter same as done in luma with max depth=1 - no 32x32 transform for chroma	Qualcomm JCTVC-H0543
4.2 JCTVC-G442	JCTVC-H0235	Mitsubishi NHK	- Implicit chroma RQT depth depending on intra and inter PU mode - allow 32x32 transform for chroma	MediaTek JCTVC- H0319
4.3 JCTVC-G980	JCTVC- H0538	Qualcomm	- Signalling Max chroma RQT depth for intra - Chroma TU split for inter same as done in luma with max depth=1 - allow 32x32 transform for chroma	Mitsubishi JCTVC- H0236
4.4.0	JCTVC- H0308	Harmonization	- Signalling Max chroma RQT depth for intra and inter - no 32x32 transform for chroma	HiSilicon JCTVC- H0258
4.4.1	JCTVC- H0308	Harmonization	- Signalling Max chroma RQT depth for intra and inter - allow 32x32 transform for chroma	Panasonic JCTVC-H0122

The harmonized solution H0308, in principle, includes elements from all 3 original proposals (G283, G442, G980), and it was decided by reflector discussion to also test G442 separately. Therefore, only H0308 and H0235 (the previous G442) needed to be considered. Among the CE participants, it was suggested to adopt H0308 without the 32x32 chroma transform (configuration 4.4.0)

The approach is to add signalling (2 flags for intra and inter) at the SPS level for limitation of chroma RQT depth (a similar approach as currently for luma and chroma combined). The maximum RCT depth for chroma would still be the same as currently, and therefore this is not a decoder complexity reduction. What was tested in 4.4.0 was using intra chroma RQT depth = 1 and inter chroma RQT depth = 2 (not sequence adaptive), and luma RQT depth = 3 as in common test conditions. With fixed restricted chroma RQT depth (not sequence adaptive), slight gain on chroma (1–2%) is reported.

One comment: An encoder could not decide how to make it adaptive per sequence when it is signalled at the SPS level.

Several experts expressed concerns over whether it is necessary to signal the chroma depth depth at all, suggesting to make it fixed relative to luma. Restriction of chroma RQT depth (without signalling) seems to be useful and if made non-adaptive could even mean a decoder complexity reduction. It appears that either luma depth minus one (as from H0317) or minus two may make sense, but the latter case was not studied. Further it is not known how the performance would be with luma RQT depth other than 3. CE participants will investigate this – also in context of consideration of H0123.

JCTVC-H0731 CE2: Additional tests on reducing Max chroma RQT depth [X. Zhao, J. An, X. Guo, S. Lei (MediaTek), L. Guo, X. Wang, M. Karczewicz (Qualcomm), A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi), A. Ichigaya, S. Sakaida (NHK), S. Ma, W. Gao (PKU)] [late 02-06]

An aspect raised in the discussion was about the effect on spatial prediction, As the size of spatial prediction is derived from transform size, this may become difficult in cases where the chroma prediction is using luma, i.e. the LM mode.

From that point of view, worst-case complexity reduction is not an argument, and in principle the only advantage is compression gain.

Combination with H0123 was implemented, with simulations still running when discused.

Track B initially recommended to adopt the result from CE2 such that (without signalling in SPS) the version from H0731 where chroma depth is luma depth -1 and luma depth -2 in inter cases (minimum 1). This was then made subject to verification of combination with H0123. The topic was then further discussed in JCT-VC plenary.

Note: It was confirmed that max chroma TU size should be kept as 16x16. This restriction is intended only for the 4:2:0 case and may be revised in the future for 4:2:2, 4:4:4, etc.

In later discussion, the potential impact on non-4:2:0 chroma formats was discussed. There was also some concern expressed about the potential cases where a region covered by multiple luma blocks would be required to be coded with a single chroma block. It was noted that there had not been subjective quality evaluation of this, and that we should be past the stage of adopting changes for purposes of very small coding efficiency improvement.

After initially being recommended for adoption in Track B, it was decided not to adopt this change.

Average BD bit rate gain for each test is shown below.

test	High Efficiency						Low Complexity						High 10	
	Intra		Random Access		Low Delay		Intra		Random Access		Low Delay		Random Access	
	Y	UV	Y	UV	Y	UV	Y	UV	Y	UV	Y	UV	Y	UV
4.1	0.02	-2.47	-0.05	-1.32	-0.15	-0.02	0.02	-1.92	-0.01	-1.39	-0.02	-0.93	0.02	-2.59
4.2	-0.05	-2.46	-0.06	-1.43	-0.07	-1.14	0.02	-2.24	-0.01	-1.59	-0.03	-2.16	-0.02	-4.45
4.3	-0.05	-2.46	-0.09	-1.35	-0.10	-0.53	0.02	-2.24	-0.01	-1.72	-0.05	-2.13	-0.03	-4.08
4.4.0	0.02	-2.47	-0.04	-1.61	-0.02	-0.92	0.02	-1.92	0.00	-1.40	-0.01	-1.11	-0.01	-2.93
4.4.1	-0.05	-2.46	-0.05	-1.67	-0.04	-1.21	0.02	-2.24	0.00	-1.61	-0.02	-1.38	-0.01	-4.29

Average runtime for encoding and decoding compared with the anchor are shown below.

test	High Efficiency						Low Complexity						High 10	
	Intra		Random Access		Low Delay		Intra		Random Access		Low Delay		Random Access	
	ENC	DEC	ENC	DEC	ENC	DEC	ENC	DEC	ENC	DEC	ENC	DEC	ENC	DEC
4.1	100%	99%	97%	100%	98%	100%	101%	99%	98%	100%	99%	100%	98%	100%
4.2	99%	99%	96%	100%	97%	100%	100%	99%	97%	100%	98%	100%	96%	100%
4.3	99%	100%	97%	100%	97%	100%	98%	100%	98%	100%	98%	100%	97%	99%
4.4.0	99%	100%	98%	100%	98%	100%	99%	100%	98%	100%	99%	100%	97%	99%
4.4.1	98%	100%	99%	100%	99%	99%	98%	100%	99%	100%	99%	99%	98%	100%

4.2.2 Contributions

Test 1

JCTVC-H0317 On Chroma Cbf Signalling [L. Zhao, X. Guo, S. Lei (MediaTek), S. Ma, W. Gao (PKU), D. Zhao (HIT)] [late]

JCTVC-H0543 CE2: Cross verification of subtest 4.1 [L. Guo (Qualcomm)] [late]

Test 2

JCTVC-H0235 CE2 4.2: report on fixed TU depth for chroma [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi), A. Ichigaya, S. Sakaida (NHK)]

JCTVC-H0319 CE2 subtest 4.2: Crosscheck Report [X. Zhao, X. Guo (MediaTek)] [late]

Test 3

JCTVC-H0538 CE2 4.3: Report on Limiting Chroma Transform Depth in RQT [L. Guo, X. Wang, M. Karczewicz (Qualcomm)]

JCTVC-H0236 CE2 4.3: cross-verification of signalling max chroma TU depth [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)] [late]

Test 4

JCTVC-H0308 CE2: Subset 4.4: Test Results on Harmonization of JCTVC-G283, JCTVC-G442 and JCTVC-G980 [X. Zhao, J. An, X. Guo, S. Lei (MediaTek), L. Guo, X. Wang, M. Karczewicz (Qualcomm), A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi), A. Ichigaya, S. Sakaida (NHK), S. Ma, W. Gao (PKU)]

JCTVC-H0122 CE2: Cross Check of Test 4.4.1 [Y. Shibahara, T. Nishi (Panasonic)] [late]

JCTVC-H0258 CE2: Cross-verification of CE2 subtest4 [X. Zheng (HiSilicon)] [late]

4.3 CE3: Chroma interpolation filter

4.3.1 Summary

JCTVC-H0033 CE3: Summary of Core Experiment on Chroma Interpolation Filter [T. Chujoh, E. Alshina]

In this CE report, test results of interpolation filters for chroma are reported. One proposal (JCTVC-H0494) had been registered in CE3 and two half-pel interpolation filters had been evaluated using the common conditions (with cross-verification).

Related non-CE contributions were noted to include JCTVC-H0180, JCTVC-H0610, JCTVC-H0569, JCTVC-H0207, and JCTVC-H0304 (which was not available).

The current half-pel chroma filter of HM5.0 is {-4, 36, 36, -4}. CE3 tested the following two filters in comparison to HM5.0.

- Variant A: {-7, 39, 39, -7}
- Variant B: {-5, 37, 37, -5}

Both variant A and B have a wider pass-band than the current half-pel chroma filter.

Variant A has wider pass-band than variant B.

The following comments had been concluded at this moment.

- Variant A with 0.1% gain and variant B with 0.2% gain for chroma on average had been tested.

- Both variants provide no performance change in terms of Luma BD bit rate.
- In several sequences on LC-LP when SAO is off, variant A causes loss of coding efficiency; however they are improved if SAO is on.
- Regarding subjective quality assessment, the differences between the proposals and anchor are negligible or very small.

When SAO is on and ALF is off, there was more gain. However, it was noted that there were also some cases with loss when SAO is off – e.g. a BQSquare case.

No action taken.

4.3.2 Contributions

JCTVC-H0494 CE3: Chroma interpolation filter with half pixel phase offset [J. Lou, K. Minoo, L. Wang, A. Luthra (Motorola Mobility)]

JCTVC-H0608 CE3: Cross-check for half-pel Chroma interpolation filter modification (JCTVC-H0494) by Samsung [E. Alshina, A. Alshin, J. H. Park (Samsung)] [late]

JCTVC-H0182 CE3: Cross-check report for Motorola Mobility chroma interpolation filter (JCTVC-H0494) [T.Chujoh (Toshiba)]

4.4 CE4: Quantization

4.4.1 Summary

JCTVC-H0034 CE4: Summary report of Core Experiment on Quantization [K Sato (Sony), M Budagavi (TI), M Coban (Qualcomm), H Aoki (NEC), X Li (MediaTek)]

The results of the CE are summarized as follows:

Subtest 1: Delta QP coding

Subtest 1.1 is the current WD5 (differential encoding relative to previous QP) wherever it came from.

Subtest 1.2 takes reference to left QP from same LCU (if available) otherwise last QP from same LCU – saves 0.1% for intra, 0.0% for inter.

Subtest 1.3 also only takes reference to QPs from same LCU, but makes it dependent on intra pred mode, or in inter case average of left & top depending on availability – saves 0.5% for intra, 0.3/0.2% for RA/LD.

Subtest 1.4 is weighted average depending on equality of neighboured QP values – saves approximately 0.2% on average .

Subtests 1.3 and 1.4 are too complex compared to the benefit they give.

Subtest 1.2 is slightly more complex than 1.1 and gives very little gain.

Conclusion: No change to WD.

Subtest 2: Quant matrix coding

There were 11 proposals, 6 are lossy or are configurable as lossy.

Subjective tests were asked to be done to identify whether lossy compression causes a problem.

A flat matrix was tested only if it is at the same bit rate.

It was requested to check whether the different proposals have the same bit rate, but they seemed likely to be in same range as tested.

Tests were done at QP 32 and 37.

It was suggested to select 3 lossy compression proposals and one lossless one.

A breakout group (coordinated by K. Sato and T. Suzuki) was asked to suggest a test setup and assess the complexity of the different lossy and lossless proposals (including memory size, e.g. using the same matrix values for groups of coefficients). The BoG reported its results in H0710.

Concern was expressed regarding whether the current set of matrices (6 in total) is sufficient.

After some subjective testing, it was planned to identify whether lossy compression causes problems.

After the H0710 BoG report was produced, subjective viewing was conducted as additional BoG activity, with results reported in H0730.

JCTVC-H0710 BoG Report on Quantization Matrices [T. Suzuki, K. Sato]

This document reported the results of discussions on quantization matrices subjective viewing and complexity analysis.

As result of discussion of the CE4 report it had been agreed that subjective quality comparison should be conducted to determine the subjective difference between flat quantization matrices and lossless quantization matrix encoding, and the difference between lossless and lossy matrix encoding – and then after the viewing session, to assess the complexity of each proposal.

It was recommended that tests should be conducted immediately with the main purpose being to identify whether lossy QM coding is affecting the video quality. Planned viewing conditions were described.

It was agreed that if proposals originally planned for being subjectively viewed are not able to provide material for viewing by noon on 02-03, these proposals might be unable to be included in the test. It was remarked that the test should, at a minimum, be run with lossless and one lossy method (one of the more low-rate versions), and in addition should include a comparison against flat quantization matrix usage.

JCTVC-H0730 BoG Report on Quantization Matrices Subjective Viewing [K. Sato, T. Suzuki, X. Zhang, R. Joshi, J. Zheng, M. Zhou]

Tested: Flat, Lossless, Lossy 2.1, 2.2, 2.4.

None of methods used compression for 4x4 and 8x8.

Two Sequences (BQ Mall, Kimono) were investigated at QP=32 only.

The lossless matrix encoding is usually judged better than flat, however typically it had a slightly higher bit rate.

There seemed to be no subjective difference between the lossless and the three lossy compression methods.

The three lossy methods have substantial differences in bit rates.

For "lossy" compression, data rate may be less of an argument than storage of matrices (e.g. using the matrix values for several coefficients by subsampling). Lossless compression of infrequently-used SPS information may also not be too relevant, whereas the storage of reconstructed values should be reduced.

If memory is of concern, should the default matrices also be downsampled?

Several experts also suggested to have non-uniform downsampling (with lower frequencies less downsampled).

It was also expressed that weighting is more important for larger transforms. No conclusion seemed possible from the current CE4 subtest 2 result.

A new design of CE4 should only target the "subsampling" (uniform and non-uniform) approaches for the matrices of 16x16 and 32x32 transforms – also to be investigated for default matrices.

No change was suggested for 4x4 and 8x8.

H0384, in the version where the 8x8 matrix is re-used as a sub-sampled matrix for the 16x16 and 32x32 cases, increases the data rate as compared to the lossless matrix case (approximately 10-15%), due to the fact that the quantization is not the same. However, H0384 is reported to have a second part where downsampled versions of the 16x16 and 32x32 original matrices were conveyed in the SPS header, which would not have visual impact and have very similar data rates (<5% difference, sometimes higher, sometimes lower). Linear interpolation is used for determining the final values. This has not been cross-checked in terms of subjective quality, but the cross-checker confirms that the BD performance is equal (0.1% difference). H0230 is similar but even simpler by using the same value for several neighbouring coefficients (i.e. zero order interpolation). It is reported that the difference in data rate compared to lossless QM encoding is very small except for BQ Mall RA (which would need some more clarification why this is the case).

Decision: Adopt the simple subsampling method (H0230 which uses separate 8x8 matrices with zero-order hold interpolation for 16x16 and 32x32, but keep DC as separate value which was not done in H0230).

This was further discussed in plenary session.

The allowed range of values for QM entries should be as in AVC (1 to 255).

Decision: Use the same subsampling for default matrices for 16x16 and 32x32, and make the defaults for 16x16 and 32x32 be the 8x8 defaults. Preliminary text, uploaded as a revision of H0230, was reviewed.

It was suggested for a CE or AHG to further investigate the following:

- default values for each size
- whether a denser sampling of the low frequency range is necessary

Note: Default matrix in hardware could be implemented differently than storing it in memory, but for software it would be desirable to implement it with the same subsampling as the loadable matrix.

Subtest 3: QP signalling on TU/PU basis instead of CU basis:

JCTVC-H0506/H0508 TU/PU level instead CU level (minimum 8x8).

Objective results: Loss in BD bit rate/PSNR, loss for TU based method (506) 0.5-1%, loss for PU based method (508) lower (0.1/0.2%).

Some results were shown with an assertion that it improves quality (still frames) – although this assertion seemed not fully obvious.

There was an argument that it is needed for rate control – argued that it is beneficial to have QP switching where motion vectors are switched (i.e. switching at the PU level would be needed here).

Instead of results from QP maps that are different from the current CE conditions (and with increased bit rate due to finer granularity), it would be better to compare, with the same maps, a CU-only versus a CU/PU based method (i.e. varying the smallest CU size).

It seemed unclear from the results whether the additional PU level signalling costs overhead or gives a benefit (compared to the same QP changes encoded at CU level only). The same granularity could be achieved by using 8x8 CUs with the current syntax, if needed. It would be anyway only for some specific applications.

No support was expressed except by proponents – and no action was taken.

JCTVC-H0260 reports PSNR gains by using different QP values for 8x8 and 4x4 TUs. As this is influencing the decision of RDO (actual bit rate varies by 2% typically).

It was asked whether this impacts visual quality. It was suggested that it may have some impact on rate control decisions, and may hurt perceptual quantization

No action taken.

Subtest 4 – Finer spatial granularity of QP selection.

The argument is that finer spatial granularity of QP selection is needed in HEVC because rate control may need to be aligned with CU boundaries which may be larger than the MBs in AVC. However, no rate control algorithm was currently available to give proven evidence about this.

The results indicate that it may be useful with constant QP but this is not relevant in practice.

No support for this was expressed by other experts in the absence of a real proof of value.

4.4.2 Contributions

Subtest 1

JCTVC-H0053 CE4 Subtest 1: Rate control friendly spatial QP prediction based on intra prediction (test 1.3) [H. Aoki, K. Chono (NEC), M. Kobayashi, M. Shima (Canon), M. Coban, M. Karczewicz (Qualcomm), K. Sato (Sony)]

JCTVC-H0054 CE4 Subtest 1: HM 4 QP prediction with reset to preceding QP in scan order at LCU boundary (test 1.2) [H. Aoki, K. Chono (NEC)]

JCTVC-H0186 CE4: Result of subtest 1.1&1.2 [K Sato (Sony)]

JCTVC-H0205 CE4: Cross-check of subtest1.3 by JVC Kenwood (JCTVC-H0053) [H. Nakamura, M. Nishitani, S. Fukushima (JVC Kenwood)]

JCTVC-H0197 CE4: Results of subtest 1.4 [H. Nakamura, M. Nishitani, S. Fukushima (JVC Kenwood]

Subtest 2

JCTVC-H0230 CE4 subtest 2.1: Enhancements of HEVC quantization matrix [Y. Morigami, J. Tanaka, T. Suzuki (Sony), V. Sze, M. Zhou (TI)]

JCTVC-H0150 CE4 Subtest 2.1: Crosscheck report of Enhancements of AVC quantization matrix in HEVC (JCTVC-H0230) [M. Shima (Canon)]

JCTVC-H0303 CE4: Cross-check report of subtest 2.1 for Sony/TI on Enhancements of AVC quantization matrix in HEVC [J. Zheng(HiSilicon)]

JCTVC-H0384 CE4 Subset2.2: Results for up-sampling large size quantization matrices based on JCTVC-G152 [S. Liu, X. Zhang, T.-D. Chuang, S. Lei (MediaTek)]

JCTVC-H0151 CE4 Subtest 2.2: Crosscheck report of up-sampling large size quantization matrices based on JCTVC-G152 (JCTVC-H0384) [M. Shima (Canon)]

JCTVC-H0306 CE4: Cross-check report of subtest 2.2 for MediaTek on quantization matrices representation Method and syntax [J. Zheng (HiSilicon)]

JCTVC-H0314 CE4: Subtest 2.4 Layered quantization matrices representation and compression [Y. Wang(Tsinghua), J. Zheng (HiSilicon), Y. He (Tsinghua)]

JCTVC-H0152 CE4 Subtest 2.4: Crosscheck report of Layered quantization matrices compression (JCTVC-H0314) [M. Shima (Canon)]

JCTVC-H0231 CE4: Cross check of CE4 Subset2.4 on JCTVC-H0314 [Y. Morigami, J. Tanaka, T. Suzuki (Sony)]

JCTVC-H0451 **CE4: Subtest 2.5: Coding of quantization matrices based on modified prediction and mapping to unsigned values [R. Joshi, J. Sole, M. Karczewicz (Qualcomm)]**

JCTVC-H0153 **CE4 Subtest 2.5: Crosscheck report of Coding of quantization matrices based on modified prediction and mapping to unsigned values (JCTVC-H0451) [M. Shima (Canon)]**

JCTVC-H0307 **CE4: Cross-check report of subtest 2.5 for Qualcomm on Quantization matrix compression and signalling [J. Zheng(HiSilicon)]**

Subtest 3

JCTVC-H0506 **CE4 subtest 3.1.a: QP adaptation at sub_CU level [J. H. Kim, X. Fang, K. Panusopone, L. Wang, A. Luthra (Motorola Mobility)]**

JCTVC-H0184 **CE4 Subtest 3: Cross-verification report for test 3.1.a (JCTVC-H0506) [H. Aoki, K. Chono (NEC)]**

JCTVC-H0508 **CE4 subtest 3.1.b: Additional constraint for QP adaptation at sub_CU level [J. H. Kim, X. Fang, K. Panusopone, L. Wang, A. Luthra (Motorola Mobility)]**

JCTVC-H0191 **CE4 Subtest 3: Cross-verification report for test 3.1.b (JCTVC-H0508) [H. Aoki, K. Chono (NEC)] [late]**

JCTVC-H0260 **CE4:Subset 3.2 Implicit signalling of QP offset based on TU size [C. Kim, Y.Park, K.Choi, J.H.Kim, J.H. Park (Samsung)]**

JCTVC-H0518 **CE4: cross check report for subtest 3.2 (JCTVC-H0260) [K. Panusopone (Motorola)] [late]**

Subtest 4

JCTVC-H0336 CE4 Subtest 4.1: Higher granularity of quantization parameter scaling [T. Lee, J. Park (Samsung), K. Keiichi (NEC)]

JCTVC-H0318 CE4.4: Crosscheck for Samsung Higher Granularity of Quantization Parameter Scaling [X. Li, X. Guo (MediaTek)] [late]

JCTVC-H0254 CE4: Cross-verification of JVC Kenwood proposal [X. Zheng (HiSilicon)] [late]

4.5 CE5: Transform skipping

4.5.1 Summary

JCTVC-H0035 CE5: Summary Report of Core Experiment on Transform Skipping [M. Mrak, J. Sole, J. Xu, A. Saxena (CE coordinators)]

Two types of transform skipping were studied:

- Transform skipping on intra coded blocks, namely Residual Scalar Quantization (RSQ), presented in JCTVC-E145, and
- Transform skipping on inter coded blocks, namely Transform Skip Mode (TSM), presented in JCTVC-G1003.

Test a: Quantization (adapting the scaling factors). Without this, there are slight losses by transform skipping. When invoked, the gain is 0.4% for RA and 0.7% in LD (excluding class F); higher in class F (1.8/4%).

When using quant matrices (and compared to the case of using default matrices without TS), the gain is 0.7/0.8% for RA and LD.

Encoder runtime increase by TS is approximately 30-35%.

Test b: If restricted to 4x4 blocks, encoder runtime increase is 8%, and the gain is 0.2/0.2% for RA and LD cases.

Test c: Mode dependent scans: no gain demonstrated.

Test d: Coding the last coefficient in bypass mode does not affect coding efficiency for default conditions, and decreases bit rate by approximately 0.2% for class F. Note: For screen content (class F), a large number of blocks (up to 70%) uses transform skipping.

Question: Are the horizontal and vertical modes useful? These were reported to be used in majority of cases for camera content (approximately 50% no skip, 20% vert/hor, 10% full skip). For screen content, approximately 30% no skip, and percentage full skip increases.

Test e: Withdrawn.

Test f: Intra coding (RSQ): Only a choice of 2D or no transform, and the usual prediction modes and mode-dependent scans are used. The deblocking filter is disabled when one of the blocks is fully skipped. No gain was shown for common test conditions, 8% gain for class F in AI-HE mode. If modified contexts

are used for the skip mode, 0.2% gain was measured in common conditions, and 10% in class F. If the deblocking filter is used as conventionally applied, the gain in class F all-intra is reduced to 6.5%.

Test g: Combination of tests a-d. Compared to HM, 0.4/0.6% gain for common test conditions, 2.1/4.7% for class F.

Transform skipping does not give a significant benefit under common testing conditions, and would be a specific tool for screen content (class F) – note: Class F sequences may be less challenging for the inter case.

A thorough investigation of the complexity impact is missing. Proponents argue that complexity is decreased but in fact it is increasing the decoder complexity (as it adds additional logic for switching the transform and the scaling for de-quantization).

Some concern was expressed for hardware implementations, particularly about the horizontal/vertical options. Frequent switching of the de-quantization operation is also of concern.

For inter coding, the version which restricts transform skipping to 4x4 blocks (only changing transform and scaling) seems to be most beneficial, but this still requires hor/vert switching and a change of scaling/dequant.

In regard to related non-CE contributions: H0061 uses only full skip for inter, H0141 is reducing the complexity for scaling/dequant.

It was said that if the transform is fully skipped, the change in dequantization can be implemented by a shift operation (further clarification was requested whether this resolves the concern above).

The relationship with lossless coding was discussed. In that case, the 2D transform would be skipped, but with no change in de-quantization (just skipping it) – this would be more acceptable.

A request was also made to investigate subjective quality.

No support was expressed by other companies except proponents, and some concern was expressed about the complexity impact and that the benefit of this tool is highly sequence dependent.

Conclusion: The additional complexity implication of the encoder and decoder would not justify the benefit it gives for specific class F sequences.

4.5.2 Contributions

JCTVC-H0208 CE5.a: Quantization for transform skipping [M. Naccari, A. Gabriellini, M. Mrak (BBC)]

JCTVC-H0330 CE5.a: Crosscheck for BBC quantization for transform skipping in JCTVC-H0208 [S.-T. Hsiang, T.-D. Chuang (MediaTek)] [late]

JCTVC-H0169 CE5.b: Transform skipping choices based on block parameters [G. Van Wallendael, S. Van Leuven, J. De Cock, R. Van de Walle (Ghent Univ.)]

JCTVC-H0560 CE 5: Cross-Check of H0169 on transform skipping choices based on block size [Ankur Saxena, F. Fernandes (Samsung)] [late]

JCTVC-H0246 **CE5: Cross-verification of Ghent University proposal on transform skipping [X. Zheng (HiSilicon)] [late]**

JCTVC-H0064 **CE5.c – Mode-dependent significance scans for transform skip [M. Mrak, A. Gabriellini (BBC)]**

JCTVC-H0584 **CE5: Cross-verification of subtest CE5.c of BBC (JCTVC-H0064) by Nokia [J. Kang, A. Hallapuro, J. Lainema (Nokia)] [late]**

JCTVC-H0454 **CE5: Subtest c: Crosscheck report [R. Joshi (Qualcomm)] [late]**

JCTVC-H0452 **CE5: Subtest d: Modifications to last significant coefficient position coding for transform skip mode [R. Joshi, J. Sole, X. Wang, M. Karczewicz (Qualcomm)]**

JCTVC-H0142 **CE5.d: Cross-verification for coefficients coding for transform skipping [E.S. Ryu, J. Dong (InterDigital)] [late]**

JCTVC-H0361 **CE5.f: Residual Scalar Quantization for HEVC [C. Lan (Xidian Univ.), J. Xu, F. Wu (Microsoft)]**

JCTVC-H0373 **CE5.f: Cross-check of Microsoft JCTVC-H0361 Residual Scalar Quantization for HEVC [X. Wen, O. Au (HKUST)] [late]**

JCTVC-H0211 **CE5.g: Integration of tools CE5.a to CE5.e [M. Mrak, A. Gabriellini (BBC), G. Van Wallendael (Ghent university), R. Joshi (Qualcomm)]**

JCTVC-H0479 **Cross-check of CE5.g: Integration of tools CE5.a to CE5.e [J. Wang, X. Yu, D. He (RIM)] [late 02-01]**

JCTVC-H0320 **CE5: Cross-check report of CE5.g combined tool by Cisco [T. Davies (Cisco)] [late]**

4.6 CE6: Intra prediction improvements

4.6.1 Summary

JCTVC-H0036 CE6: Summary Report of Core Experiments on Intra Coding Improvements [A. Tabatabai, K. Chono, E. Francois (CE Coordinators)]

The experiments are divided into 3 subsets, as listed below:

1. Subset CE6a: Intra Chroma Prediction
2. Subset CE6b: Improved Intra Prediction
3. Subset CE6c: Intra mode coding cleanup and simplification

4.6.2 Contributions

Subtest a

Every proposal in this category adds some complexity:

- G173 = H0295 is using reconstructed Cb residual as a refinement for Cr prediction.
- G244 is checking irregularities to find the most suitable value for alpha in LM mode.
- G346 uses reconstructed luma residual for chroma prediction additionally to LM mode.
- G358 adds two new variants of LM mode (LML and LMA).

Note: The current HM5 has 6 chroma prediction modes, and G244, G346 and G358 introduce more modes.

(Document numbers of the previous meeting are used above rather than document numbers of this meeting, as these techniques had been proposed at the preceding meeting and had been discussed using those document numbers.)

None of the proposals adds a big advantage in compression performance.

Some concern was expressed that the intra prediction is already fairly complex (particularly in LM mode). H0295 seems to be the least complex, but introduces a new dependency in all modes. It was suggested to check the impact on hardware implementation.

For some architectures, there may be an increase in complexity (mostly at the encoder side, less for the decoder side).

One expert would be OK with having such a mode if it can be disabled by an SPS flag (which seems like not something we should do for a very specific prediction mode).

No action was taken in this area.

JCTVC-H0117 CE6.a: Chroma intra prediction based on residual luma samples [K. Kawamura, T. Yoshino, H. Kato, S. Naito (KDDI)]

JCTVC-H0118 CE6.a: Cross-check results of intra chroma prediction [K. Kawamura, S. Naito (KDDI)]

JCTVC-H0129 CE6.a: Cross-check results of intra chroma prediction [S. Matsuo, M. Matsumura, S. Takamura, H. Jozawa (NTT)]

JCTVC-H0171 CE6: Results on experiments related to section a on Intra Chroma Prediction [C.Gisquet, E. François (Canon), Y.-J. Chiu, Y. Han (Intel), X. Zhang, O. Au (HKUST), K. Kawamura, T. Yoshino (KDDI)]

JCTVC-H0172 CE6: Cross verification of results related to section CE6.A [E. François, C. Gisquet (Canon)]

JCTVC-H0295 CE6.a: Cross-channel prediction refinement to improve intra chroma prediction [Y.J. Chiu, Y. Han, L. Xu, W. Zhang, H. Jiang (Intel)]

This contribution reports test results of the cross-channel prediction refinement technique to improve intra chroma prediction of HM 5.0. Presented at JCT-VC meeting at Geneva, the cross-channel prediction refinement technique produces a refinement signal based on a fixed weighting of the reconstructed cross-channel chroma residual signal. Two test data points of the chroma cross-channel prediction refinement are reported: global weighting prediction and mode-dependent weighting prediction. Compared to the HM5.0 anchor of the common test condition, the mode-dependent weighting prediction provides a reported average BD bit rate change of -0.3% on Y, -0.6% on Cb, and -3.4% on Cr on the AI HE test cases A-E, of -0.3% on Y, -0.8% on Cb, and -3.3% on Cr on AI LC test cases A-E, and of -0.3% on Y, -0.6% on Cb, and -3.3% on Cr on AI HE-10 test cases A-F, without significant impact on the CPU run time (1% decrease in Enc time, 0% increase in Dec time for AI HE case, 0% increase in Enc time, 1% increase in Dec time for AI LC case, and 1% decrease in Enc time, 0% increase in Dec time for AI HE-10 case).

JCTVC-H0573 Cross Check for Intel intra chroma prediction (JCTVC-H0295) [K. Kawamura (KDDI)] [late]

JCTVC-H0296 CE6.a: Cross-check report for CE6a on intra chroma prediction [Y.J. Chiu, Y. Han, L. Xu, W. Zhang(Intel)]

JCTVC-H0323 CE6.a: Cross-check of three combined cases of the four intra chroma prediction tools by Huawei [H. Yang (Huawei)]

JCTVC-H0539 CE6.a: Cross-check report for intra chroma prediction [X. Zhang, O. Au (HKUST)]

JCTVC-H0544 CE6.a: New modes (LML and LMA) for chroma intra prediction [X. Zhang, O. Au, J. Dai, X. Wen, C. Pang, F. Zou (HKUST)]

Subtest b

JCTVC-G135/H0437 proposes to add two prediction unit (PU) types (i.e. 2NxN and Nx2N) to Intra coding units (CU) in addition to the existing PU types (i.e. 2Nx2N and NxN) relative to the current HM design. It also reports NSQT harmonization results with and without 8x2/2x8 transforms.

JCTVC-G119/H0059 proposes to make the total number of remaining intra modes a power of two and use FLC encoding for the binarization.

It was asked what is the relationship between H0437 and H0455 (the latter being categorized as an AHG16 related contribution). It was suggested that they should give the same results, but are different. H0437 is subsumed in H0455 and it was suggested that H0437 can be discussed in the context of AHG16 discussions.

JCTVC-H0437 CE6.b: Rectangular (2NxN and Nx2N) PU for Intra Prediction [X. Zhang, S. Liu, S. Lei (MediaTek)]

JCTVC-H0297 CE6.b: Cross verification of MediaTek rectangular (2NxN and Nx2N) intra prediction (JCTVC-H0437) [Y.J. Chiu, Y. Han, L. Xu, W. Zhang (Intel)]

JCTVC-H0346 CE6.b crosscheck for MediaTek proposal [Y. Lin, C. Lai, L. Liu, J. Zheng (HiSilicon)]

JCTVC-H0268 CE6: Cross-check for Subtest CE6b of Rectangular (2NxN and Nx2N) Intra Prediction [S. Oudin (Fraunhofer HHI)]

JCTVC-H0403 CE6.b: Cross-check report for Rectangular (2NxN and Nx2N) PU for Intra Prediction [J. Xu, A. Tabatabai (Sony)]

JCTVC-H0187 CE6: Crosscheck of JCTVC-G119 [K Sato (Sony)]

JCTVC-H0057 CE6 subset 5.2.2 and 6.2.2: Intra coding improvements [Y. Lin, L. Liu, J. Zheng (HiSilicon), H. Yang, H. Yu (Huawei)]

Relating to subtest b, this is removing the Hor+8 and Ver+8 modes and adding a new mode which is the average of both. In terms of compression, there was no benefit (at most 0.1% BR reduction). It reduces one mode, but needs to add in the averaging process, and therefore it is not a real simplification.

Relating to subtest c, removing the Hor+8 entirely resulted in no loss in compression.

JCTVC-H0192 CE6: Cross-check report for Subtest CE6b and CE6c on modifications to Intra-frame coding [H. L. Tan, C. Yeo, Y. H. Tan (I2R)] [late]

Subtest c

JCTVC-H0075 CE6: Subtest 6c (6.2.1) – Intra mode coding simplification [C. Yeo, Y. H. Tan, H. L. Tan, Z. G. Li (I2R)]

This contribution proposed a modification to the intra prediction mode coding in the HM based on the proposal JCTVC-G153. The remaining mode coding uses a binary+FLC binarization. When the binary flag is coded in bypass mode, there is reportedly no loss in coding performance for AI-HE and AI-LC configurations. When the binary flag is coded using a context, there is reportedly an average BD bit rate gain of 0.2% for both AI-HE and AI-LC configurations.

General opinion: This is a straightforward approach of simplification.

It is conceptually similar to the 3 MPM approach

Various similar methods targeting simplification had been proposed (see CE summary) – similar to H0057 and H0075, and it was agreed to establish a breakout group on simplification of intra mode coding (coordinated by K. Chono) – see further discussion in section 5.17.

JCTVC-H0058 Cross-verification of CE6 subset 6.2.1: On intra prediction mode coding (JCTVC-H0075) [Y. Lin, L. Liu (HiSilicon)]

JCTVC-H0440 CE6.c: Cross-check of JCTVC-H0075: Intra mode coding simplification [X. Zhang, S. Liu (MediaTek)] [late]

JCTVC-H0478 CE6.c: Cross check of Huawei/HiSilicon proposal JCTVC-H0057 [J Kim, C Kim, B Jeon (LG)]

4.7 CE7: Additional transforms

4.7.1 Summary

JCTVC-H0037 CE7: Summary Report of Core Experiment on Additional Transforms [R. Cohen, C. Yeo, R. Joshi, F. Fernandes (CE coordinators)]

Three types of additional transforms for luma TUs had been evaluated:

- Tool 1 is a mode-dependent secondary transform for 8x8, 16x16, and 32x32 Intra TUs, applied after the HM core transform.
- Tool 2 applies a boundary-dependent primary transform for 4x4, 8x8, and 16x16 Inter TUs. Size 4 transforms use the HM DCT or HM DST Type-VII (currently used for Intra TUs) extended to the Inter case. At size 8 and larger, HM DCT and DST-Type IV are used. The DST-Type IV is generated from the DCT-Type IV by flipping basis vectors.
- Tool 3 applies the boundary-dependent primary transform from Tool 2 for 4x4 Inter TUs and a boundary-dependent secondary transform for 8x8, 16x16, and 32x32 Inter TUs. The secondary transform matrices in Tools 1 and 3 are the same. The performance of this tool is also evaluated with Tool 1.

Performance summaries for All-Intra configurations (N/A: Not Applicable)

Tool	AI-HE				AI-LC			
	Avg Y BD bit rate (%)	Min,Max Y BD bit rate (%)	Enc Time (%)	Dec Time (%)	Avg Y BD bit rate (%)	Min,Max Y BD bit rate (%)	Enc Time (%)	Dec Time (%)
1: JCTVC-H0125 Mode-dependent secondary (Intra)								
4x4	**-0.5**	-0.2,-0.8%	101	99	**-0.6**	-0.3,-1.1%	102	102
8x8	**-0.7**	-0.3,-1.2%	103	102	**-0.8**	-0.4,-1.5%	105	102
2: JCTVC-H0309 Boundary-dependent primary (Inter)	N/A				N/A			
3: JCTVC-H0126 Boundary-dependent secondary	N/A				N/A			

Performance summaries for Random Access 8-bit configurations

Tool	RA-HE				RA-LC			
	Avg Y BD bit rate (%)	Min,Max Y BD bit rate (%)	Enc Time (%)	Dec Time (%)	Avg Y BD bit rate (%)	Min,Max Y BD bit rate (%)	Enc Time (%)	Dec Time (%)
1: JCTVC-H0125 Mode-dependent secondary (Intra)								
4x4	**-0.2**	-0.1,-0.3	101	101	**-0.3**	-0.2,-0.6	100	102
8x8	**-0.3**	-0.2,-0.5	100	100	**-0.4**	-0.2,-0.7	100	101
2: JCTVC-H0309 Boundary-dependent primary (Inter)	**-0.3**	-0.2,-0.5	101	101	**-0.3**	-0.3,-0.6	101	100
3: JCTVC-H0126 Boundary-dependent secondary								
4x4 Inter	**-0.3**	-0.2,-0.4	102	100	**-0.3**	-0.3,-0.5	101	102
8x8 Inter	**-0.3**	-0.2,-0.4	102	100	**-0.4**	-0.3,-0.6	102	101
4x4 Inter + Tool 1 4x4 Intra	**-0.5**	-0.4,-0.7	102	102	**-0.7**	-0.5,-1.1	101	101
8x8 Inter + Tool 1 8x8 Intra	**-0.6**	-0.4,-0.9	102	100	**-0.8**	-0.5,-1.3	102	102

Performance summaries for Low Delay configurations

Tool	LB-HE				LB-LC			
	Avg Y BD bit rate (%)	Min,Max Y BD bit rate (%)	Enc Time (%)	Dec Time (%)	Avg Y BD bit rate (%)	Min,Max Y BD bit rate (%)	Enc Time (%)	Dec Time (%)
1: JCTVC-H0125 Mode-dependent secondary (Intra)								

4x4	**-0.1**	+0.1,-0.2	100	100	**-0.1**	+0.1,-0.2	100	100
8x8	**-0.1**	+0.2,-0.2	100	101	**-0.1**	+0.2,-0.2	101	102
2: JCTVC-H0309 Boundary-dependent primary (Inter)	**-0.5**	-0.4,-0.6	101	101	**-0.6**	-0.6,-0.7	102	100
3: JCTVC-H0126 Boundary-dependent secondary								
4x4 Inter	**-0.3**	-0.2,-0.4	101	99	**-0.4**	-0.3,-0.5	101	100
8x8 Inter	**-0.4**	-0.2,-0.4	101	99	**-0.5**	-0.4,-0.6	101	100
4x4 Inter + Tool 1 4x4 Intra	**-0.4**	-0.1,-0.5	101	101	**-0.5**	-0.2,-0.7	101	101
8x8 Inter + Tool 1 8x8 Intra	**-0.5**	-0.1,-0.6	102	101	**-0.6**	-0.2,-0.8	102	100

- Note: The last two rows in "tool 3 performance" are combination of tool 1 and tool 3.

The most attractive solution w.r.t. performance vs. complexity seemed to be Tool3 with 4x4 secondary for inter, and Tool1 with 4x4 for intra.

Concern was expressed about increased latency due to the additional transform stage, and an increased number of building blocks, decision elements, buffers, etc., in general. (The same concerns had been expressed at the last meeting.)

The latency problem is more severe for intra due to the higher amount of dependencies.

With appropriate implementation, the latency could potentially be zero. The implication of boundary-dependent decisions on complexity/latency was not fully clear.

The cross-checker supports the proposal, emphasizing that the gain is remarkable for high-resolution sequences.

However, no consensus was reached, and no action was taken on this.

4.7.2 Contributions

JCTVC-H0125 CE7 : On secondary transforms for intra prediction residual [A. Saxena, Y. Shibahara, F. Fernandes, T. Nishi (Samsung)]

JCTVC-H0126 CE7: On secondary transforms for inter prediction residual[A. Saxena, Y. Shibahara, F. Fernandes, T. Nishi (Samsung)]

JCTVC-H0589 CE7: Cross-check for Tool 1 and 3 (H0125 and H0126) by BBC [M. Mrak, D.Flynn (BBC)] [late]

JCTVC-H0124 CE7: Cross check report of Tool1, Mode dependent secondary transform [A. Ichigaya, Y. Sugito (NHK)]

JCTVC-H0393 CE7: Cross verification of JCTVC-H0126, on secondary transforms for inter prediction residual [R. Cohen (MERL)]

JCTVC-H0309 CE7: Boundary-Dependent Transform for Inter-Predicted Residue [J. An, X. Zhao, X. Guo, S. Lei (MediaTek)]

JCTVC-H0080 CE7: Cross-check of Tool 2, Boundary-dependent transform for inter [Y. Sugito, A. Ichigaya (NHK)]

JCTVC-H0127 CE7: Cross-Check for H0309 [A. Saxena, F. Fernandes (Samsung)] [late]

JCTVC-H0324 CE7: Cross verification of JCTVC-H0309, Boundary Dependent Transform for Inter Predicted Residue [R. Cohen (MERL)]

4.8 CE8: Non-deblocking loop filtering

4.8.1 Summary

JCTVC-H0038 CE8: Summary report of Core Experiment on non-deblocking loop filtering [T. Yamakage, I. S. Chong, M. Narroschke, Y.-W. Huang]

A summary of core experiment 8 (CE8) on non-deblocking loop filtering was reported. There were six Subtests in CE8:

- Subtest a: Implementation-friendly improvement of non-deblocking in-loop filtering (four proposals),
- Subtest b: ALF simplification (two proposals),
- Subtest c: Necessity of sign bits for SAO offsets (one proposal),
- Subtest d: SAO simplification and line buffer reduction (two proposals),
- Subtest e: SAO improvement (five proposals), and
- Subtest f: Subjective picture quality assessment of ALF.

These were evaluated based on the common test conditions in JCTVC-G1200 and additional conditions described in JCTVC-G1208. All mandatory results were verified by cross-checkers.

Subjective viewing was conducted.

H0714 is a report of subjective test results for subtest f. The other subjective testing was reported in a powerpoint deck for H0038. The results were made available and were discussed on Friday 02-03.

H0382 reports the overall gain from ALF.

H0277 reports the gains of ALF and SAO. The gain of ALF (with SAO on in both cases) was reported as 1.6/3.3/2.8/4.2% in AI/RA/LB/LP HE (more for Class A, and more in LP), with the benefit asserted to be visible for some sequences.

The gain is greater for HD and higher-than-HD resolution (and higher for non-CTC sequences).

H0714

ALF on vs. off visual quality improvement was tested at equal bit rates.

For post filtering, the bit rates were somewhat higher (2% on average). Somewhat higher complexity was also noted to occur, as generally there is more filtering applied in the post-filtering case (reported in H0382 as 10-17% in non-intra-only use cases – although there may be some implementation issues involved in that analysis).

H0714 did not (in preliminary analysis) find a statistically significant visual difference in quality between ALF on, ALF off, and ALF as a post-filter.

However, it was noted that it is generally difficult to find statistically significant differences in subjective tests when gains are relatively small (e.g. less than 5-10%).

It was also noted that the method of determining, in an encoder, the filtering parameters that will be sent to the decoder, is unknown and outside the scope of the standard (and may not be MSE-based). However, it was acknowledged that this is a general problem for the whole codec design.

It was suggested that generally any quality difference was difficult to perceive, and most likely to be found at the highest QP values.

The test methodology, i.e. reference, A, B rather than just A versus B and selection of which is better, was somewhat questioned.

A participant commented that visual effects at very high QP values (perhaps beyond the range of what was tested in this test) may provide additional insight.

Regarding subtest CE8.a:

It is asserted to be desirable to allow picture-level optimization of the filtering decisions. If the filtering control data needs to be interleaved into the slice data, the slice data cannot be generated until the filtering decisions are completed. Moreover, the filter coefficients could not be shared across multiple pictures or perhaps even multiple slices (e.g. by putting them into the APS) if they need to be interleaved into the slice data. This motivates the desire on the part of some contributors to send the control data separately from the slice data.

The benefit of the "a.4" picture-based encoding relative to "a.2" (H0066) was reported as: AI/RA/RA_10/LD/LDP = 0.2/0.4/0.7/0.1/-0.1 (more for higher resolution).

However, from the decoder perspective, a need to store all the filter control data before starting the other LCU-level decoding processes for the slice is undesirable. From the encoder perspective, the need to generate two separate chunks of data while encoding and then send them sequentially has an undesirable complexity burden and an undesirable delay burden in very-low-delay uses.

It was remarked that the LCU-based signalling effectiveness is affected by LCU size. These tests were done with 64x64 LCUs. For smaller LCU sizes, LCU-based signalling would not perform as well.

It was remarked that LCU-based operation for ALF doesn't really help unless the rest of the codec can operate in an LCU-based fashion as well.

The idea of doing a direct A vs. B subjective preference measurement was further discussed (although the the test that was done was done as recommended by V. Baroncini and according to well-established practice). It was remarked that a preference indication might be extractable from the already-measured data.

It was commented that, from the perspective of a very low delay application, the current ALF is not useful.

It was commented that the ALF software / design has real problems, e.g. as visible by studying the software or simply observing its number of lines of code.

See also notes elsewhere in this report regarding ALF.

CE8.a.3 LCU-based SAO

This test evaluates H0273 (also proposed as F056 and G831).

Substantial benefit was shown; it enables SAO usage with slices. The loss in whole-picture SAO usage is minimal (0.1-0.2% average).

It was remarked that there is also a non-CE LCU-based SAO proposal in H0067.

It was asked whether there is any need to be able to send SAO control parameters in the APS. It was remarked that picture-level optimization with multiple slices may mean that the APS is a better idea than the slice header. This is further discussed in notes elsewhere in this report.

In the case of "Fine granularity slices", the control data for some LCU is sent more than once. We will impose a bitstream conformance constraint such that the control data must be equal within an LCU. This was agreed.

A limit is needed for limiting the maximum number of control parameters sent for a picture. The proposed draft text is missing the value of this limit, which needs to be determined as a profile/level constraint.

CE8.c SAO simplification and line buffer reduction

It was remarked that there is a related contribution in CE8.3.

In terms of PSNR, some small chroma gain was reported for some proposals.

In terms of subjective quality, there seemed to be no overall significant difference.

H0436 and H0174 were discussed as reductions of the offset buffer.

H0174 seemed to have better chroma PSNR than H0426.

Some encoder complexity was suggested to be associated with H0174.

It was remarked that decisions on various issues related to SAO would interact with the decision on LCU-based SAO operation.

However, it was suggested that minimizing the number of band offsets would be especially helpful for LCU-based SAO operation.

The non-CE proposal H0438 was suggested to potentially be better.

Another non-CE proposal H0406 was also suggested to be worth consideration.

H0553 is LCU-signalling-related reduction of band offsets for LCU-based SAO operation.

JCTVC-H0726 BoG report on reduction of SAO BO offset buffer [T. Yamakage]

A BoG on reduction of the number of band offsets (CE: H0174, H0436, Non-CE: H0406, H0438, H0553) was coordinated by T. Yamakage. It was noted that:

- H0406 had no WD text or software. Text was later submitted.
- H0553 had no simulation results (although they were provided later in a revision).

Current syntax: 256 region * 16 offsets * 4 bits * 3 colour components = 6 kbytes (for 8b video)

If LCU-based syntax is adopted, a reduction of the number of band offsets would have more benefit in terms of coding efficiency.

There has been a proposal to establish a limit on the maximum number (F056, G831, H0273).

The BoG recommended to study "H0174-B", H0438 and H0406 for potential adoption.

An update of H0174-B had been submitted that changed a number of bands parameter from 8 to 4. This would reduce the buffer size to the same value as used in H0406. With this modification, H0174-B and H0406 are essentially the same thing.

In technical terms, H0406 is H0174-B with modification of number of bands from 8 to 4 and unsigned 5b FLC/bypass coding of the left edge of the band rather than se(v) | ae(v) coding of the center of each band. Decision: Adopt as described – software to be provided by the H0174-B proponent, text to be based on the H0174-B draft, altered to reflect the modifications proposed in H0406 (number of bands set to 4 and unsigned 5b FLC/bypass coding of the left edge of the band).

It was remarked that there was some loss (roughly 0.5% on luma) on Class F for this approach. It was suggested that the edges in Class F are so strong that any reduction in the number of bands would have such an effect.

The BoG also studied H0553. See notes in the section specific to that contribution.

CE8.d.2 Line buffer reduction

H0375 is line buffer reduction. It seems to have no degradation of objective or subjective quality.

It was suggested that we should be conservative about line buffer memory reductions that could potentially cause artefacts. It was remarked that there is also value in keeping the design straightforward.

There is only one line buffer in SAO. It was noted that the line buffer can be reduced by non-normative behaviour to 2 bits per sample. The proposal is to reduce this to 1 bit per sample.

No action was taken on this proposed modification.

CE8.c "salt and pepper" noise issue

Two approaches were tested to address this issue.

It has been questioned whether the sign bit in SAO is useful.

The CE8.c.1 proposal H0434 suggests to remove the sign bit.

When the sign bit is 1, the SAO filter is effectively a sharpening filter.

Two things were tested. The first was to remove the sign bit, and the other was an encoder-only restriction. The first approach had no apparent adverse effect on PSNR coding efficiency for luma (and a very small degradation for chroma). The second approach actually, counter-intuitively, had slightly better chroma results. Subjectively, there was no significant difference, but if we look at the mean values, the situation observed for PSNR was reversed (i.e. normative removal of the sign bit was slightly better).

It was remarked that H0276 shows some evidence that the sign bit is sometimes useful.

H0276 describes a non-normative approach to the "salt and pepper" issue. It contained some still images illustrating cases in which an asserted benefit was evident, as eliminating the sign bit might excessively blur texture.

H0114 is a related non-CE contribution. It confirms that the "salt and pepper" issue exists. It suggests having a limitation of the SAO offset range as an approach to the issue (but a range that included some small negative values). This could be done non-normatively by an encoder. However, the contribution also suggested to make a normative range change with a different way of encoding of the value, as an asserted simplification of the encoding. The normative and non-normative approaches seemed to have about the same effect on PSNR.

It was remarked that specification of a maximum range of values without any change of the encoding representation method could be an alternative, and that some smaller range limit needs to be specified in the text.

Decision: Removal of sign as proposed in H0434.

CE8.e SAO quality improvement

Note from prior meeting report: "A CE is suggested on various proposals of SAO offset adaptation which slightly reduce the rate but also appear to slightly increase complexity – is that worthwhile? It is emphasized by the chair of track A that, if the results indicate only minor benefit, these parts of the CE may not be considered/reviewed in next meeting (note: this could apply to some other CEs as well and would just mean to execute rules that were already set up previously)."

Some proposals on this subject were already discussed in other discussions.

RA HE PSNR improvement results were: luma 0.1 to 0.3%, chroma 0.4-2.4%.

CE8.e.3 = H0223, using more offsets: no subjective statistical difference, average below anchor in all 3 cases.

CE8.e.4 = H0557, enforced lowpass operation by clipping: no subjective statistical difference, average below anchor in 1 of 3 cases.

CE8.e.5 = H0225, a combination of CE8.e.2 and CE8.e.3: no subjective statistical difference, average below anchor in 2 of 3 cases.

No action taken.

4.8.2 Contributions

Subtest A

JCTVC-H0272 CE8.a.1: One-stage SAO and ALF with LCU-based syntax [C.-Y. Chen, C.-Y. Tsai, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek), I. S. Chong, M. Karczewicz (Qualcomm), T. Yamakage, T. Itoh, T. Watanabe, T. Chujoh (Toshiba)]

JCTVC-H0102 CE8.a.1: Crosscheck of MQT One-stage SAO and ALF with LCU-based syntax (JCTVC-H0272) [T. Ikai (Sharp)] [late]

JCTVC-H0066 CE8.a.2: ALF with LCU-based syntax [A. Fuldseth, G. Bjøntegaard (Cisco)]

JCTVC-H0586 Crosscheck of Cisco proposal JTCVC-H0066 [G. Clare, F. Henry (Orange)] [late]

JCTVC-H0170 CE8.a.2: Cross-check of Cisco proposal on ALF with LCU-based syntax (JCTVC-H066) [T. Yamakage (Toshiba)] [late]

JCTVC-H0273 CE8.a.3: SAO with LCU-based syntax [C.-M. Fu, C.-Y. Chen, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), I. S. Chong, M. Karczewicz (Qualcomm), E. Alshina, A. Alshin (Samsung)]

JCTVC-H0103 CE8.a.3: Crosscheck of MQS SAO with LCU-based syntax (JCTVC-H0273) [T. Ikai (Sharp)] [late]

JCTVC-H0274 CE8.a.4: One-stage/Two-stage SAO and ALF with LCU-based syntax [C.-Y. Chen, C.-Y. Tsai, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek), I. S. Chong, M. Karczewicz (Qualcomm), T. Yamakage, T. Itoh, T. Watanabe, T. Chujoh (Toshiba)]

JCTVC-H0408 CE8.a.4 Cross-check [A. Fuldseth (Cisco)] [late]

JCTVC-H0422 CE8: Cross-check CE8.a.4. ALF_ONLY [P. Lai, F. C. A. Fernandes (Samsung)] [late]

JCTVC-H0371 CE8 subtest A: Cross-check report for JCTVC-H0274 [S. Esenlik (Panasonic)]

Subtest B

JCTVC-H0413 CE8.b.1: ALF BA feature computation at upper-left 4 pixels in a 4×4 block [P. Lai, F. C. A. Fernandes (Samsung), E. Maani, A. Tabatabai, M. Ikeda (Sony)]

It seems no longer important to consider this contribution due to the change of filter shape recorded below.

JCTVC-H0385 CE8.b.1: Crosscheck of Modification of ALF BA classification (JCTVC-H0413) by Qualcomm [I. S. Chong, M. Karczewicz (Qualcomm)]

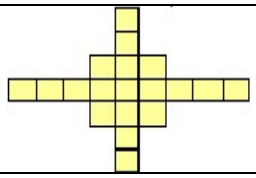
JCTVC-H0068 CE8.b.2: ALF with single filter type [M. Budagavi (TI)]

Several different alternative candidate shapes were considered for the region of support for filters in ALF.

It was remarked that the single-filter type concept has not been tested together with LCU-based ALF. However, that seemed unlikely to be a problem.

Decision: Adopt the 9x7 cross with center 3x3 square as illustrated below – initially subject to review of H0571, and then later confirmed.

	filter taps		AI-HE	RA-HE	RA-HE10	LB-HE	LP-HE
9x7 cross, center 3x3 square	**10**	Class A	0.0%	0.1%	0.1%		
		Class B	0.0%	0.0%	0.1%	0.1%	0.1%
		Class C	-0.1%	0.0%		0.1%	0.1%
		Class D	0.0%	0.2%		0.2%	0.1%

		Class E	-0.2%			0.3%	0.5%
		Average	***-0.1%***	***0.1%***	***0.1%***	***0.2%***	***0.2%***
		Enc Time	103%	101%	101%	101%	101%
		Dec Time	101%	103%	103%	102%	103%

JCTVC-H0416 CE8.b.2 Crosscheck of TI single filter shape ALF [P. Lai, F. C. A. Fernandes (Samsung)] [late]

Subtest C

JCTVC-H0434 CE8 Subset c: Necessity of Sign Bits for SAO Offsets [W.-S. Kim, D.-K. Kwon (TI)]

JCTVC-H0331 CE8.c.1: Crosscheck for TI necessity of sign bits for SAO offsets in JCTVC-H0434 [E. Alshina, A. Alshin (Samsung), C.-M. Fu, Y.-W. Huang (MediaTek)] [late]

Subtest D

JCTVC-H0436 CE8 Subset d.1: Reduced Number of Band Offsets in SAO [W.-S. Kim, D.-K. Kwon (TI)]

JCTVC-H0332 CE8.d.1: Crosscheck for TI reduced number of band offsets in SAO in JCTVC-H0436 [C.-M. Fu, Y.-W. Huang (MediaTek)] [late]

JCTVC-H0375 CE8.d.2: SAO Line Buffer Reduction [S. Esenlik, M. Narroschke, T. Wedi (Panasonic)]

JCTVC-H0334 CE8.d.2: Crosscheck for Panasonic SAO line buffer reduction in JCTVC-H0375 [C.-M. Fu, Y.-W. Huang (MediaTek)] [late]

Subtest E

JCTVC-H0276 CE8.e.1: Offset coding in SAO [C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek), I. S. Chong, M. Karczewicz (Qualcomm)]

JCTVC-H0173 **CE8: Cross verification of Mediatek results regarding section e.1 [G. Laroche, T. Poirier, P. Onno (Canon)] [late]**

JCTVC-H0174 **CE8: Results related to section e.2 [G. Laroche, T. Poirier, P. Onno (Canon)]**

JCTVC-H0229 **CE8.e.2: Cross check of CE8.e.2 (JCTVC-H0174) [K. Andersson (Ericsson)]**

JCTVC-H0223 **CE8.e.3: Modified SAO edge offsets [K. Andersson, P. Wennersten, R. Sjöberg (Ericsson), S. Esenlik, M. Narroschke, T. Wedi (Panasonic)]**

JCTVC-H0390 **CE8.e.3: Crosscheck of Modified SAO edge offsets (JCTVC-H0223) by Qualcomm [I. S. Chong, M. Karczewicz (Qualcomm)]**

JCTVC-H0557 **CE8.e.4 Selection and Coding of SAO Parameters [Koohyar Minoo, David Baylon (Motorola)]**

JCTVC-H0335 **CE8.e.4: Crosscheck for Motorola Mobility selection and coding of SAO parameters in JCTVC-H0557 [C.-M. Fu, Y.-W. Huang (MediaTek)] [late]**

JCTVC-H0225 **CE8.e.5: Combination of CE8.e.2 and CE8.e.3 [K. Andersson, P. Wennersten, R. Sjöberg (Ericsson), G. Laroche, P. Onno, T. Poirier (Canon), S. Esenlik, M. Narroschke, T. Wedi (Panasonic)]**

JCTVC-H0337 **CE8.e.5: Crosscheck for combination of CE8.e.2 and CE8.e.3 in JCTVC-H0225 [C.-M. Fu, Y.-W. Huang (MediaTek)] [late]**

Subtest F

JCTVC-H0714 **CE8.f: ALF subjective testing results [A. Tabatabai (Sony), M. Budagavi (TI), D. Flynn (BBC), P. Chen, W. Wan (Broadcom), K. Minoo (Motorola Mobility), T. Suzuki, C. Auyeung, J. Xu (Sony), D-K. Kwon, M. Zhou (TI)] [late]**

JCTVC-H0622 CE8.f : Crosscheck report on objective evaluation of visual testing [O. Nakagami, M. Ikeda, T. Suzuki (Sony)] [late]

4.9 CE9: MV coding and skip/merge operation

4.9.1 Summary

JCTVC-H0039 CE9: Summary report of Core Experiment on MV Coding and Skip/Merge Operations [I.-K Kim, J. Jung, S. Oudin (CE coordinators)]

In this CE report, test results of two categories of proposals are reported: modification of bi-prediction (BP) and simplification of the first merge pruning process (SP). Eight experiments for BP and one experiment for SP were conducted.

For modification of bi-prediction, 8 experiments were conducted to verify the efficiency of the bi-prediction modification, which was originally presented in JCTVC-G305. For all these tests, the only reference used is HM-5.0. In BP01, as the original form of the proposal, the motion vector difference (MVD) for List1 is not signalled and sets to (0, 0) for GPB pictures (reference picture list 1 is identical to reference picture list 0). A variation, which alters L0 MVD instead of L1 MVD, is tested in BP02. In BP03, the same approach as BP01 is applied to all inter pictures. Also, in order to investigate the effects of syntax change, two experiments are done with encoder only changes in BP04 and BP05. The effect of combination with 2nd motion estimation for bi-prediction in non-GPB pictures is investigated by BP06. In BP07 and BP08, the same modifications to BP01 and BP02 are tested with the addition of the HM ticket #175 fix. The HM ticket #175 is applied since this fix is related to the bi-predictive motion estimation (ME) enhancement. The impact on visual quality by the modification of ME part is also investigated.

Summary of BP-series tests:

- LD (LD-HE, LD-LC)
    - Gain of BP08 (including a syntax addition and bi-predictive ME fix) is 1.1% on average without encoding and decoding time increase for classes A-E. For class F it is 1.9% on average. The cross-checker concludes that BP08 does not show any unusual or undesired effect on reconstruction quality.
    - Gain of BP05 (gain from encoder-only 2nd motion estimation for bi-predictive mode) is 0.7% in average with 31% encoding time increase for classes A-E. For class F the gain is is 0.7%. It is worth noting that BP05 does not include bi-predictive ME fix. (With bi-predictive ME fix, the gain will increase to 0.7% for classes A-E case and 1.7% for class F case, respectively. These results are reported in JCTVC-H0111.)
    - Gain from adding a syntax element is average 0.7%, which is derived by comparing results between BP01 and BP04.
- RA (RA-HE, RA-LC, RA-HE-10 bits)
    - Gain of BP08 (including a syntax addition and bi-predictive ME fix) is 0.3% on average without encoding and decoding time increase for classes A-E. For class F the gain is 0.7%. The cross-checker concludes that BP08 does not show any unusual or undesired effect on reconstruction quality.
    - Gain of BP05 (gain from encoder-only 2nd motion estimation for bi-predictive mode) is 0.6% in average with 21% encoding time increase for classes A-E. For class F the gain is 0.4%. It is worth noting that BP05 does not include the bi-predictive ME fix. (With the bi-predictive ME fix, the gain will increase to 0.7% for classes A-E case and 1.1% for class F case, respectively. These results are reported in JCTVC-H0111.)

- Gain of BP06 (gain from BP01 + encoder-only 2nd motion estimation for bi-predictive mode) is 0.7% on average with 18% encoding time increase for classes A-E. For class F there is 0% impact. It is worth noting that BP06 does not include bi-predictive ME fix. (With bi-predictive ME fix, the gain will increase to 0.7% for classes A-E case and 1.1% for class F case, respectively. These results are reported in JCTVC-H0111.)
- Gain from adding a syntax element is average 0.2%, which is derived by comparing results between BP01 and BP04.

Summary of SP test:

- SP is reported as resulting in 0.1% loss in average, but it is claimed to have several benefits: reduction of complexity of merge list generation, decoding time reduction by early exit and improved error resilience.

Recommendations from the CE9 summary report were:

- Fix the HM ticket #175 (encoder-only modification to remove a clipping) –
  Decision (SW): Agreed.
- Recommend BP08 as the best method among 8 test cases and have BP08 be discussed as a candidate for adoption at the meeting, along with consideration of non-CE contributions.

It was remarked that this is a syntax change is essentially to optimize for a particular encoder design, and that a modification that does not add syntax could achieve similar gain without the syntax change.

It was suggested to review JCTVC-H0431 in that regard.

Further discussion was deferred for review of non-CE input, and was later closed by a BoG (see notes for H0709).

In the simplified pruning (SP) test, the first pruning process in HM5.0 was removed, and instead a smaller number of parallelizable motion information comparisons are performed only between the spatial candidates. The motion information of a spatial candidate is inserted into the merge list, depending on a specific condition on this spatial candidate.

There are two aspects of the proposal. For the first aspect, another contribution (JCTVC-H0133) proposes the same thing.

For the second aspect, the spatial candidate is not compared against the TMVP candidate. This is asserted to simplify the checking, improve loss resilience, and improve parallelism. This has a loss of 0.1% for RA and 0.2% for LB. After some side discussion, the proponent of JCTVC-H0133 also considered the other aspect to be beneficial.

Decision: Adopted (both aspects; text was checked during meeting).

4.9.2 Contributions

JCTVC-H0111 CE9: Modification of bi-prediction [Y. Suzuki (NTT Docomo)]

JCTVC-H0344 CE9: Cross-check report for tests BP01 and BP04 (JCTVC-H0111) [P. Helle (Fraunhofer HHI)]

JCTVC-H0583 CE9: cross-check of experiment BP02 and BP06 (JCTVC-H0111) [J. Jung (Orange Labs)] [late]

JCTVC-H0074 CE9: Cross-verification of BP03 (JCTVC-H0111) [S. Fukushima, M. Ueda (JVC Kenwood)]

JCTVC-H0217 CE9: Cross-check report of BP05 by Panasonic [T. Sugio, T. Nishi (Panasonic)]

JCTVC-H0625 CE9: Cross-check report on experiment BP07 and BP08 of JCTVC-H0111 [I.-K Kim (Samsung)] [late]

JCTVC-H0252 CE9: Results of SP experiments on simplification of merge process [O. Bici, J. Lainema, K. Ugur (Nokia)]

JCTVC-H0143 CE9: Cross verification of Nokia proposal JCTVC-G593 [S. Lu, K. Sato (Sony)]

JCTVC-H0655 CE9: Motion information derivation of deformable block [N. Zhang, X. Fan, S. Ma, D. Zhao (Harbin Inst. Tech.)] [late]

4.10 CE10: Deblocking filter

4.10.1 Summary

JCTVC-H0040 CE10: Summary report of Core Experiment on deblocking filtering [A. Norkin, X. Guo, B. Jeon, M. Narroschke (CE coordinators)]

JCTVC-H0713 BoG report on subjective viewing test for CE10 deblocking filter proposals [A. Norkin, K. Andersson, M. Narroschke, X. Guo, G. van der Auwera]

This document was a BoG report on informal subjective viewing for the deblocking filtering that was held during the San Jose meeting on February 2, 2012. The subjective viewing was conducted according to the mandate of Core Experiment 10 on deblocking filtering JCTVC-G1210. The goal of the informal subjective viewing test was to determine how the deblocking filter proposals affect the subjective quality. In total, 15 proposals from CE10 were evaluated in the subjective test.

(The first version of the document had an error in the computation of confidence intervals.)

No significant differences seemed discernable from the subjective test results.

4.10.2 Contributions

Subtest 1

JCTVC-H0084 CE10 Subtest 1: Test results on unification of luma and chroma filtering [M. Zhou (TI)]

JCTVC-H0147 CE10.1: Symmetric rounding in the deblocking filter [M. Narroschke, A. Kotra, T. Wedi (Panasonic)]

The current HM-5.0 deblocking filter generates an offset due to a non-symmetric rounding operation. Proposed is a symmetric rounding operation to eliminate this undesired offset. Compared to HM5.0, the following BD-bit rate reductions are achieved at similar complexity: I-HE: -0.1%, I-LC: -0.1%, RA-HE: -0.1%, RA-LC: 0.0%, RA-HE-10: 0.0%, LD-HE(B): -0.1%, LD-LC(B): -0.1%, LD-HE(P): 0.0%, LD-LC(P): 0.1%. Measured run-time ratios are all around 100%. It was proposed to adopt the symmetric rounding into the next version of the HM.

It was remarked that the domain in which this asymmetric rounding occurs might be in a position where the asymmetry doesn't matter.

It was remarked that the proposed modification seems to increase complexity, depending on how it is implemented.

JCTVC-H0262 CE10 Subtest1: Cross-verification for Panasonic proposal JCTVC-H0147 [M. Ikeda, T. Suzuki (Sony)]

JCTVC-H0263 CE10 Subtest1: Cross-verification for TI proposal JCTVC-H0084 [M. Ikeda, T. Suzuki (Sony)]

JCTVC-H0298 CE10 Subtest1: Cross verification of MediaTek chroma deblocking filter (JCTVC-H0310) [Y. J. Chiu, L. Xu, Y. Han, W. Zhang(Intel)]

JCTVC-H0299 CE10 Subtest1: Cross verification of MediaTek simplified chroma deblocking (JCTVC-H0311) [Y. J. Chiu, L. Xu, Y. Han, W. Zhang(Intel)]

JCTVC-H0310 CE10 Subtest1: Chroma Deblocking Filter [Q. Huang, J. An, X. Guo, S. Lei (MediaTek)]

JCTVC-H0311 CE10 Subtest1: Simplified Chroma Deblocking Filter in JCTVC-H0310 [Q. Huang, J. An, X. Guo, S. Lei (MediaTek)]

Subtest 2

JCTVC-H0149 CE10.2: Cross check results for the deblocking filter line buffer reduction of Sony and MediaTek [A. Kotra, S. Esenlik, M. Narroschke (Panasonic)]

JCTVC-H0264 CE10 Subtest2: Cross-verification for Ericsson proposal [M. Ikeda, T. Suzuki (Sony)]

JCTVC-H0280 CE10.2.1: Reducing one pixel line buffer by modified deblocking filter for horizontal LCU boundaries [C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek), M. Ikeda, T. Suzuki (Sony)]

This contribution proposed to modify the deblocking in HM-5.0. The luma vertical filtering for the upper side of the horizontal LCU boundary reads three pixels and writes two pixels (instead of four and three), and the other parts of deblocking are not changed. The change is made only for LCU boundaries.

The proposed method can save one pixel line buffer. It is reported that no changes in BD bit rates, run times, and subjective quality are observed. Moreover, the luma virtual boundary of adaptive loop filtering is shifted to three pixels above the horizontal LCU boundary to match the proposed deblocking. Simulation results also reportedly show no changes in BD bit rates, run times, and subjective quality.

It was remarked that we should be very conservative about line buffer reduction attempts, in fear of line-structured artefacts, and that line buffers are not so much of a terrible burden (e.g. they would be present in an AVC decoder, and most HEVC decoders would probably also be AVC decoders).

It was remarked that the "slideshow" sequence has loss in multiple conditions, e.g. LP and LB.

No action taken.

JCTVC-H0472 CE10.2: Level restrictions on tiles for line buffer reduction [A. Norkin, R. Sjöberg (Ericsson)]

No apparent visual impact. This should be considered in profile/level definition work.

JCTVC-H0575 CE10.2: cross-verification of Sony and Mediatec proposal on deblocking line memory reduction [A. Norkin (Ericsson)] [late]

Subtest 3

JCTVC-H0108 CE10 Subtest3: Simplified BS calculation process in deblocking filter [S. Park, B. Jeon (LG)]

Part 1 is discussed below.

Part 2 reduces BS calculation complexity by using 4 samples to calculate the BS and using that value for the next 4 samples as well. No action was taken on this aspect.

JCTVC-H0146 CE10.3: Simplified delta calculation in the deblocking filter [M. Narroschke, A. Kotra, T. Wedi (Panasonic)]

JCTVC-H0155 CE10.3: Simplification of First Delta Calculation in Deblocking by SKT/SKKU [J. Yang, J. Kim, K. Won, B. Jeon (SKKU), J. Lim (SKT)]

JCTVC-H0156 CE10.3: Simplification of Second Delta Calculation in Deblocking by SKT/SKKU [J. Yang, J. Kim, K. Won, B. Jeon (SKKU), J. Lim (SKT)]

The contribution proposed a simplification of the deblocking filter by simpler calculation of the second delta value. Simulation results reportedly show that the BD bit rate results and subjective quality are equivalent to the HM5.0 anchor with a benefit of reduced decoding execution time.

It was remarked that this could amplify high frequencies, as was previously remarked in Turin.

It was remarked that there are significant losses for LC LP in some cases.

JCTVC-H0157 CE10.3: Cross verification of SKT/SKKU Simplification of Second Delta Calculation in Deblocking (JCTVC-H0156) [S. Lee, N. Eum (ETRI)] [late]

JCTVC-H0261 CE10 Subtest3: Cross-verification for Panasonic proposal JCTVC-H0146 [M. Ikeda, T. Suzuki (Sony)]

JCTVC-H0396 CE10 Subtest 3: Deblocking Filter Simplifications [G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm)]

This contribution contains two aspects, part 1 of which is within the scope of CE10 and part 2 of which was new. Part 2 should be considered to be outside of CE10.

Part 1 modifies the delta calculation to simplify it for luma and make the way it is done for chroma consistent with the way it is done for luma. The modification for luma makes the effect of the filter weaker. There does not seem to be a clear case for doing that. No action was taken on this.

JCTVC-H0209 CE10.3: Cross-verification Results of Qualcomm Simplification of Deblocking (JCTVC-H0396) by SKT/SKKU [J. Yang, J. Kim, K. Won, B. Jeon (SKKU), J. Lim (SKT)] [late]

JCTVC-H0459 CE10.3: Cross Check of SKT/SKKU Proposal JCTVC-H0155 [G. Van der Auwera (Qualcomm)]

JCTVC-H0473 CE10.3: Deblocking filter simplifications: Bs computation and strong filtering decision [A. Norkin (Ericsson)]

Part 1 removes a loop on 4-pixel boundaries inside of 8-pixel boundaries. The current structure seems a bit obtuse. Decision: Adopt part 1.

(This is also part 1 of H0108.)

Part 2 is a simplification of the strong filter decision. No action was taken on that part.

JCTVC-H0618 Cross-verification of Ericsson proposal on deblocking filter simplifications (JCTVC-H0473) [S. Park, B. Jeon (LG)] [late]

JCTVC-H0576 CE10.3: Cross-verification of proposal on deblocking Bs simplification from LG [A. Norkin (Ericsson)] [late]

Subtest 4

JCTVC-H0148 CE10.4: Deblocking filter using adaptive weighting factors [A.-K. Seifert, T. Wedi, M. Narroschke (Panasonic)]

JCTVC-H0350 CE10 Subtest4: Cross-verification for Panasonic proposal JCTVC-H0148 [M. Ikeda, T. Suzuki (Sony)] [late]

JCTVC-H0398 CE10 Subtest 4: Transform Dependent Deblocking Filter Parameter Adjustment [G. Van der Auwera, R. Joshi, X. Wang, M. Karczewicz (Qualcomm)]

One aspect of the proposal is an SPS-level flag to save one bit per slice (assuming that the semantics of inherit_dbl_params_from_APS_flag = 1 will result in inferred values of zero in the case where no parameters have been provided in the APS) when the flag is set to indicate that deblocking control parameters are never sent.

In AVC, there was a conceptually-similar flag at the PPS level.

This is actually a high-level syntax issue rather than a deblocking filter design issue.

Decision: Put such a flag in the PPS level as in AVC, rather than in SPS, as proposed.

JCTVC-H0656 CE10 Subtest 4: Cross-check of Qualcomm Transform-Dependent Deblocking Filter Parameter Adjustment JCTVC-H0398 [T. Yamakage, S. Asaka (Toshiba)] [late]

JCTVC-H0474 CE10.4: Cross check of Ericsson proposal [G. Van der Auwera (Qualcomm)] [late]

JCTVC-H0574 CE10.4: deblocking parameters signalling [A. Norkin, K. Andersson, J. Enhorn, R. Sjöberg (Ericsson)] [late]

4.11 CE11: Coefficient scanning and coding

4.11.1 Summary

JCTVC-H0041 CE11: Summary report of Core Experiment on coefficient scanning and coding [V. Sze, T. Nguyen, K. Panusopone, Y. Piao, J. Sole (CE coordinators)]

Various methods have been proposed for coding the transform coefficients of the residual signal to reduce complexity and/or improve coding efficiency. This core experiment evaluates the coding efficiency and complexity impact of:

A. Context modeling/selection for syntax elements related to transform coefficients

B. Signalling method related to transform coefficients (e.g. data hiding)

The objectives of this CE include:

1) Investigation of the impact of context selection and signalling schemes for transform coefficient coding on the coding efficiency and complexity

2) Coding efficiency and complexity measurement of transform coefficient scanning order methods

Complexity measures are described in the CE summary report. The coding efficiency impact of the proposed changes is shown in the table below for various test cases.

Doc#	Summary of Changes	AI HE	RA HE	LB HE	AI-LC	RA LC	LB LC	RA-HE10
H0095	Reduce number of neighbours (to two) used in newly defined high frequency region	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Zero neighbours for high freq.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H0282	Group contexts of high frequency for 4x4 and 8x8 TU; sub-sample for 8x8 TU	0.0	0.0	0.1	0.1	0.1	0.1	0.0
H0509	Share luma and chroma for significant_coeffgroup_flag; for 16x16/32x32 TU, significant_coeff_flag calculated with max (ctxIdx, 3), ctxIdx based on 5 neighbours	0.1	0.0	0.1	0.1	0.1	0.0	0.2
H0352	Remove all neighbours for 3-bin parallel processing.	0.6	0.4	0.4	0.5	0.3	0.2	0.6
	Adapted method removing recently processed neighbours from context selection for 3-bin parallel processing*	0.1	0.1	0.1	0.1	0.1	0.0	0.1
	4-bin parallel processing*	0.2	0.1	0.1	0.1	0.1	0.0	0.2
H0160	Reduce number of contexts for ctxSet 1, 2, 4 and 5, 4→3 for coeff_abs_level_greater1_flag and 3→2 coeff_abs_level_greater2_flag, respectively.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H0130	Reduce number of ctxSets for luma level coding from 6 to 4.	0.0	0.0	0.0	0.0	0.0	0.0	0.0

H0224	Hide sign of first non-zero coeff into parity of sum of non-zero coefficient	-0.6	-0.5	-0.6				-0.4
H0283	Use vertical scan for 16x4 and 32x8 and horizontal scan for 4x16 and 8x32. Use position based context of 4x4 TU for 4x16/16x4, and use position based context of 8x8 TU for 8x32/32x8.		0.1	0.2		0.0	0.0	0.1
H0511	Use diagonal scan for 4x16/16x4; Share luma and chroma for significant_coeffgroup_flag; significant_coeff_flag calculated with max (ctxIdx, 3) based on 5 neighbours	0.1	0.0	0.0	0.1	0.1	0.0	
H0443	Use position based context of 8x8 TU for 4x16/16x4		0.1	0.1				0.0

* = Not in original document G917 from Geneva Meeting; tests were planned and designed for harmonization with HM5.0 and were confirmed as part of CE11 on e-mail reflector on 2012-01-12.

It was noted that there were also various non-CE proposals with similar targets.

A major goal should be to make the design as clean and clear as possible, and implementation friendly, without losing compression performance.

H0352 (and other non-CE proposals) mainly target parallelism.

This work was further reviewed in a BoG on significance map coding (coordinated by G. Martin-Cocher and reported in H0719) and a BoG on level coding (coordinated by V. Sze and reported in H0724).

4.11.2 Contributions

Subtest 1 Significance map coding

JCTVC-H0095 CE11.1 Simplified significant_coeff_flag context derivation at high frequency area [T. Ikai (Sharp)]

This contribution proposes to define a 3rd region where the context derivation is position-based for large block sizes and such that boundary checks are not needed. No loss was reported at normal and low QP testing. A cross-checker verified that the implementation was simple.

This seems to help with the worst-case. A comment was made in the plenary that there is no need to do boundary checks with the current HM design in an actual implementation.

Experts expressed interest in having region 3 being position-based. The dependency still exists in region 1 and 2.

The regions scale with TU size.

The boundary of the 3rd region is not the same for 16x16 and 32x32, as it depends on TU size. One expert requested to have it fixed and aligned for both TU sizes.

One expert asked what is the threshold for 16x4 and 32x8. The threshold for 16x4 and 4x16 follows the 16x16 region assignment, and for 32x8, it follows the 32x32 region assignment.

There was support for the proposal, but also a request for alignment of region 1 with the one defined in H0290 and no scaling for region 2 and 3 (assuming there would be no loss). Proponent agrees to do more tests during the week.

New test with partial results (integrated with H0290) shown with two thresholds; Threshold 4 some loss (0.1%), threshold 6 some loss (0.04%).

One expert noted that there would be no region 3 for 16x4.

	AI HE	AI LC	RA HE	RA LC	LD HE	LD LC	RA HE 10
Variable threshold (without H0290)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Threshold 4 (with H0290)	0.1%						
Threshold 6 (with H0290)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%

One expert suggested that the loss comes from the threshold more than from the integration with H0290.

Threshold 4: for 16x16 and 32x32, 10 blocks would be template based.

Threshold 6: for 16x16; 15 blocks would be template based, and 21 for 32x32.

Variable threshold: for 16x16 6 blocks that will be template based, and 21 blocks for 32x32

Recommendation from BoG: adopt JCTVC-H0095 with variable threshold upon confirmation of minimal loss when integrating with JCTVC-H0290 (only Intra coding).

It was confirmed (to be uploaded in a new version of the H0095 *.xls sheet) that the loss is 0.07% for AI/HE and 0.04% for AI/LC.

Decision: Adopt H0095 method 2.1.

JCTVC-H0645 CE11.1 Cross-check report for Sharp method 2.1 of simplified significant_coeff_flag context derivation at high frequency area (JCTVC-H0095) [T.Chujoh (Toshiba)] [late]

JCTVC-H0354 CE11: Cross-check results for subtest 3.1.1 [V. Sze (TI)] [late]

JCTVC-H0282 CE11.1.2: Simplified method for coding 4x4 & 8x8 significance maps [S.-T. Hsiang, T.-D. Chuang, S. Lei (MediaTek)]

JCTVC-H0101 CE11: Crosscheck of MediaTek significant_coeff_flag modification (JCTVC-H0282) [T. Ikai (Sharp)] [late]

JCTVC-H0616 CE11: Cross-check of subtest 3.1.2 (JCTVC-H0282) [Y. Piao, J. H. Park (Samsung)] [late]

JCTVC-H0377 CE11: Cross-check of Mediatek proposal H0282 by BBC [M. Mrak, D. Flynn (BBC)] [late]

JCTVC-H0509 CE11 subtest 3.1.3: Simplification of significant map coding for CABAC [V. Kung, K. Panusopone, L. Wang (Motorola Mobility)]

JCTVC-H0705 CE11.3.1.3: Crosscheck for Motorola Mobility simplification of significant map coding for CABAC in JCTVC-H0509 [C.-W. Hsu, T.-D. Chuang, Y.-W. Huang (MediaTek)] [late 02-05]

JCTVC-H0352 CE11: Test results for Subtest 3.1.4. [V. Sze (TI)]

JCTVC-H0519 CE11: Cross check report for subtest 3.1.4 (JCTVC-H0352) [K. Panusopone (Motorola)] [late 02-02]

JCTVC-H0162 CE11: Cross-check report for TI proposal (Subtest 3.1.4 fixed context) [H. Sasai, K. Terada, T. Nishi (Panasonic)] [late]

Subtest 2 Coefficient level coding

JCTVC-H0134 Cross-check of CE11 subtest2: On context simplification for coefficients entropy coding(JCTVC-H060) [Y. Piao, J. H. Park (Samsung)] [late]

JCTVC-H0484 CE11: Crosscheck of JCTVC-G301 on context simplification for coefficients entropy coding [C. Auyeung (Sony)] [late]

JCTVC-H0130 CE11 Subtest 2: Level luma context reduction [Y. Piao, J. Min, J. H. Park (Samsung)]

Reduces the number of ctxSets for luma level coding from 6 to 4.

Decision: Adopted.

JCTVC-H0355 CE11: Cross-check results for subtest 3.2.2 [V. Sze (TI)] [late]

JCTVC-H0446 CE11: Cross-check of Samsung context number reduction for level coding in CABAC [J. Sole (Qualcomm)] [late]

JCTVC-H0160 CE11: Context reduction for coefficient level [K. Terada, H. Sasai, T. Nishi (Panasonic)]

Subtest 3 Sign coding

JCTVC-H0224 CE11: Sign Data Hiding [G. Clare, F. Henry, Joel Jung, Stephane Pateux (Orange)]

This contribution discusses the CE11 subtest on "Sign Data Hiding", a method to embed sign information into the residual coding. More specifically, the sign of the first non-zero coefficient of a residual block is not always explicitly written in the bitstream. Instead, at decoding time, the sign is inferred from the parity of the sum of the quantized coefficients, using a specified convention. At encoding time, if the sign of the first non-zero coefficient and the parity do not match, one of the quantized coefficients is changed by the encoder to obtain the desired parity. As tested, the quantized coefficient that changed is the one providing the smallest measured rate-distortion (RD) penalty. The RD costs computed during the RDOQ stage are used for making this decision. This alternate way of transmitting the sign of the first non-zero coefficient is dependent on a decoder-side decision function. The proposal reportedly yields an average BD bit rate compression performance of -0.6% (AI), -0.5% (RA), -0.6% (LB) in High Efficiency configurations with an average encoder runtime of 103% (AI), 103% (RA) and 103% (LB) and decoder runtime of 99% (AI), 99% (RA) and 100% (LB) relative to HM5.0 anchors.

A non-RDOQ version is reported in H0227 with similar results.

The decoder is required to check the parity of residues, depending on the number of zero/nonzero coefficients in the block. One expert said that he has checked this since the last meeting from the viewpoint of hardware implementation and it is likely not to have a major impact on decoder complexity. It would not affect throughput, and the additional logic would be minimal.

It was asked whether this produces visual distortion in the RDOQ off case. The proponent said that this was not observed. (Madhukar Budagavi was asked to check this.)

Several experts expressed the opinion that this is providing interesting gain vs. moderate increase of complexity.

H0481 is also related – see further conclusion in notes for that contribution.

JCTVC-H0651 CE11: Cross verification of sign data hiding from Orange Labs (H0224) [Z. Ma, Ankur Saxena (Samsung)] [late]

JCTVC-H0480 Cross-check of CE11 Subtest3: Orange Labs' Sign Data Hiding [J. Wang, X. Yu, D. He (RIM)] [late]

Subtest 4 NSQT/SQT remapping

All three proposals in this area suggest defining specific scan methods depending on the non-square TU size. It seems questionable whether this is a better solution than the current HM method where sub-block scanning, as borrowed from 16x16, is applied for all. It would be desirable to even go further and define a singe way of scanning and context definition across all square and non-square block sizes. Some of the non-CE proposals in significance scanning may point in that direction – this was asked to be further discussed in the related BoG (see H0724).

Further investigation of NSQT/SQT in the context of the AHG on transform coding harmonization is necessary.

JCTVC-H0511 CE11 subtest 3.4.4: Entropy coding for non-square blocks [V. Kung, K. Panusopone, L. Wang (Motorola Mobility)]

JCTVC-H0245 CE11: Cross-verification of Motorola proposal [X. Zheng (HiSilicon)] [late]

JCTVC-H0283 CE11.4.2: Modified NSQT coefficient scan [C.-W. Hsu, T.-D. Chuang, Y.-W. Huang, S. Lei (MediaTek)]

JCTVC-H0356 CE11: Cross-check results for subtest 3.4.2 [V. Sze (TI)] [late]

JCTVC-H0443 CE11: Harmonization of residual coding and NSQT [J. Kim, B. Jeon (LGE), J. Sole, M. Karczewicz (Qualcomm)]

JCTVC-H0402 CE11 subset 4: Cross-check report of JCTVC-H0443 [J. Xu, A. Tabatabai (Sony)]

5 Non-CE Technical Contributions

5.1 Clarification and Bug Fix Issues

JCTVC-H0486 Suggested figures for the HEVC specification [C. Fogg (Harmonic)]

This contribution was a suggested editorial improvement – consideration was delegated to the editor.

5.2 HM settings and common test conditions

No contributions were noted to be specific to this subject area.

5.3 HM coding performance

See also JCTVC-H0116 and JCTVC-H0022.

JCTVC-H0063 Coding efficiency comparison between HM5.0 and JM16.2 based on PQI, PSNR and SSIM [Y. Zhao (Zheijang Univ.)]

(Random-access configuration test only.)

This contribution compared the compression efficiency of HM5.0 and JM16.2 (the AVC codec generating the AVC anchors in the CfP) under the "random-access, high efficiency" test conditions. Three objective quality metrics (PSNR, SSIM, and PQI) were used to evaluate video quality and thus to evaluate the average BD bit rate saving over 15 sequences in class A to D. The three metrics reportedly each measure

around a 40% BD bit rate reduction on average HM5.0 for relative to JM16.2 when using the "random-access, high efficiency" configuration.

AVC anchors from CfP were used. Compared to common test conditions for HM, the lowest QP was removed (and a high QP was included) to get a better overlap between the curves. Several experts suggested that it would be a better comparison to remove the lowest rate points for AVC to get a more useful range of matching acceptable visual qualities.

PQI and SSIM provided very similar numbers as PSNR – and it was questioned whether they are really better matching the subjective visual quality.

The BD bit rate performance of HM anchors after the QP adjustment was reported as follows:

Class	Sequence	BD bit rate performance of HM anchors		
		PSNR	SSIM	PQI
A	S01_Traffic	-40.27%	-38.66%	-37.31%
	S02_PeopleOnStreet	-32.72%	-34.32%	-31.68%
B	S03_Kimono1	-44.61%	-45.73%	-38.92%
	S04_ParkScene	-34.60%	-35.47%	-35.33%
	S05_Cactus	-39.18%	-37.06%	-39.63%
	S06_BasketballDrive	-45.49%	-48.26%	-41.53%
	S07_BQTerrace	-51.57%	-52.79%	-50.51%
C	S08_BasketballDrill	-41.86%	-41.88%	-46.04%
	S09_BQMall	-40.51%	-40.11%	-44.43%
	S10_PartyScene	-37.14%	-36.62%	-54.58%
	S11_RaceHorses	-38.40%	-39.87%	-50.59%
D	S12_BasketballDrill_416	-31.01%	-34.27%	-36.87%
	S13_BQMall_416	-50.64%	-41.88%	-49.15%
	S14_PartyScene_416	-31.25%	-27.58%	-36.55%
	S15_RaceHorses_416	-28.21%	-29.18%	-32.54%
Average		-39.16%	-38.91%	-41.71%

JCTVC-H0360 Comparison of Compression Performance of HEVC Working Draft 5 with AVC High Profile [B. Li (USTC), G. J. Sullivan, J. Xu (Microsoft)]

This contribution is a further study of the relative objective (i.e. PSNR-based) compression performance of HEVC and AVC High Profile. It builds upon the prior work reported in JCTVC-G399, updating the results by using the latest available reference software (JM-18.2 and HM-5.0) and configuration common conditions. Experimental results reportedly show that, when compared with JM-18.2:

1) for the high-efficiency all-intra configuration, HM-5.0 can save about 23% in bit rate;
2) for the high-efficiency random-access configuration, HM-5.0 can save about 33% in bit rate; and
3) for the high-efficiency low-delay configuration, HM-5.0 can save about 41% in bit rate.

It is noted that these results are based on PSNR measurements, which are an imperfect substitute for subjective quality assessment, and that the subjective performance of HEVC may actually be generally somewhat better than its objective (PSNR) performance may indicate.

A combined weighted (with 6:1:1 weighting) average YUV PSNR measure was used for the quality measurement.

The summary test results are shown in the tables below.

Table for All-intra case

	Y	U	V	YUV
Class A	-24.5%	-21.9%	-16.8%	-23.8%
Class B	-24.0%	-27.6%	-24.5%	-24.5%
Class C	-20.9%	-25.9%	-26.9%	-22.2%
Class D	-17.0%	-20.9%	-22.0%	-18.1%
Class E	-28.4%	-19.7%	-24.4%	-27.4%
Average Without F	-22.6%	-23.8%	-23.6%	-23.0%
Class F	-24.3%	-23.2%	-24.7%	-25.0%

Table for Random access case

	Y	U	V	YUV
Class A	-33.3%	-31.4%	-29.6%	-33.0%
Class B	-41.9%	-43.9%	-39.6%	-42.0%
Class C	-32.1%	-36.5%	-37.1%	-33.1%
Class D	-30.1%	-34.6%	-36.2%	-31.3%
Class E				
Average Without F	-35.0%	-37.8%	-36.7%	-35.6%
Class F	-27.5%	-30.2%	-32.0%	-28.6%

Table for Low delay case

	Y	U	V	YUV
Class A				
Class B	-46.3%	-46.9%	-47.0%	-46.5%
Class C	-38.5%	-44.4%	-45.1%	-39.7%
Class D	-35.3%	-43.3%	-43.4%	-36.7%
Class E	-49.9%	-46.1%	-49.7%	-49.7%
Average Without F	-42.3%	-45.2%	-46.2%	-43.0%
Class F	-35.1%	-40.7%	-42.2%	-37.0%

The reported results were basically similar to what was reported at the preceding meeting in JCTVC-G399.

The biggest difference from last time was probably due to using 8b vs. 10b encoding for the HE configuration.

JCTVC-H0562 Informal Subjective Quality Comparison of Low-Delay Compression Performance of HEVC Working Draft 5 with AVC High Profile [F. Kossentini, N. Mahdi, H. Guermazi, M. Horowitz, S. Xu (eBrisk Video Inc.), B. Li (University of Science and Technology of China), G. J. Sullivan, J. Xu (Microsoft Corp)]

(Low-delay configuration test only.)

This contribution presented the results of an informal subjective quality comparison between the current state of the HEVC draft standard and the AVC High Profile (HP) for low-delay configurations, using five Class B (1080p) and Class E (720p) video sequences. More specifically, the study compares the high efficiency, low delay configuration of the HEVC reference software against a similarly configured AVC HP JM encoder. These tests were suggested to be complementary to the formal tests performed by AHG22, by focusing on low-delay rather than random-access configurations.

The encoding methodology used here was reportedly as described in JCTVC-H0360 (very similar to that previously used for JCTVC-G399), since that methodology was reportedly designed to reflect relevant application scenarios and to enable a fair comparison to the maximum extent feasible, i.e. using comparable quantization settings, reference frame buffering, etc. Relative to JCTVC-G399, the HEVC software version was updated to version HM 5.0, the AVC software version was updated to version JM 18.2, and the JM configuration was updated to maximally reflect the non-normative aspects of the HM 5 common test configuration.

When viewing HEVC encoded video side-by-side with AVC video encoded at approximately two times the HEVC average bit rate per sequence, in approximately 75% of the test cases and for four of the five tested encoding pairs, the (mostly non-expert) viewers reportedly indicated either that they had no preference, or that they preferred the HEVC encoded video. For three of the five encoding pairs, the number of people who expressed a preference for the HEVC encoding was substantially greater than (by a ratio of 1.7 to 1 or more) the number of people who expressed a preference for the AVC encoding (and in one of the two remaining cases, the number differed by only 1). The selection of which encoding was displayed on which side for the side-by-side viewing was established in a randomized double-blind fashion. It is suggested that the results generally confirm that the HEVC design (as represented by HM 5.0) exhibits a substantial improvement in compression capability beyond that of AVC (as represented by a similarly-configured JM 18.2) for low-delay video applications.

Target and Achieved Bit Rates for the Test Bitstreams:

Configuration	**Class**	**Sequence**	**AVC Bit Rate (Mbps)**	**HEVC Bit Rate (Mbps)**
			Target/Achieved	**Target/Achieved**
	B (1080p)	Kimono	2.0/2.07	1.0/1.02 (49.2% of AVC rate)
		ParkScene	2.0/1.94	1.0/0.96 (49.5% of AVC rate)
		Vidyo3	1.0/1.10	0.5/0.56 (50.5% of AVC rate)
		Vidyo1	1.0/1.08	0.5/0.55 (51.1% of AVC rate)
Low Delay		Raven	2.5/2.54	1.25/1.27 (50.0% of AVC rate)

Subjective evaluation results:

Configuration	Sequence	Number of Viewers	Preferred AVC	Preferred HEVC	No Preference
Low Delay	Kimono	22	3	18	1
			14%	82%	5%
	ParkScene	22	4	10	8
			18%	45%	36%
	Vidyo3	13	5	4	4
			38%	31%	31%
	Vidyo1	13	7	2	4
			54%	15%	31%
	Raven	22	4	7	11
			18%	32%	50%
Total		**92**	**23**	**41**	**28**
		100%	**25%**	**45%**	**30%**

Compared to the objective results, the visual quality difference between AVC and HEVC appears to be larger (in favor of HEVC).

5.4 Profile/level definitions

Some key issues were noted in discussions to include the following:

- Restrictions on picture segmentation (tiles, wavefronts, slices, slice granularity, entropy slices), especially having to do with reset/initialization/flushing effects. See also related contribution H0472 regarding tile structuring for deblocking filter line buffer memory reduction.
- ALF, AMP, and NSQT.
- Restriction of bits per LCU or similar.

Joint meeting discussion 1600-1700 Tuesday VCEG/MPEG/JCT

A joint meeting discussion was held from 1600–1700 on Tuesday 7 Feb 2012.

A focus of the discussion was the contribution JCTVC-H0734 "Straw man for profiles and levels". It had been submitted during the meeting by a number of participants.

It proposed an initial profile by starting the discussion from the prior LC configuration plus SAO.

In terms of "tools", LMChroma, AMP, ALF and NSQT were not included in its proposed profile. It was asserted that there does not seem to be a major difference in coding efficiency depending on whether these "tools" are enabled or not.

There was also discussion of the "flexible" (negotiable) profiles as described from H0637. Regarding the so-called "fixed" & "flexible" approaches – e.g. as discussed in H0637, some skepticism was expressed, although it was noted that such systems have existed previously and are supported in standard protocols. This approach was already supported in some ITU-T protocols, e.g. for H.263+, but it is not generally known to what extent such additional flexibility has been used in practice (particularly with cross-vendor interoperability). This type of approach was considered not applicable for broadcast applications. There was some discussion of how to test conformance with such flexibility. Two approaches were considered possible: adding tools or subtracting tools. We did not have a concrete proposal regarding specifically what coding tools should be optional and whether they are beneficial to use in such a flexible-negotiation scenario.

The conclusion reached at this point was to adopt one draft profile, and to adopt levels with numbering somewhat aligned with AVC – not pursuing the so-called flexible approach for the time being.

A BoG coordinated by K. McCann was requested to further discuss and refine the profile/level definition based on the above. The report of that BoG was produced as document H0738, which was later reviewed as noted below.

JCTVC-H0738 JCT-VC BoG report on profiles & levels [K. McCann, T. K. Tan (BoG coordinators)]

The BoG recommended to establish a "Main" profile. The proposal was discussed, revised as follows, and agreed, with the following characteristics:

- Coding tools not to be included were: ALF, AMP, LMChroma, NSQT.
- MaxLCU = 64, MinLCU = 16.
- Slice spatial granularity = LCU level (not finer)
- Weighted prediction allowed
- Max pictures per second = 300
- Bit rate for level 1 = 128 * 1000 b/s, max CPB size 350 * 1000 b.
- VCLfactor = 1100.
- A proposed slice rate constraint was presented.
- Higher levels are required to decode lower level bitstreams (even if they have larger numbers of frame storage requirements – although this is not planned per the next item below).
- Regarding MaxDPB capacity, it was noted that our CTC uses a "GOP" length of 8 with DPB size of 5 (i.e. 4 plus the current picture). After discussion, it was then agreed to establish MaxDPB = 6 always (including the current picture).
- Tiles allowed (but not required), although constrained to be at least 384 samples wide.
- WPP not allowed.
- Entropy slices (perhaps not the best name for this feature) not allowed.

Decision: Adopted per above (consult BoG report for clarification or missing details).

JCTVC-H0116 AHG8: Objective and subjective evaluation of HM5.0 [T. K. Tan, A Fujibayashi, J. Takiue (NTT Docomo)]

This contribution reported objective and subjective performance measures for the HM5.0 compared to JM18. In addition to the high efficiency (HE) and low complexity (LC) common conditions as specified in JCTVC-G1200, combinations of LC with one or more tools enabled in HE but not in LC were also investigated. The contribution provided an assessment of the performance of HM5.0 and its tools combinations starting from objective measurements and followed by informal subjective assessments.

Graphs of the average BD bit rate vs. encoding / decoding time reportedly showed that the objective gains of HE compared to LC were mainly contributed by RDOQ, ALF and SAO. It was also reported that RDOQ does not incur any additional decoding time for the decoder, while SAO and ALF contribute most if not all of the additional decoding time needed by HE compared to LC. Between SAO and ALF, ALF contributes the larger portion of the decoding time.

This contribution also asserted that visual comparison showed that all the tools in the HE configuration beyond those in the LC configuration, except for SAO, did not give any significant subjective quality improvement. Based on these results, a clustering of coding tools was made and LC with RDOQ and

SAO enabled (LC+RDOQ+SAO) was suggested as the subset of tools combination that gave the best tradeoff in terms of coding gains and decoding time.

Subjectively, RDOQ did not seem to help measurably in subjective quality although it did in PSNR. It was reported that RDOQ can sometimes cause noisiness.

However, SAO seemed to have substantial effectiveness in subjective quality improvement – perhaps more than would be expected by PSNR.

The reported subjective testing results used only the Class B and Class C CTC sequences.

It was reported that ALF gives good SNR improvement but no apparent measurable visual benefit.

Subjective viewing was conducted in two rounds: Pre-investigation with expert viewers, and then a test with non-expert viewers

Reported subjective performances of different combination of tools for random access coding structure were as follows:

Random Access	
Tools	Observations
LC	Some colour bleeding, aliasing, wobbling were observed.
LC+RDOQ	Similar quality to LC. But artefact seems more pronounced.
LC+ALF	Similar quality to LC. Some colour bleedings were slightly reduced but impact seems small.
LC+SAO	Same quality as HE (as measured).
LC+ALF+SAO	Same quality as HE (as measured).
LC+RDOQ+ALF	Similar quality to LC + RDOQ.
LC+RDOQ+SAO	Same quality as HE (as measured).

Reported subjective performances of different combination of tools for low delay B coding structure:

Low delay B	
Tools	Observations
LC	Some colour bleeding, aliasing, blockiness were observed.
LC+RDOQ	Similar problems but seems to be worse than LC
LC+ALF	Similar quality to LC (as measured).
LC+SAO	Same quality as HE (as measured).
LC+ALF+SAO	Same quality as HE (as measured).
LC+RDOQ+ALF	Similar quality to LC or LC + RDOQ
LC+RDOQ+SAO	Same quality as HE (as measured).

The contribution suggested the following commented clustering of HM tools:

Tool cluster	Cluster 0: RDOQ	Cluster 1: LMChroma	Cluster 2: AMP NSQT	Cluster 3 SAO	Cluster 4 ALF
Impact on decoding time	None	Negligible	Negligible	Low to medium	High
Objective Gains (BD bit rate	1.4% to 4.2%	Mostly chroma only 1.9% to	Small (less than 1.0% BD bit rate)	0.5% to 5.4%	1.7% to 6.4%

relative to BD bit rate LC)		5.6%			
Subjective improvements	Can sometime cause some noisiness in the subjective quality			Visible on some sequences: BasketballDrill and Kimono1	Not (measurably) visible

Reported informal test comparing HM5.0 high efficiency to JM18.2* (where " JM18.2*" indicates the JM-based encoding described in JCTVC-H0360) under random access conditions:

Number of observer votes received by a test case (combination of votes)			Number of test cases where the combination of votes occurred	Cumulative % where majority voted that HM5.0 HE at half the bit rate has a quality better than or equal to JM 18.2*.
HM5.0 HE at half the bit rate is better than JM 18.2*	HM5.0 HE at half the bit rate and JM 18.2* are comparable	JM 18.2* is better than HM5.0 HE at half the bit rate		
4	0	0	20	56%
3	1	0	2	61%
3	0	1	5	75%
2	2	0	1	78%
2	1	1	1	81%
1	3	0	1	83%
1	0	3	2	
0	2	2	2	
0	0	4	2	

Thus, in 83% of the tested cases, the quality of the HM (HE RA) was rated as comparable or better than the double-bit-rate encoding using JM 18.2* (i.e. the JM encoding described in JCTVC-H0360).

The following were suggested as conclusions in this contribution.

- BD bit rate measures give a very rough indication of the actual performance gains achieved by HEVC. Sometimes, subjective gains are not visible despite significant objective gains and vice-versa.
- It was recommended that subjective assessment should be the norm rather than the exception when accessing the performance of the HEVC.
- HM5.0 HE and HM5.0 LC+RDOQ+SAO at the same bit rate have the same subjective quality (within measurement tolerances).
- For the random access coding structure, both HM5.0 HE and HM5.0 LC+RDOQ+SAO has achieved the target of 50% bit rate savings over AVC and it is quite possible than the bit rate savings is even higher than 50%.

JCTVC-H0168 Proposal of HEVC profile/level definitions [T. Suzuki (Sony), H. Sasai, T. Nishi (Panasonic)]

This contribution proposed some aspects of HEVC profile / level definition.

It requested to avoid too much flexibility (and AVC was suggested to be somewhat confusing). It proposed 8 levels, and restrictions on bitstreams such as max/min LCU sizes and max number of SPS/PPS/APS.

The proposed level definition was as follows:

Level	Typical size	Max luma pixel rate (pel/sec)	Max luma frame size (pel)	Max bit rate (1000 bit/sec)	MinCR	Max DPB (number of frames)	Max CPB size (1000 bits)
1	TBD						
2	720x480@24p, 720x480@30p, 720x480@60i, 720x576@50i	10,368,000	414,720	7,000	2	4	7,000
3	1280x720@60p, 1440x1088@60i, 1920x1088@24p, 1920x1088@30p, 1920x1088@60i	62,668,800	2,088,960	30,000	4	4	30,000
4	1920x1088@60p, 2048x1088@60p	133,693,440	2,228,224	40,000	4	4	40,000
5	3840x2160@24p, 3840x2160@30p, 4096x2160@24p, 4096x2160@30p	265,420,800	8,847,360	100,000	8	4	100,000
6	3840x2160@60p, 4096x2160@60p	530,841,600	8,847,360	150,000	8	4	150,000
7	7680x4320@30p	995,328,000	33,177,600	200,000	?	4	200,000
8	7680x4320@60p	1,990,656,000	33,177,600	300,000	?	4	300,000

Proposed "Main" profile constraints were suggested as:

LCU size:

- Max LCU size equal to 64x64
- Min LCU size equal to 16x16

Slice constraints:

- Min slice granularity equal to LCU size
- Each slice starting from LCU boundary

Max number of reference frames:

- Max value of num_ref_frame equal to 4 (may be 5, if necessary)

Number of PS:

- Max number of SPS equal to 8
- Max number of PPS equal to 16
- Max number of APS equal to 8

CABAC constraints:

- Some of the CABAC constraints in AVC were asserted to increase encoder complexity, while decoder impact is asserted to not be critical for such cases. The cited example is the max number of bits for each MB. Unnecessary constraints should not be defined.

Parallel processing tool:

- Considering the decoder implementation, having too many parallel processing tools would not be helpful.
- Entropy slices was suggested to be a simple tool to support parallel processing of entropy coding.
- If tiles are supported, it was proposed that each tile should be completely independent. For example, it was proposed that in-loop filtering should be turned off at tile boundaries, any slice should not continue beyond a tile boundary, and so on.

Potential candidate constraint:

- Implementation is simpler if picture size is a multiple of LCU. It was suggested to potentially be beneficial to impose such a constraint in future.

The following was proposed for level-specific constraints:

Memory bandwidth restrictions:

- To reduce MC memory bandwidth, it wsa proposed that MC block size and/or MV numbers should be restricted.
- For 8x4, 4x8 block size, only uni-pred was proposed to be allowed at least for HD and larger picture sizes.

For 4K and larger, more constraints were suggested to be necessary. Further study was suggested. JCTVC-H0221 proposes such constraints – e.g.:

- Vertical MV range:
- Restrictions of vertical MV range was suggested not to be necessary.

In discussion of the proposal, it was agreed that a maximum decoder frame buffering capacity somewhere between 4 and 8 would be our plan.

It was remarked that our current RA CTC uses 5 (4 plus the current picture).

JCTVC-H0353 AHG8: Comments on HEVC version 1 Profile and Level definition [M. Zhou, V. Sze, H. Tamama (TI)]

For HEVC version 1 Profile and Level definition, it was proposed to define two profiles, namely a "Baseline" Profile (BP) and a "High" Profile (HP). It was proposed that BP should support the low-latency applications, while HP supports high-efficiency applications. "Bi-directional B-frames" were proposed not to be allowed in BP, while it was suggested that other "tools" can be the same for BP and HP. It was proposed to impose constraints on parallel processing tools (tiles, wavefront parallel processing, entropy slices and slices) for BP and HP. It was proposed that tiles should be required in bitstreams when the pixel rate exceeds 1080p@60 (125 Mpixels/sec), and should be prohibited when pixel rate is below 1080p@60. Tiles, when used, were proposed to be required to be independent and evenly-divided in terms of pixel rate. Slices, entropy slices and wavefront parallel processing (WPP) were proposed to be prohibited across tile boundaries. Constraints were also proposed to be imposed on entropy slices to limit the CABAC initialization overhead.

Although the proposal suggested to define two profiles, one profile would be desirable from TI's viewpoint.

For parallel processing capability, the contribution suggests that tiles should be independent, and that tiles should be used for balancing pixel numbers between the cores, with other approaches (entropy slices, wavefront) for bit rate/entropy decoding load balancing.

JCTVC-H0668 Profiles and Level considerations [A. Wells, C. Fogg (Harmonic)]

It was proposed that profile and level definitions for HEVC should permit bitstreams that use a single tile and single slice per frame encoding at coded frame sizes up to 4K (3840x2160 for consumer applications, with 4096x2304 for capture). It was asserted that this extends a common practice of coding a single slice per frame in AVC at 1080p levels. Additionally, it was proposed to restrict the frequency of regular (non-lightweight / entropy) slices should be limited to no more than 4 per coded frame. It was also proposed that limits should be imposed on the number of motion vectors per window of coded blocks in a similar manner as they were for AVC.

In discussion, it was suggested that the proposed restriction of number of slices could be removed or relaxed if certain parameters would be kept fixed over multiple slices in the picture.

JCTVC-H0637 Profiles and Levels for HEVC [A. Luthra (Motorola)] [late]

This contribution suggested that, in addition to defining "fixed" profiles and levels, a mechanism should also be developed such that clients and servers can negotiate attributes at a finer level of granularity. It was suggested that this mechanism could be based on two-way negotiation, in which a client would send an XML document describing its capabilities at a particular time. This was suggested to involve the standardization of:

- The names of individual coding tools that could be negotiated.
- The attributes associated with the tools that could be negotiated.
- The names of parameters associated with levels that have values that could be modified.

The proposal also suggested to consider going outside of the "onion structure" for profiles and levels (if necessary).

It was commented that having some common baseline/core of a guaranteed interoperability mode of operation may be beneficial.

It was remarked that such concepts have been common practice and previously standardized for real-time multimedia communication systems (e.g., for H.323 and H.320).

Also, it was suggested to use "neutral" sounding naming such as A, B, C, etc., or Venus, Tango, Cairo, etc., for the names of profiles, rather than names that may appear to have implicit meanings.

Moreover, it was suggested that only one profile, called Profile A, should be defined at this stage, with a focus on high coding efficiency.

The proposal suggested to keep the same "major numbers" for the levels as found in AVC.

In discussion, it was commented that giving up an onion structure should only be done for good reasons.

Some concern is raised that the flexibility is advantageous for encoders, but may be a burden for decoder implementation (mainly for hardware-based decoders).

JCTVC-H0382 Inclusion of adaptive loop filtering in the HEVC standard [T. Yamakage (Toshiba), I. S. Chong (Qualcomm), Y.-W. Huang (MediaTek)]

This contribution proposed to include ALF in the HEVC standard, and provided information on how the HM 5 decoder is implemented. In a revision of the contribution, some subjective test results were provided to support the assertion that ALF provides measurable objective and subjective quality improvement. 11 test sequences were chosen for this testing, either from the common test set or other test sets (i.e., sequences from VCEG activity) with QP=32, 37 for random access and low delay B coding structures. It was reported that the ALF cases mostly have lower bitrate and higher PSNR than the non-ALF encodings. It was reported that out of the 11 sequences, 4 sequences showed a clear visual gain for still images and a slight gain for moving pictures. It was reported that in some particular cases, ALF shows visual gain even though its BD bit rate gain is less than it is for some other test cases.

JCTVC-H0734 Straw man for Profiles and levels [M. Horowitz (eBrisk Video), A. Ichigaya (NHK), K. McCann (Samsung/ZetaCast), T. Nishi (Panasonic), S. Sekiguchi (Mitsubishi), T. Suzuki (Sony Corporation), T. K. Tan (NTT Docomo), W. Wan (Broadcom), M. Zhou (TI)] [late 02-06]

This multi-company contribution was discussed in joint meeting with MPEG Requirements, MPEG Video and VCEG. (See additional notes above.)

9 levels were proposed, three of which have an extension "H" that would allow higher (typically double) bit rate.

It was proposed to start with definition of a "Main Profile" only for 4:2:0 and 8 bit applications

The proposed Main profile would be the current LC configuration (from common test conditions) plus SAO.

Coding efficiency features from the HE configuration that were proposed not to be included in the profile were: LM chroma, AMP, NSQT, ALF.

5.5 Source video test material

JCTVC-H0294 YUV4:4:4 test sequences for screen content coding [J. Cao, K. Zhou, S. Wang, T. Lin (Tongji Univ.)]

At the moment, we do not have 4:4:4 encoding capability. However, it is highly appreciated to have such sequences available. Tongji Univ. (T. Lin) indicated that they were willing to donate their source video test sequences to the public domain, and would upload a revised contribution to state this explicitly. The original contribution contained remarks about copyright availability that appeared suitable for our use. A question was asked about potential underlying content rights, esp. for sequences depicted in Figs. 2 & 4. Pending clarification or revision of the test sequences to omit some material, we would not use those two sequences.

JCTVC-H0389 New Class E videoconferencing source content [W. Jang, J. Boyce, D. Hong (Vidyo)] [late]

New source video test sequences were submitted and demonstrated as candiates for replacement of our current "Class E" test sequences (due to artefacts in the prior Class E sequences). Vidyo (S. Wenger) indicated that they were donating their sequences to the public domain and provided a revision of the contribution to clarify this.

It was agreed to replace our current Class E test material with these sequences and put them on the usual ftp site, along with a note of this public domain status.

5.6 *Functionalities*

5.6.1 Very-low delay

JCTVC-H0487 Importance of very high bit rate and ultra-low latency applications [A. Duenas, F. Javier Roncero (Cavium)]

This contribution asserts that there is a rising importance of some applications that require video compression standards that allow for very high bit rates to be supported and ultra-low latency to be achieved.

Application characteristics were asserted to include up to 100 Mbps or higher, in some cases with less than one frame of latency, and with 4:4:4 chroma format. Entropy coding throughput and entropy coding latency were asserted to be important issues. Operation of the CPB with sub-frame decoding units was proposed.

Discussed applications included local wireless display and wireless cameras.

JCTVC-H0471 Proposed Mechanism for Improving Ultra Low Delay Coding Efficiency [O. Bar-Nir (Harmonic)] [late]

This contribution proposed an approach for ultra low delay coding using the HEVC standard. Intra coded pictures in HEVC are significantly larger than inter coded pictures, and hence they require significantly longer transmission delay. The extra delay increases with the ratio between the sizes of intra and inter pictures. Ultra low delay coding requires a more uniform bit distribution between pictures, and preferably also within the picture. A way to achieve a more uniform distribution of bits between pictures is to replace the I-pictures with a progressive refresh mechanism, using rows or columns of Intra CUs.

It was asserted that row intra refresh produces an uneven distribution of bits over the top-to-bottom representation of the picture.

The main hurdle in implementing ultra low delay in HEVC was asserted to be the various in-loop filters that "contaminate" refreshed pixels that are filtered with non-refreshed pixels.

Past ultra low delay related proposals such as JCTVC-G183 and others proposed a similar approach to low delay coding, but were suggested to have been rejected due to having an added burden on the decoder (JCTVC-E600). This proposal suggests an alternative approach that is asserted to have a minimal impact on the decoder.

It was proposed to provide a means for the encoder to inform the decoder of the location of a vertical refresh line to the decoder, in the PPS or in the slice header, or by using a dedicated SEI message and a VUI flag. (In discussion, the APS was suggested as potentially being better.) The decoder would then use this information to disable deblocking, SAO and ALF across the refresh line.

It was proposed to disable in-loop filtering across the refresh border.

Tiles were suggested to be a way to do this. It was commented that the current tile design might need some modification to do this better and achieve low latency.

It was commented that such a scheme may produce visual artefacts.

It was commented that column refresh is not necessarily the only or best approach, such that it may not be desirable to customize the design and decoding process for that specific scheme.

It was commented that with non-normative control on the encoder side and recovery point SEI messages, and perhaps with disabling of loop filtering across slice boundaries (or disabling it altogether), there are various ways to achieve the described "gradual decoding refresh" capability.

For further study.

JCTVC-H0215 Market needs and practicality of sub-picture based CPB operation [K. Kazui, S. Shimada, J. Koyama, A. Nakagawa (Fujitsu), A. Duenas (Cavium)]

Sub-picture based operation of CPB (Coded Picture Buffer) for interoperable ultra low delay video transmission was proposed at the 7th JCT-VC meeting in G188.

This contribution provided information and further expressed the asserted needs and the practicality of the proposed operation to the current HRD specification.

The idea behind the proposal is that there are ways to average the number of bits of each sub-picture of a picture. One example is the vertical intra line refresh scheme explained in JCTVC-G183. When the number of bits of each sub-picture is controlled in such a way, an encoder encodes a parameter M in the bitstream which implies arrival times of the last bit of a M sub-pictures are uniformly distributed between removal times of two consecutive pictures. The arrival time of i-th sub-picture in the n-th picture, tr(n, i) is defined as tr(n, i) = tr (n - 1) + (tr (n) - tr (n - 1)) * i / M, where tr(n) is the removal time of the n-th picture.

One source of latency was mentioned to be CABAC. However, slice (or entropy-slice) level operation could help with that, as CABAC is flushed at slice boundaries.

As written, the proposal referred to removal of "groups of treeblocks" from the CPB. Some mechanism may be needed to identify which coded bits correspond to such a "group of treeblocks".

The proposal seemed to consider the removal of units of data from the CPB that were potentially smaller than NAL units.

Some specification of decoding times for the smaller-than-AU chunks of data from the DPB would be needed. The proposal suggested evenly-distributed chunk removal times over the duration of the period from tr(n – 1) to tr(n).

In the discussion it was suggested that a way of addressing the needs of this application would be an SEI message indicating conformance to such a "tighter" CPB operation constraint.

Hypothetically, an additional class of decoder conformance and/or potentially the specification of some special profile(s) would be a substantially stronger approach.

Some details seemed to need to be worked out in the proposal, although it seemed feasible to work toward definition of an SEI (or other) approach to this. Further study was needed to establish these details and work toward specific draft text. The AHG on HLS was requested to work to further develop the scheme.

5.6.2 Scalable coding

This subject area is closely related to the high-level syntax topic. See also section 5.13.

JCTVC-H0388 High level syntax hooks for future extensions [J. Boyce, S. Wenger, W. Jang, D. Hong (Vidyo), Y.-K. Wang, Y. Chen (Qualcomm)]

Hooks to the high-level syntax of the HEVC design were proposed to enable future scalable and 3DV extensions in a backwards-compatible manner, maintaining the existing temporal scalability capability.

The NAL unit header design was proposed to be revised, and a "video parameter set" (VPS) was proposed.

The proposed VPS provides a common set of parameters that describes the CVS for all layers (including, e.g. dependency structure information). Some syntax of the current SPS is moved to the VPS.

Temporal layers are called sub-layers rather than layers.

A "group parameter set" (GPS) was also proposed, with referencing of multiple different types of parameter sets in the slice header with only one parameter set ID. The GPS identifies the VPS, SPS, PPS and APS. The slice header carries a GPS ID (and no other PS IDs).

A 5-bit layer_id field is proposed to be added to the NAL unit header, while maintaining a 2-byte NAL unit header length, fixed for both VCL (currently 2 bytes) and non-VCL NAL units (currently 1 byte), in a manner intended to enable allowing "media aware network elements" (MANEs) to perform bitstream adaptation based on either or both of layer_id and temporal_id. To make room for the 5 bit layer_id, the output_flag and 4 reserved bits are removed. It is proposed for the output_flag to be moved to the PPS or slice header. It was remarked that moving the output_flag out of the NAL unit header is desirable regardless of the rest of the proposal.

For the first version of the standard, the layer_id would be require to be zero, so it would not really make any difference whether those bits are called layer_id or reserved_5zero_bits in the first version of the standard.

So the immediate request in the proposal, as far as the effect on the NAL unit header is concerned, is to make the NAL unit header one byte longer for non-VCL NAL units and to move the output_flag elsewhere.

The proposed layer_id is somewhat similar to the prior priority ID.

An example design that support both scalability and 3DV was provided for information in JCTVC-H0386, to illustrate how the proposed high-level syntax hooks enable future scalable and 3DV extensions in a way that is backwards-compatible with the base HEVC specification.

A revision was later reviewed.

It moved the profile/level information to the (new) VPS. Some participants expressed a reluctance to do this.

The handling of NAL units with reserved values was discussed.

The need to provision for various types of hypothetical future extensibility was discussed (e.g., instead of our prior 8 constraint set flags, we may need more, and may want the ability to express conformance to multiple profile/level definitions).

It was remarked that if some reserved bits are available in the SPS level of the syntax, that could become something else (such as a VPS index) later.

Suggestion: Move output_flag to slice header, conditioned on a presence bit in the PPS.
Decision: Agreed.

The discussed NAL unit header would be fixed length of 2 bytes, in which the output_flag is not present and temporal_id is present using 3 bits and 5 reserved bits currently equal to '00001' are present, and decoders are required to ignore NAL units in which the 5 reserved bits are equal to any other values.
Decision: Agreed.

It was additionally agreed that provisioning for extensibility (for scalability and other hypothetical other extensions) will be a fundamental element of our syntax design, although we should study further to determine the precise form of such provisioning – e.g. reserved FLC space near the beginning of the data stucture, reserved meaningless ue(v) variables, reserve variable-length packages of unknown junk, etc.

No change was agreed to the SPS level syntax in response to this proposal at this time. Such modifications were designated for further study in AHG work.

JCTVC-H0386 Information for scalable extension high layer syntax [J. Boyce, S. Wenger, W. Jang, D. Hong (Vidyo), Y.-K. Wang, Y. Chen (Qualcomm)]

This contribution provided an explanation of the type of use envisioned in a next phase of work for the hooks proposed in JCTVC-H0388.

JCTVC-H0410 Simple NAL Unit Header for HEVC [J. W. Kang, H. Lee, J. S. Choi, T. C. Thang (ETRI)]

The NAL unit header was asserted to be crucial for a network node to process the video bitstream packet by packet. This contribution proposes some options for the NAL unit header that can support extensions of HEVC. The main objective of the proposed options was to have self-contained packet header so as to facilitate simple adaptation at the packet level.

The contribution proposed two variants for the NAL unit header syntax.

In both variants, the NAL unit header is variable length and has a scalability information flag that determines whether some scalability information is present in the header or not.

The first option has flags to indicate the types of other scalability-related fields that are present in the NAL unit header and those flags have a fixed length when present.

The second option uses higher-level information (e.g. SPS level) to determine how to parse the NAL unit header.

In the discussion of the proposal, it was commented that the variable length nature and dependency structure of the NAL unit header size and parsing may be a burden on MANEs and, to some extent, on decoders.

JCTVC-H0701 Hooks for scalable extensions [M. M. Hannuksela (Nokia)] [late]

This proposal can be summarized as containing the following aspects:

- A component picture is defined, which in the current HEVC WD is the coded picture of an access unit, and in the future scalable extensions would be, for example, a view component, a depth map, or a layer representation.
- A component picture delimiter NAL unit was proposed, which may carry some of the slice header syntax elements and, in the future, scalable extensions could carry scalability properties of component pictures. (In discussion, it was remarked that this is similar in concept to a picture header or APS, with a predictive updating scheme.)
- A two-byte NAL unit header would be specified, including a component picture delimiter ID (cpd_id).
- A prediction mechanism of slice header parameters between component picture delimiter NAL units of the same access unit would be specified to reduce the slice header byte count overhead in the future scalable extensions.
- Sub-bitstream extraction would be performed based on cpd_id.

See notes above relating to changes made for NAL unit header.

The proposal suggested to change the AUD to become part of the decoding process, allowing it to carry some data that otherwise would reside in the slice headers. These syntax elements could optionally be repeated in the slice headers. The presence of AUDs would remain optional.

This would change the concept that the APS is where data should go that would otherwise be in the slice header. The asserted benefit of using the AUD would be to enable detection of lost header data.

As a side note, it was commented that we should think about whether it is really wise to require all SEI messages to precede the first VCL NAL unit of the primary coded picture in the access unit.

Further study was highly encouraged.

JCTVC-H0566 AHG15: Temporal layer access pictures [J. Samuelsson, R. Sjöberg (Ericsson)]

This contribution presented a proposal for the signalling of "clean random access" (CRA) pictures and temporal layer switching points in what is referred to as "temporal layer access" (TLA) pictures. It was proposed to replace the CRA NAL unit type with a TLA NAL unit type. The TLA NAL unit type imposes constraints on the bitstream but does not, in this contribution, have any impact on the decoding process.

It is stated in the contribution that both random access information and temporal layer switching information is of high value to a network node and thus should be available in the NAL unit header, independent of data outside that NAL unit header, specifically the SPS and PPS. It is further stated that a unified syntax and definition of TLA pictures would make the standard text more readable and comprehensive.

The proposal is essentially a repetition of JCTVC-G584.

It was noted that there are some switching points that can be expressed with the current syntax that cannot be expressed with the proposal.

It was commented that the structuring of the TLA and CRA definitions might be better as independent definitions.

The contributor suggested that having a CRA picture with temporal ID greater than 0 is not very useful.

The proposal would remove the temporal layer switching point flag (per layer) from the PPS. Instead, the NALU type of 4, which is currently used for CRA, would indicate a temporal layer switching point when the temporal ID value is 0.

It was suggested to use a separate NALU type for this, so that it would not be necessary to check the level ID in order to identify CRA pictures, and that the temporal ID of CRA pictures should be required to be zero.

Decision: The temporal ID of CRA pictures should be required to be zero.

There was some discussion of which classes of picture should be defined as governed by the TLA constraint indication, and whether a separate NALU type should be used. It was agreed that output order should not be restricted.

Decision: Adopted (new NALU type, prohibiting temporal ID equal to 0 with that NALU type, without output order restriction).

JCTVC-H0568 AHG15: Specification of bitstream subsets [J. Samuelsson, R. Sjöberg (Ericsson)]

This document analyses some high-level aspects of the HEVC working draft text and proposes to include text regarding bitstream conformance and specification of bitstream subsets. More specifically the following was proposed:

- Copy the AVC bitstream conformance section into the HEVC WD and split it into two conformance points
    - Output timing conforming bitstreams (copied from AVC) – in principle, we already have this.
    - Output order conforming bitstreams
- Copy the SVC specification of bitstream subsets for temporal_id with the following changes
    - Separate output timing conformance from output order conformance and make output timing conformance optional
    - Add a sub-bitstream extraction process for removal of individual access units

- Make all information needed for sub-bitstream extraction available in fixed length without dependency on PPS or SPS
    - Temporal Layer Access pictures for defining temporal layer switching points (JCTVC-H0566)
    - Add a fixed length copy of picture order count into the access unit delimiters

The concept of making output timing conformance optional from the bitstream perspective would be a departure from past practice. It was commented that it would become difficult to determine whether a bitstream could be decoded at full speed or not or with any limit on the required buffering capacity if there is no assurance of bitstream timing conformance. This could enable creation of exceptionally "evil bitstreams" from the decoder perspective.

The proposed temporal sub-bitstream extraction process enables the extraction process to vary the layer that it is extracting as the bitstream is processed from beginning to end – i.e., to operate using "adaptive bitstream thinning". It was remarked that we believe we may have already achieved this – at least in VBR operation – such that there may not be a need to describe such an operation explicitly in the standard.

It was agreed that we should have at least the AVC style of extraction and conformance supported for temporal layers in HEVC as it is in AVC. This is already our implicit understanding, if not fully expressed in the draft text. Decision: Specify extraction in the same spirit as in SVC, based only on temporal ID.

It was commented that the interaction with the system level is conceptually difficult to understand and specify, and trying to change our understanding about that high level behaviour substantially while trying to finalize the basic coding design may be overly ambitious.

The contribution includes a proposal to send POC in the AUD as well as sending the POC LSBs in the slice header. (Without any normative effect on the decoder.) This idea had also been mentioned at the preceding meeting.

It was discussed whether, if we do this, we should send the entire POC value (including the inferred MSBs) or just the LSBs as sent in the slice header. In previous work, we have generally considered it unnecessary to send the MSBs of the POC, as only relative order is necessary to understand from the bitstream. No action was taken on that aspect.

It was discussed whether primary_pic_type is actually useful. (Potentially removing this was mentioned in JCTVC-H0386, which is an information document.) It was remarked that it at least lets the decoder detect intra pictures (including those that are not CRA pictures). No action was taken on that aspect.

JCTVC-H0669 Sharp proposals for HEVC scalability Extension [H. Kumai, T. Yamamoto, A. Segall, N. Ito (Sharp)] [late]

Outside the current scope of work.

5.6.3 Adaptive resolution coding

JCTVC-H0234 AHG18: Design considerations for Adaptive Resolution Coding (ARC) [T. Davies (Cisco)]

This contribution considers various ARC features from a complexity perspective. It proposes level constraints on the number of reference resampling operations per frame period and the frequency with which resolution can be changed. A variety of short-length reference resampling filters were evaluated on low delay configurations, and their effects were reported to be transient, especially for up-sampling. For reference up-sampling, both simple linear and DCTIF upsampling filters reportedly had no loss on average against an anchor employing common filtering for reference and input/output pictures. For reference down-sampling, a 3-lobe Lanczos-windowed filter was observed to perform best of those tested against the anchor with mean luma BD bit rate losses of 0.45%.

Particularly for high QP, coding gains were reported previously in some cases in JCTVC-G264.

Constraints were proposed for how often the resolution could change (in output order) and how many reference pictures could be resampled when it happens. It was commented that it may be beneficial to constrain the resolution changes in output order as well as in decoding order.

It is proposed for collocated motion vectors to be marked as not available when resolution differs.

It was remarked that unless the higher resolution uses a coded picture size that is a multiple of two times the SCU size, there would be different alignment effects at the border. In the proposal software, padding was proposed.

Various short filters were tested for the normative reference resampling filters and the non-normative encoder-only filtering. Only 2:1 resolution changes were tested. It was reported that for the upsampling filters, it basically didn't matter what the filters were, and a co-sited linear interpolation filter was suggested. For downsampling, it mattered a bit more, and a 3-lobe Lanczos filter (5 non-zero taps [-1 0 9 16 9 0 -1]) was suggested.

A participant suggested alternatively considering the resampling filters that had been proposed in JCTVC-G264.

It was commented that such a feature, if adopted, might need to be left out of some profiles (e.g. not used for broadcast).

It was commented that the relationship with SVC should be studied. The proponent asserted that ARC is a simpler approach than SVC, and may have better coding efficiency.

JCTVC-H0185 Cross-check of Adaptive Resolution Coding (ARC) [G. Van Wallendael, S. Van Leuven, J. De Cock, R. Van de Walle (Ghent Univ.)] [late]

JCTVC-H0321 AHG18: Resolution Adaptation Coding (ARC) using single resolution in DPB [P. Bordes, P. Andrivon (Technicolor)]

This contribution presents a method for implementing Adaptive Resolution Coding (ARC) in which the DPB holds one coded size for each picture, which is its decoded size. The resampling and motion compensation filtering are combined in the decoding process (which lengthens the filter). It is reported that the scheme has encoding gains, relative to a different approach for dynamic resolution change, of between 0.1% to 1.8% in Luma and up to 4.9% in Chroma on average depending on configuration cases and scenarios (low-to-high or high-to-low). The DPB memory size is reportedly reduced at the decoder side, compared to previous ARC proposals, by avoiding storage of more than one resolution for each picture in the DPB. At the encoder side, both resolutions are still necessary to compute motion estimation only. The proponent indicated an interest in investigating the use of shorter filters. Further study would be needed to determine the potential value for such an approach.

JCTVC-H0351 AHG18: Cross-check of JCTVC-H0321 by Cisco [T. Davies (Cisco)] [late]

JCTVC-H0447 Reduced Resolution Update Mode for enhanced compression [Alexis Tourapis, Lowell Winger (Magnum)]

(Informative contribution.)

This contribution proposed the consideration of reduced resolution update (RRU) techniques (e.g. as in H.263 Annex Q) as potential methods for enhancing encoding performance for video compression. RRU techniques allow encoding a video signal by, commonly predicting that signal at full resolution while encoding any residual information at a lower resolution. Such information needs to be up-sampled before

it is used for the reconstruction of the final image. It has reportedly been shown in the past that RRU methods can provide considerable coding advantages, both subjectively and objectively, especially at lower rates, versus full resolution as well as reduced resolution encoding. The proponent indicated that, unlike what was reported in previous contributions on the same topic, additional coding advantages or flexibility may be achieved by considering applying RRU concepts separately at different colour components or colour component groups, as well as extending RRU methods at the slice or region, and even at the coding unit level. Support also of down-sampling of not only the residual but also of the prediction signal was suggested to also be considered. This was asserted to essentially make the RRU process a superset that already potentially accounts for the techniques already presented in AHG 18. It was suggested by the submitter that such methods should be carefully evaluated.

It was noted that there is some overlap in concept between RRU and the use of large block sizes (for MC and residual) and possibly also with selective dropping of high-frequency coefficients.

5.6.4 Colour component sampling

JCTVC-H0394 Coding in 4:4:4: Preferred Conversions in Colour and Sampling [P. Topiwala (FastVDO)]

It was asserted that, for the most part, cameras capture, and displays render, RGB 4:4:4, whereas the HEVC draft design works in YUV 4:2:0. Two key components are needed to make the connection between what is captured/rendered, and the codec – colour transforms and resampling filters. The contribution proposed integer colour transforms and resampling filters. The resampling filters are targeted for dynamic resolution conversion, and correspond to the prior proposal G264.

It was asked whether the proposed filters had been tested for screen content.

JCTVC-H0065 Mixed Chroma Sampling-rate coding: combining the merits of 4:4:4 and 4:2:0 and increasing the value of past 4:2:0 investment [Tao Lin, Shuhui Wang (Tongji Univ.)]

For compound image compression, this contribution proposes a "mixed chroma sampling-rate" (MCS) coding technique that combines and mixes one chroma sampling rate (such as full-chroma YUV 4:4:4) coding with another chroma sampling rate (such as chroma-subsampled YUV 4:2:0) coding at the coding unit (CU) boundary, the coding chain component (such as prediction, transform, quantization, entropy coding etc.) boundary, or other properly selected boundary. Typically, the full-chroma coder is discontinuous-tone content oriented to code mostly computer-generated discontinuous-tone content such as text, chart, graphics, and icon in a compound image like screen content, while the chroma-subsampled coder is continuous-tone content oriented to code mostly camera-captured continuous-tone content such as photograph, movie/TV clips, and natural picture video sequences in a compound image.

JCTVC-H0073 4:4:4 screen content coding using Macroblock-Adaptive Mixed Chroma-Sampling-Rate [Shuhui Wang, Tao Lin (Tongji Univ.)]

This contribution presents a "macroblock- (or CU)-adaptive mixed chroma-sampling-rate" (MAMC) technique for 4:4:4 screen content coding. MAMC coding consists of two coders – one is a traditional "continuous-tone content oriented" (CCO) chroma-subsampled (4:2:0 or 4:2:2) coder such as the existing HEVC/ AVC coder with 4:2:0 or 4:2:2 chroma format. The other is a "discontinuous-tone content oriented" (DCO) 4:4:4 full-chroma coder such as a dictionary-entropy coder. One of the two coders is selected to code each macroblock (or CU), based on the rate-distortion performance.

Another aspect of the contribution is to propose a modification to the existing 4:2:0 or 4:2:2 chroma format HEVC/AVC coder to be used in MAMC coding. Since the full-chroma pixels are available in MAMC coding, the prediction can be done in full-chroma format without any change to the existing syntax and semantics including prediction modes of the 4:2:0 or 4:2:2 chroma format HEVC/AVC standard specifications except adding a "MAMC flag" bit in the SPS.

The main point of MAMC is to enable 4:4:4 chroma format content coding in HEVC and AVC, which, it was asserted, could expand their market adoption especially in cloud-mobile computing and wireless display areas, with minimum addition, modification, and complexity increment to the current 4:2:0/4:2:2 chroma format HEVC/AVC coder design.

Coding experimental results reportedly indicate that MAMC coding consisting of a gzip-based dictionary-entropy coder and an AVC High profile coder can get much higher PSNR than ordinary AVC High profile coding. Using full-chroma prediction AVC coder instead of traditional AVC High profile coder in MAMC coding can reportedly get further PSNR improvement in two pictures which have a lot of discontinuous-tone content.

The contribution provided examples and experiment results relating to the coding scheme proposed in H0065.

The emphasis was on screen content coding, for which alternative coding mechanisms were reported to provide very substantial coding improvements relative to conventional waveform-oriented coding.

The group is certainly interested in having good capability of representing 4:4:4 video.

It was suggested that this is somewhat similar, in the chroma domain, to RRU or perhaps ARC on the coding unit level.

The proposal had not been tested in the HEVC context.

Further study would be needed to study the complexity and coding performance of the proposed techniques and to develop the full details of an HEVC specification for this capability.

JCTVC-H0457 Removal of Monochrome Chroma Format Support [T. Hellman, W. Wan (Broadcom)]

This submission proposes a claimed simplification to the standard by the removal of monochrome chroma format. It contends that the gain from adding specific monochrome support versus coding monochrome material in 4:2:0 is likely quite small, and in any case only applies only to a small fraction of video source material. The proposal recommends removing support for the monochrome format, or performing further study to measure the actual gain for a future decision.

It was remarked that alpha has been supported using auxiliary coded pictures in AVC, and the separate colour plane scheme in AVC is also built on the monochrome concept.

Monochrome could be left out of a profile if that is desirable. If it is left out of a profile, there should be some (e.g. VUI) indicator that the decoded video is actually monochrome. Consideration of true monochrome may be best left to some later phase of work when the same parts of the design are being modified to also support 4:4:4.

Decision: We will have some profile that does not support monochrome, and an indicator flag in VUI. If feasible, we would like the flag to indicate that the chroma will be exactly 128 (i.e., 1 << (bitDepth − 1)) if decoded.

JCTVC-H0650 AHG20: 4:2:2 support in HEVC [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)] [late]

This contribution proposes support of 4:2:2 format in the HEVC standard, which it was asserted could expand opportunities of its market adoption especially in digital broadcasting area. The main point of this proposal is to introduce modifications as small as possible in order to accommodate 4:2:2 format. Modifications of the current specification to support 4:2:2 format were described (at the concept level, without draft text). The proposal requested no change of syntax other than the sending of additional transform coefficients.

It was commented that 4:4:4 is conceptually simpler to support – basically applying luma-like processing for all components.

For the residual coding there are basically two possible approaches, which would be to use more blocks or to use vertically larger blocks. This proposal is to use larger blocks. Both approaches seem desirable to investigate.

To be studied in an AHG.

5.6.5 Interlace

JCTVC-H0056 AHG13: On interlace indication [K. Chono, H. Aoki (NEC)]

This contribution was summarized in the AHG13 report as:

- Move the VUI flag in the AHG13 starting text to SPS and modify its definition to specify the type of the associated coded sequence in addition to the presence of the SEI message in each of access units.
- One-bit interlace field indication in SEI message to indicate the parity of each field.
- Modified access unit delimiter RBSP to indicate dynamically changing source material properties.

The first element proposes two aspects: 1) moving the location of the SPS-level flag, and 2) defining the flag as an indication that the coded video sequence is interlaced fields.

The second element proposes to reduce the length of the field in the SEI message to use only 1 bit rather than 4 bits.

The last element was provided as information, rather than for immediate adoption.

JCTVC-H0588 AHG13: Proposed interlace format indication for HEVC [K. Sugimoto, S. Sekiguchi (Mitsubishi)] [late]

This contribution was summarized in the AHG13 report as:

- Define a constraint that a coded sequence shall contain coded pictures consisting of frames only (progressive or interlace) or fields only.
- One-bit interlace format indication in SPS or VUI
- One-bit interlace field indication in SEI message to indicate the parity of each field.

This is very similar to JCTVC-H0056.

It was remarked that the question of whether the content is coded as fields is different than the question of whether the input sampling structure was progressive or interlaced.

It was suggested to avoid the use of interlaced sampling as a concept in the specification – rather, simply using the geometric concept of top and bottom fields (although a note with some acknowledgement of a relationship may be appropriate).

It was suggested that it may be desirable, when frames are coded, to enable an indication that the frames are interlaced and which field is temporally first.

JCTVC-H0666 Interlace Indicators [Chad Fogg (Harmonic)] [late]

This contribution was summarized in the AHG13 report as:

- A flag to indicate the scanning method of the original source of a coded sequence.
- A flag to indicate whether a coded sequence contains frames only or fields only.
- A flag to indicate the parity of each field.

- A flag to indicate whether the coded frame or field is a "dummy frame" resulting from a repetition process, such as 3:2 pulldown.

One thing not in the proposal was the aforementioned indication which field is temporally first when a picture is a frame. A suggestion was to provide a flag to indicate a conceptual pairing of fields – i.e. which field is first in a pair.

The three remaining bits of the byte would be reserved.

A BoG (coordinated by K. Chono & C. Fogg) was asked to prepare text. The result was reported in JCTVC-H0720.

JCTVC-H0222 Introduction of AVC derivation process of chroma motion vector for interlace format support [K. Kazui, J. Koyama, S. Shimada, A. Nakagawa (Fujitsu)]

This contribution was summarized in the AHG13 report as:

- SPS flag to specify the scanning method of an input source.
- One-bit interlace field indication in slice header when SPS flag indicates that the input source is interlaced scan.
- AVC-style chroma MV phase adjustment.

It proposes part of the prior JCTVC-G196: field motion compensation for chroma as in AVC.

The claimed improvement was 0.4 dB average BD PSNR benefit (up to 1 dB) for chroma components (using self-selected interlaced content). No cross-verification was provided.

It was asked whether the improvement is visible. It was remarked by a non-proponent that there previously has been a conclusion that there is some visual benefit in AVC chroma artefact reduction as a result of this technique.

If adopted, we might need to have a profile that excludes it. It was commented that if we are willing to customize the decoding process for field coding, we should probably not just do this, but should go further – however, we really don't plan that. No action taken.

JCTVC-H0720 BoG report on interlace indicators [K. Chono, C. Fogg, D. Flynn, S. Sekiguchi]

After further review and discussion, it was agreed to have a flag that indicates the mandatory presence of an SEI message that indicates whether all pictures are frames vs. all pictures being fields, and conveys four picture-level property flags as described above.

The text was subsequently reviewed and refined by the group, with the result uploaded as the -v4 version.

Decision: Adopt as reviewed and uploaded as -v4 of H0720.

5.6.6 Robustness against transmission loss

JCTVC-H0072 NAL Unit loss software [S. Wenger (Vidyo)] [late]

Attached to this contribution was a NAL unit loss simulator (loss.c) that can be used to apply error pattern files to a bitstream according to Annex B bitstream format. Further included was a converter program (convert.c) that converts the error pattern files as generated by the JCTVC-G1050 software to a more compact interim format – the same format used previously in JCT-VC, as well as converted error pattern files. Both software and patterns could benefit from testing.

This software seems useful for loss testing purposes, and its use is encouraged. We will put it, along with the example error patterns, into the reference software tools package for distribution as part of the reference software. Decision (SW): Agreed.

5.7 Deblocking filter

JCTVC-H0190 Non-CE10: Difference-QP-based Deblocking [K. Sato (Sony)]

In common test conditions, the QP value remains the same within a picture, but in real applications it will vary. Performance of HEVC with varying QP should well be studied before it becomes an international standard.

One of the tools that should be studied under the varying QP scenario is the deblocking filter. In the 7th meeting, there were two proposals related to this topic. One was JCTVC-G384, which proposed using the maximum QP of the two neighbouring blocks for deblocking. Another was JCTVC-G640, which proposed using the average QP. The latter one is the same as AVC and was adopted into HM-5.0.

However, it is asserted that blocking artefacts are visible if the QP of one block is small and the one for the other block is large. Either of the previous proposals can reportedly reduce such blocking artefacts.

This document proposes one additional operation for the deblocking filter that is asserted to take the difference of QPs of neighbouring blocks into account.

This document proposes the following additional logic into the strong/weak filter criterion:

```
if (Bs > 0) && (AVE[QP_P, QP_Q] >= 34) && (Diff[QP_P, QP_Q] >=8)
    StrongerFilterApplied;
```

Still-frame examples of the asserted subjective benefit were shown.

In PSNR terms, a small loss was reported (0.1-0.2%).

It was commented that the idea seems attractive and worthy of study, as we should avoid neglecting the consideration of non-constant-QP operation. However, the particular method of approaching the issue did not necessarily seem like the most clean and correct approach. Further study of deblocking for non-constant QP was requested to be performed in an AHG.

JCTVC-H0644 Non-CE10: Cross-verification report for difference-QP-based deblocking (JCTVC-H0190) [H. Aoki, K. Chono (NEC)] [late 02-04]

The cross-checker did not check visual quality.

JCTVC-H0275 Non-CE10: Introduction of strong filter clipping in deblocking filter [M. Ikeda, T. Suzuki (Sony)]

This contribution addresses strong filter operation in deblocking filter. The strong filter currently does not have a clipping process, but the weak filter does.

In some cases, especially in Class F, the pixel value is changed by a large amount when the strong filter is applied.

In this proposal, a clipping process using 2*tc is proposed to be introduced to strong filter operation. It was asserted that this proposed technique can prevent pixels from being filtered too much.

It was reported that the average compression impact results, excluding class-F, are as follows: AI HE: 0.0%, RA HE: 0.0%, RA HE10: 0.0%, LB HE: 0.0%, AI LC: 0.0%, RA LC: 0.0% and LB LC: 0.0% and that the average ones including class-F are as follows: AI HE: 0.0%, RA HE: -0.1%, RA HE10: 0.0%, LB HE: -0.1%, LP HE: -0.1%, AI LC: -0.1%, RA LC: -0.1%, LB LC: -0.2% and LP LC: -0.1%.

The overall impact on Class F PSNR is beneficial in all cases: 0.4-0.7% benefit on average in every configuration.

Considering the use of clipping in the weak filter case, this may be characterized as a bug fix.

Decision: Adopted.

JCTVC-H0587 Non-CE10: Cross check of the introduction of strong filter clipping in deblocking filter of Sony (JCTVC-H0275) [M. Narroschke, A. Kotra, S. Esenlik (Panasonic)] [late]

JCTVC-H0281 Non-CE10: Removing QP line buffer [Y.-W. Chen, J.-L. Lin, Y.-W. Huang, S. Lei (MediaTek)]

In HM-5.0, deblocking filter (DF) employs an average of QPs on both sides of an edge to look up the β and t_c parameters. When LCUs are processed by the DF in a raster scan order, each LCU needs the QP values from its upper LCU. Therefore, a line buffer of 3.9K bits is required to store QPs of upper LCUs for 4Kx2K video in hardware. Since the QP line buffer is only used by the DF, in this contribution, a simplified DF is proposed to remove the QP line buffer as follows. When processing the horizontal edges between a current LCU and its upper LCU, only the QP of the current LCU is used. Simulation results reportedly show that the proposed method introduces no meaningful change in BD bit rates and run times when QP adaptation is enabled on top of the JCTVC-G1200 common test conditions. The proponents also claim that the visual quality is the same as HM-5.0.

It was noted that the "line buffer" is at the QP granularity, which is probably a factor of 8 or 16 lower than the pixel level.

QP variation conditions of CE10 were used in experiment. No degradation of visual quality was reported.

It was remarked that this seems to conflict with the spirit of H0190, and could hypothetically cause line-buffer-related artefacts at LCU row boundaries.

Relatively modest modifications of QP were tested.

The minimum spatial granularity of QP variation in the profiles (which are yet to be defined) has not yet been determined. It could hypothetically be as small as 4x4, although it seems unlikely that we would want to allow that.

Further study (along with H0190) in an AHG was encouraged.

JCTVC-H0639 Cross-check report on Removing QP line buffer (JCTVC-H0281) [I.-K Kim (Samsung)] [late]

JCTVC-H0424 Non-CE10 Subtest 4: On Deblocking Parameter Signalling [G. Van der Auwera, Y.-K. Wang, X. Wang, M. Karczewicz (Qualcomm)]

This contribution proposes to add a condition in the slice header that checks the deblocking_filter_in_aps_enabled_flag to determine whether deblocking parameters are signalled in the APS, and in only that case it is proposed to include the inherit_dbl_params_from_APS_flag in the slice header. The benefit is that the signalling overhead of the inherit_dbl_params_from_APS_flag is avoided in case deblocking parameters are only signalled in the slice header.

Closely related to H0398, and actually more a matter of high-level syntax than deblocking filtering.

Decision: This aspect is adopted (merged with adoption as recorded in notes for H0398).

In addition, this contribution addresses a minor mismatch between the working draft text and the HM5.1 source code. However, this had already been fixed in a more recent draft.

Also, a potential non-normative improvement of the deblocking filter source code was suggested. This (non-normative) aspect was delegated to the software coordinator for consideration.

JCTVC-H0577 Cross-verification of Qualcomm proposal JCTVC-H0424 on deblocking filtering [A. Norkin (Ericsson)] [late]

JCTVC-H0448 AHG6: Deblocking of IPCM Blocks Containing Reconstructed Samples [G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm)]

This contribution addresses the deblocking of IPCM blocks containing reconstructed samples. The HM5 deblocking filter always assigns the quantization parameter (QP) value 0 to IPCM blocks, independent of the value of the pcm_loop_filter_disable_flag (SPS), which results in inadequate QP values for deblocking parameter lookup. The proposal is to assign the reconstructed QP value (QPY) to the IPCM blocks in case deblocking is enabled on IPCM samples (pcm_loop_filter_disable_flag equals 0). In case deblocking is disabled on IPCM samples (pcm_loop_filter_disable_flag equals 1), deblocking filtering of non-IPCM samples is proposed to be determined by the reconstructed QP value of the non-IPCM block that is neighbouring the IPCM block, while the IPCM block is assigned QP value 0.

Based on the discussion, a suggested CE or AHG starting basis (AHG6, established as recorded below) we outlined as follows:

- Never deblock inside of IPCM regions
- Send a QP for the IPCM region (terminate CABAC, then send number of successive blocks n, then send n QP values using FLC with the minimum number of bits needed for the QP range or as delta QP with se(v) or as ue(v), then send byte alignment bits, then send samples).
- Outside of the IPCM region, apply deblocking as usual.

JCTVC-H0578 AHG6: Inspection report on deblocking of IPCM Blocks containing reconstructed samples (JCTVC-H0448) [K. Chono, H. Aoki (NEC)] [late]

JCTVC-H0722 Clarification request on varying QP in deblocking [M. Horowitz (eBrisk)] [late 02-05]

It was reported that the software does not use unavailable QP values to derive beta and t_c values for deblocking, but text seems to.

Decision (SW): The software (as well as the text) should use the neighbour region's QP whenever deblocking the boundary edge with a neighbouring region, regardless of whether it is in a different slice or tile (unless otherwise controlled – e.g. by disabling the filter at that boundary).

JCTVC-H0733 Response to clarification request on varying QP in deblocking in JCTVC-H0722 [C.-W. Hsu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)] [late 02-06]

5.8 Non-deblocking loop filters

5.8.1 Adaptive loop filter

A BoG was requested to discuss contributions in this area (H0409, H0094, H0420, H0483, H0372, H0277, H0418, H0571, H0413), coordinated by T. Yamakage.

JCTVC-H0732 BoG report on Adaptive Loop Filtering [T. Yamakage]

Break-out group meetings on Adaptive Loop Filtering were held at 14:30-18:00 on Feb. 5, 2012 and at 16:10-17:30 on Feb. 6, 2012. All BoG discussions were chaired by T. Yamakage. Approximately, 20 participants were present (including the chair).

The BoG reviewed and summarized the non-CE proposals on Adaptive Loop Filtering (JCTVC-H0372, JCTVC-H0571, JCTVC-H0418, JCTVC-H0409, JCTVC-H0415, JCTVC-H0094, JCTVC-H0483, JCTVC-H0420).

The BoG recommended adoption of JCTVC-H0409 and JCTVC-H0483.

The BoG recommended further study of JCTVC-H0372, including subjective viewing in a CE or AHG. This was agreed.

The BoG recommended further study of JCTVC-H0094 in a CE or AHG. This was agreed.

The BoG found no evidence to revert the decision of Session A to adopt JCTVC-H0068.

JCTVC-H0735 Analysis of differences of various ALF signalling schemes [T. Yamakage]

This contribution discussed where to signal ALF information.

It was noted that the current Wiener-based filter design technique for ALF would not be the only way to design the filter control parameters, and that enabling optimization over larger regions improves the opportunity for optimization while increasing latency.

Control parameters can be placed in the APS, SH, or SD.

When frame-level (or multi-frame) optimization is performed, it would be an undesirable burden to require the encoder to go back and CABAC-encode the control parameters within the slice data stream.

For low-delay encoding, there are two possibly reasonable approaches:

- Multiple slices per picture with control send in the slice header (likely involving byte alignment before and/or after it) or in a slice-specific APS. This would be reasonable when tiles or wavefronts are used.
- Sending control information in an interleaved fashion.

The current WD has some syntax operation at a finer level than the LCU level. The value of this finer-than-LCU level of syntax effect is unknown.

Class A gain for ALF is reported to be approximately 4.5% for the two 8 b sequences, and 5.7% for the two 10 b sequences. For RA HE, it is reportedly 5.6% for all 4 sequences coded with 8b encoding (not concentrated in any particular sequence).

H0066 always has control at LCU level and also proposes signal processing simplifications. It was suggested that this may have some penalty, e.g. for small LCU operation.

The H0274 "two-stage design" variant has control at either the LCU level or coarser (quadtree based) without signal processing changes to HM 5 (with a simplification to remove the RA mode). In principle, if the control is at the LCU level, it could be interleaved with the SD.

With regard to removal of the BA or RA mode, another participant suggested a preference for removal of the BA mode rather than removal of the RA mode. Some other participants remarked that BA is better than RA mode.

Decision: Adopt H0274 "two-stage design" with control at LCU level or coarser and simplification to remove the RA mode.

Further study of additional simplification (e.g. per H0066) and BA vs. RA and placement of syntax is to be done in CE or AHG.

JCTVC-H0094 Non-CE8: Modification of directional classification for block-based adaptation on ALF [M. Matsumura, S. Takamura, A. Shimizu, H. Jozawa (NTT)]

The BoG (see H0732 BoG report) recommended further study of JCTVC-H0094 in a CE or AHG. This was encouraged.

JCTVC-H0158 Non-CE8: Cross-check of modified directional classification for block-based adaptation on ALF (JCTVC-H0094) [T. Yoshino, K. Kawamura, S. Naito (KDDI)]

JCTVC-H0136 Non-CE8: Report on visual artefacts by ALF virtual boundary processing and proposal on the filtering process modification [O. Nakagami, M. Ikeda, T. Suzuki (Sony)]

This contribution reports that visual artefacts may occur that have a relation to ALF virtual boundary processing. The fixed position of the artefact pattern makes the artefact visible.

However, the particular described problem is no longer a concern due to a change of the ALF filter shape.

It seems useful to consider the potential for such an issue.

It was commented that we had a discontinuity in the processing at a boundary, introduced by the ALF virtual boundary processing, and some concern was expressed that it might still cause some problem.

It was noted that ALF is otherwise beneficial to the subjective quality of this sequence, so disabling it would not be desirable as a solution.

JCTVC-H0163 Cross-check of JCTVC-H136 [A. Ichigaya, S. Iwamura (NHK)] [late]

JCTVC-H0372 Non-CE8: Line memory reduction fix at independent slice and tile boundaries [S. Esenlik, M. Narroschke, T. Wedi (Panasonic)]

The BoG (see H0732 BoG report) recommended further study of JCTVC-H0372, including subjective viewing in a CE or AHG. This was encouraged.

JCTVC-H0661 Non-CE8: Crosscheck for Panasonic line memory reduction fix at independent slice and tile boundaries in JCTVC-H0372 [C.-Y. Chen, Y.-W. Huang (MediaTek)] [late]

JCTVC-H0415 Non-CE8: ALF BA feature computation only accessing 3x3 area [P. Lai, F. C. A. Fernandes (Samsung)]

This contribution seemed no longer important to consider as-is, due to the adopted change of filter shape. However, it was suggested to have some relevance with the modified filter shape.

JCTVC-H0683 Non-CE8: Cross check of Modification of ALF BA classification [I. S. Chong, M. Karczewicz (Qualcomm)] [late]

JCTVC-H0417 Non-CE8: Supplementary analysis of ALF with single shape [P. Lai, F. C. A. Fernandes (Samsung)]

JCTVC-H0418 Non-CE8: Unification of k-index mapping for filter coefficients of the two ALF shapes [P. Lai, F. C. A. Fernandes (Samsung)]

JCTVC-H0419 Non-CE8: Techniques in LCU-based ALF in CE8.a.2 and CE8.a.4 [P. Lai, F. C. A. Fernandes (Samsung)] [late]

JCTVC-H0420 Non-CE8: Variable codebook size for LCU-based ALF [Z. Ma, P. Lai, F. C. A. Fernandes (Samsung)]

JCTVC-H0097 Subjective quality assessment of ALF on still images [Y. Yasugi (Sharp)]

JCTVC-H0198 Comments on slice-independent loop filtering [M. Li, P. Wu (ZTE)]

It was asserted that, currently, loop filtering across slices (for all three filters) is controlled by a flag at the SPS level. See notes on H0391.

JCTVC-H0409 Harmonization of number of ALF classes between RA and BA modes [E. Maani, A. Tabatabai (Sony)]

16 classes are proposed to be possible for the BA mode instead of the current 15 classes in WD5, in order to have the same number of classes between the RA and BA modes. This method merges the smooth areas into one class since they do not have substantial directional characteristics.

The potential need for a more substantial cleanup than this (e.g. to use the same classes for both the RA and BA modes rather than just harmonizing the number of classes) was suggested and discussed. However, based on the information currently available, this seemed to be an improvement relative to our current design.

Decision: Adopted as recommended by BoG (see H0732 BoG report).

This was further discussed, and reconfirmed. Further study in a CE or AHG was encouraged to consider reducing the number of classes.

JCTVC-H0674 Non-CE8: Cross-check of H0409 on Harmonization of number of ALF classes between RA and BA modes [P.Lai, F. Fernandes (Samsung)] [late 02-01]

JCTVC-H0483 Harmonization of ALF Luma and Chroma Center Coefficient Prediction [J. Zhao, A. Segall (Sharp)]

This document reports an inconsistency in the design of the ALF coefficient coding for luma and chroma. Specifically, the prediction method employed for luma coefficients is the negative of the prediction method used for chroma coefficients. This document proposed a modification that was asserted to better harmonize the luma and chroma center coefficient prediction methods.

Decision: Adopted as recommended by BoG (see H0732 BoG report).

JCTVC-H0571 ALF with multi shapes versus ALF with single shape [Faouzi Kossentini, Hsan Guermazi (eBrisk Video Inc.), Wang Lai, F. Fernandes (Samsung)]

5.8.2 Sample adaptive offset

JCTVC-H0067 Non-CE8.a.2: SAO with LCU-based syntax [A. Fuldseth, G. Bøntegaard (Cisco)]

This scheme was proposed as an alternative approach to that in H0273 (also proposed as F056 and G831.

Asserted simplifications included the following:

- No band offset
- Edge offset +/-1

The syntax elements are proposed to be interleaved at the LCU level (which would make it harder to perform whole-picture optimization).

The proponent indicated a code size reduction by 3000 to 4000 lines of code (but it was remarked that the resulting software does not support the full required functionality – e.g. interactions with tiles, variable-size slices, non-CTC LCU sizes).

Only a single CABAC context was used (as proposed) – there could be gain from using multiple contexts (e.g., different contexts for different syntax elements).

Coding efficiency impact: AI/RA/LB/LP/RA_10 = -0.1/0.3/0.8/0.7/1.1% for CTC.

It was commented that Class F has significant losses.

It was commented that the edge offset limitation harms the 10-bit case.

It was commented that if this scheme is compared with whole-picture optimization of H0067, significant loss occurs.

It was suggested that whether the data is interleaved or placed in the slice header could be controlled by a flag. Doing that, with a single decoder signal processing operation that is invariant to the location of the sent data, seems like a good idea.

It was suggested to test H0273 with a such a flag during this meeting and discuss the subject further. Further study of other aspects was also suggested.

That testing was reportedly performed (using 3 added contexts), and was reportedly cross-checked by TI. It was commented that using the bypass mode in CABAC might be preferable.

Without interleaving into the SD, the effect on coding efficiency was 0.1/0.1/0.3/0.3% degradation for AI/RA/LB/LP. With interleaving into the SD, the reported effect was 0.0/0.2/0.4/0.6% on luma, with greater losses for chroma.

This version still used 16 offsets, and the adopted reduction of the number of offsets to 4 should mitigate the losses reported with interleaving.

The proposal limits the maximum number of different offsets per picture to 1024.

The HM uses a quadtree with a maximum depth of 4 that does not reach below the LCU level. This would probably be more efficient when the LCU size is smaller.

The use of bypass mode should be studied.

Decision: Adopt this modified form of H0273. When not interleaved, the control data should be sent in the APS (not using a quadtree), and the APS must be static for the entire picture.

It was remarked that the APS cannot be parsed without the SH or SPS.

Decision: Put a loop quantity indicator in the APS as necessary to enable parsing it without the SH or SPS.

It was noted that the text impact for the H0273 and H0274 related adoptions is relatively high. The contributors worked with the chief editor during the meeting to allay these concerns for H0273.

Concerns remained expressed for H0274; however, the contributors indicated their willingness to substantially assist with editorial improvement of the text for H0274.

In was noted that the availability of suitable text is a fundamental requirement in our work (see also section 7.1 in this regard).

Further study of additional simplifications (e.g. of H0067), quadtree syntax, and other aspects in CE or AHG was requested.

JCTVC-H0716 Crosscheck of JCTVC-H0067 on "Non-CE8.a.2: SAO with LCU-based syntax" [C. Auyeung (Sony)] [late 02-04]

JCTVC-H0711 Cross-verification of Non-CE8.a.2: SAO with LCU-based syntax (JCTVC-H0067) [W.-S. Kim, M. Zhou (TI)] [late]

JCTVC-H0088 Non-CE8.a.2: Cross-check of SAO with LCU-based syntax (JCTVC-H0067) [T. Nishi, K. Uchibayashi (Panasonic)] [late]

JCTVC-H0114 Non-CE8: Sample adaptive offset with constrained ranges of edge offset [E. Alshina, A. Alshin, J. H. Park (Samsung), I. S. Chong, M. Karczewicz (Qualcomm), C.-M. Fu, C.-I. Chen, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)]

This contribution was discussed as recorded above in relation to CE8 related contributions.

JCTVC-H0183 Non-CE8: Cross-check report for sample adaptive offset with constrained ranges of edge offset (JCTVC-H0114) [T.Chujoh (Toshiba)] [late]

JCTVC-H0115 Sample adaptive offset in Low Complexity test [E. Alshina, A. Alshin, J. H. Park (Samsung)]

In this contribution, performance test results were provided for enabling Sample Adaptive Off-Set (SAO) relative to the LC test configuration. On top of HM5.0, SAO reportedly provides 1.0% (AI-LC), 2.1% (RA-LC), 3.6% (LD-LC), 8.4% (LP-LC) average Luma BD bit rate gain, and some higher Chroma BD bit rate gain. The motion compensation (MC) part complexity measurement reportedly shows 2% reduction of multiplications and 1% average memory bandwidth reduction when SAO is enabled.

It was asserted that the denoising effect of SAO caused the encoder to choose the "more difficult" motion compensation fractional positions less often, thus achieving an asserted reduction in overall average complexity of the motion compensation process (as measured by multiplies, adds, and memory accesses).

The cross-checker confirmed that the measurements were accurate and that the statistics of the motion vectors had changed. The cross-checker also suggested that SAO may be useful for low-complexity ME encoders that do not fully search for fractional positions.

The contributor indicated that similar effects are observable with ALF (although ALF has more complexity).

The contributor proposed to include SAO in LC configurations.

JCTVC-H0579 Cross-verification of sample adaptive offset in low complexity test (JCTVC-H0115) [K. Chono, H. Aoki (NEC)] [late]

JCTVC-H0201 Non-CE8: Method of removing boundary artefacts for SAO [T.Matsunobu, H. Sasai, T. Nishi (Panasonic)]

In this contribution, some visual artefacts associated with SAO in HM5.0 were reported, and an approach to remove the artefacts was proposed. The artefact was reportedly observed at SAO partition boundaries and category boundaries. In the proposal, a "weak" offset value is proposed to be added to reconstructed samples along the boundaries. It was reported that the artefact was not observed when this proposal is applied on top of HM5.0. Experimental results reportedly showed that the proposed changes can be introduced on top of HM5.0 with 0.1%-0.3% average BD bit rate loss for the common test conditions.

Two methods were proposed for the artefact removal:

- Weakening the offsets near partition boundaries
- Weakening the offsets near category boundaries

The proposed approaches might seem to increase complexity. The cross-checker said that the category boundary approach would not add much complexity, but he did not know which might be enough or whether both might be needed.

It was commented that the artefact is associated with band offsets, that a modification of the band offsets had been adopted that may mitigate the problem, and that an encoder constraint to avoid large differences at boundaries may be sufficient to deal with the problem.

We would definitely want to conduct further study to determine whether there is still such a problem, and if there is a non-normative way to fix it (without degrading visual quality), we would want such a fix in our reference software encoder. Further study was certainly encouraged.

AHG or CE work on the study of visual quality of in-loop filtering was planned.

JCTVC-H0439 Cross-verification of Non-CE8: Method of removing boundary artefacts for SAO (JCTVC-H0201) [W.-S. Kim, D.-K. Kwon (TI)] [late]

JCTVC-H0438 Non-CE8: New Chroma Band Offset (BO) Design in SAO [W.-S. Kim, D.-K. Kwon (TI), Y. Yasugi, T. Ikai (Sharp)]

This contribution was discussed as recorded above in relation to CE8-related contributions.

JCTVC-H0338 Non-CE8: Crosscheck for Sharp and TI BO in JCTVC-H0438 [C.-M. Fu, Y.-W. Huang (MediaTek)] [late]

JCTVC-H0552 Non-CE8: Modified EO offset operation and offset quantization [K. Minoo, D. Baylon (Motorola Mobility)]

In the HM5.0 process, an offset is added to each pixel in attempt to reduce the distortion of the reconstructed pixel relative to the original pixel. In this contribution, the operation in which the offset is applied to the pixel is modified, and the offsets are quantized.

See also the related contribution H0557.

It was commented that the analysis seemed correct and would resolve any potential "salt and pepper noise" issue, but would increase complexity.

The contributor indicated that, with the removal of the sign bit, the complexity of the clipping might be less. Further study was highly encouraged.

JCTVC-H0553 Non-CE8: Harmonization of LCU-based SAO [K. Minoo, Y. Yu, D. Baylon, L. Wang (Motorola Mobility)]

This contribution was discussed as recorded above in relation to CE8-related contributions. No simulation results were in the contribution. A revision was later uploaded to include simulation results.

The decoder would determine a min/max range over the LCU, avoiding the need for signalling.

It was remarked that this seemed promising. Further study was encouraged in a CE or AHG.

JCTVC-H0708 Non-CE8: Crosscheck for Motorola Mobility harmonization of LCU-based SAO in JCTVC-H0553 [C.-M. Fu, Y.-W. Huang (MediaTek)] [late 02-05]

JCTVC-H0406 Flexible Band Offset Mode in SAO [E. Maani, O. Nakagami (Sony)]

This contribution was discussed as recorded above in relation to CE8-related contributions. No working draft text was in the contribution.

JCTVC-H0617 Cross-verification of Flexible Band Offset Mode in SAO (JCTVC-H0406) [W.-S. Kim, M. Zhou (TI)] [late]

5.8.3 Combined approaches

JCTVC-H0277 Non-CE8: Additional simulation results of SAO and ALF [T.-D. Chuang, Y.-W. Chen, J.-L. Lin, Y.-W. Huang, S. Lei (MediaTek)]

5.9 NSQT/SDIP harmonization

Note AHG report JCTVC-H0016.

JCTVC-H0347 AHG16: SDIP unified with NSQT [X. Cao, Y. He (Tsinghua), X. Peng (USTC), C. Lai, X.Zheng, L. Liu, J. Zheng (HiSilicon), J. Xu (Microsoft), H. Yang, J. Song, H. Yu (Huawei), J. Lim, B. Jeon (LGE), J. Sole, L.Guo, X. Wang, M. Karczewicz (Qualcomm), J. Xu, E. Maani, A. Tabatabai (Sony), X. Zhang, S. Liu, S. Lei (MediaTek)]

This contribution reported the results of a unification of SDIP and NSQT. SDIP with 2NxN/Nx2N and 2NxhN/hNx2N PU were tested with the same non square TUs as with NSQT. Results with or without 8x2/2x8 TUs were also reported. For the all-intra HE case, when 2x8/8x2 TU are used, 1.8% and 1.7% gain can be achieved with 128% and 130% encoding time increases for SDIP with 2NxN/Nx2N PU and SDIP with 2NxhN/hNx2N PUs, respectively. Without 2x8/8x2 TUs, for SDIP with 2NxN/Nx2N PUs and SDIP with 2NxhN/hNx2N PUs, the gain is 1.0% and 1.0%, with 117% and 119% encoding time increases. No obvious decoding time increase was reportedly observed. Note: "hN"="Half N".

Some reservations were expressed against 2x8 and 8x2 modes. These are also not in harmony with the current non-square inter coding.

It was asked how de-blocking is done. This was said to be at 8x8 boundaries, as in NSQT.

For intra-only coding without 8x2, no remarkable difference between Nx2N and hNx2N was reported.

Two WD texts were included – one for Nx2N, one for hNx2N. Neither of them includes 2x8/8x2.

For RA coding, the BD BR gain is 0.9% with the 2x8/8x2 modes, and 0.4% without (Nx2N/2NxN), and a little bit more for hNx2N.

More information was requested to understand what are the detailed changes.

The encoder implementation uses an early skip decision for non-square blocks.

A short review of the WD text version for Nx2N was done which unveiled that various changes are necessary to the decoding process of intra (PU, MPM, mode derivation, transform, deblocking filter).

A new version was also shown which had not yet been uploaded.

Concerns were expressed about the maturity of the text, the amount of changes and implications on decoders, and also about the complexity of encoders. No action was taken.

JCTVC-H0106 AHG16: Crosscheck of SDIP and NSQT harmonization (JCTVC-H0347) [T. Yamamoto (Sharp)] [late]

JCTVC-H0300 AHG16: Crosscheck of SDIP and NSQT unification (JCTVC-H0347) [Y.J. Chiu, L. Xu, W. Zhang, Y. Han (Intel)]

JCTVC-H0455 AHG16: Harmonization of 2NxN/Nx2N Intra PU with SDIP and NSQT [X. Zhang, S. Liu, C.-W. Hsu, T.-D. Chuang, S. Lei (MediaTek)]

This contribution proposed a set of methods for harmonization of 2NxN/Nx2N PUs with SDIP and NSQT. The coding efficiency and run-time of the proposed methods built on top of AHG16 software were reported. Experimental results reportedly average 1.8% BD bit rate reduction for All Intra HE with encoding runtime increased by 32% and decoding runtime increased by 3% with 8x2/2x8 transforms enabled. Experimental results reportedly average 1.4% BD bit rate reduction for All Intra HE with encoding runtime increased by 31% and decoding runtime increased by 2% when 8x2/2x8 transform was

disabled. With further encoder complexity reduction, experimental results reportedly average 1.2% BD bit rate reduction for All Intra HE with encoding runtime increased by 23% and decoding runtime increased by 2%. By applying the proposed PU type signalling method on 2Nx0.5N/0.5Nx2N intra prediction units, experimental results reportedly average 0.0% BD bit rate difference for All Intra HE with negligible encoding and decoding runtime changes compared to AHG16 software. Two context models were removed.

No WD text was available, but it was said that it would be identical to the text of JCTVC-H347 (the variation with Nx2N).

JCTVC-H0302 AHG16: Crosscheck of MediaTek harmonization of 2NxN/Nx2N Intra PU with SDIP and NSQT (JCTVC-H0455) [Y. J. Chiu, L. Xu, W. Zhang, Y. Han (Intel)] [late]

JCTVC-H0558 Cross-Check of AhG16: SDIP [Ankur Saxena, F. Fernandes (Samsung)] [late]

JCTVC-H0492 Clean-up of NSQT implementation [Y. Yuan (Tsinghua), X. Zheng (HiSilicon), H. Yu (Huawei), Y. He (Tsinghua)]

This contribution provided a proposal of NSQT implementation. In particular, the proposed solution reportedly merged the derivation of square and non-square TU address derivation, removed redundant codes related to non-square transform block operation, and unified the software design of square and non-square transformation process. After the clean-up, nearly 1000 lines of code could reportedly be removed relative to HM5.0, and the coding styles of square quadtree and non-square quadtree could be made more consistent.

This removed approximagely 1000 lines of code by unifying square and non-square transform usage. A slight deviation of results was reported, due to a bug fix in BS calculation. This was confirmed by a cross-checker.

Decision (SW): Adopt (software only).

JCTVC-H0605 Cross-check of JCTVC-H0492 on Clean-up of NSQT implementation [E. François (Canon)] [late]

5.10 Block structures and partitioning

5.10.1 RQT

JCTVC-H0315 Non-CE2: Separate RQT structure for Y, U and V components [J. An, X. Zhao, X. Guo, S. Lei (MediaTek)]

This contribution proposes a method using separate residue quad tree (RQT) structure for Y, U and V components. In HM5.0, the splitting transform unit (TU) information, signalled at TU level, is shared by Y, U and V components. In the proposed method, the splitting information of Y, U and V is signalled separately. Moreover, the maximum RQT depth values indicated in the sequence parameter set (SPS) are also separated for luma and chroma. It was reported that, by setting the proposed maximum chroma RQT depth to one, 1%~5% BD bit rate reduction was achieved for chroma. It was also reported that more BD

bit rate reduction was achieved for chroma by setting the maximum chroma RQT depth greater than one. The run time was reported to be similar to HM5.0.

The suggestion in this proposal was to define separate split flags for Y, Cb, Cr.

Gain of 1-3% for chroma BD BR were reported, sometimes higher.

Increased encoder complexity was noted. No action was taken on this.

JCTVC-H0542 Non-CE2: Cross-verification of Separate RQT for Y,U and V from MediaTek (JCTVC-H0315) [L. Guo (Qualcomm)] [late]

JCTVC-H0123 RQT: Merge transform_tree and transform_coeff [Y. Shibahara, T. Nishi (Panasonic)]

This contribution proposed to merge the transform tree syntax and transform coefficient syntax for simplification. In WD5.0, split_transform_flag and coded_block_flag are coded in transform_tree, and transformed coefficients are separately coded in transform_coeff even though the structure of these two trees is reportedly identical. An experimental result reportedly shows negligible differences in coding efficiency (in the range of 0.001%) with no increase in software runtime relative to HM5.0 for all configurations in the common test conditions.

This was a request to attach encoded transform coefficients to the transform tree. It proposed a reordering of the bitstream, with no change in bit rate.

This would allow to remove significant redundancy from the WD description.

One of the main reasons to have this the way it is was the existence of two entropy coders with different coding of transform coefficients.

It was asled where the chroma cbf is sent, and whether there would be implications when the chroma tree has a different depth (as considered in CE2).

It was commented that there could be a problem with the position of delta-QP signalling.

It was remarked that this change was desirable, although it requires a substantial amount of changes.

Decision: Adopt

Clarification is needed regarding whether this interferes with potential adoption of CE2 (different chroma RQT depth) – the proponent of H0123 was asked to work with CE2 proponents to clarify the situation, although it was agreed that adoption of H0123 has a higher priority than CE2 (both for software and draft text, and that a unified tree must be the basis for any CE2-related subsequent modification).

JCTVC-H0128 Cross-Check of H0123 on merge transform tree and transform coefficient [A. Saxena, E. Alshina, F. Fernandes (Samsung)] [late]

5.10.2 Coding of LCU/TU/PU

Note that some contributions in this area relate to high-level syntax – see also section 5.13.

JCTVC-H0154 Side information signalling improvement for TU [B. Lee, M. Kim (KAIST)] [late]

No need to be presented.

JCTVC-H0664 Cross check of KAIST proposal JCTVC-H0154 [J. Kim, C. Kim (LGE)] [late]

JCTVC-H0202 PU structure for intra NxN [H. Nakamura, S. Fukushima (JVC Kenwood)]

The PU structure for intra NxN is reportedly not clear in the HM5.0 implementation. Moreover, the WD5 description reportedly does not match the HM5.0 software implementation.

This contribution recommended that the prediction unit syntax described in the text should correspond to the HM software implementation, with the smallest possible changes.

It was suggested to change both the draft text and the HM software somewhat. The prediction information for both luma and chroma prediction blocks in the same location was proposed to be coded in the same prediction unit. More specifically, each of the intra prediction modes for each luma and chroma prediction block having partition index PartIdx equal to 0 would be coded in the same prediction unit in the case of PART_NxN as well as PART_2Nx2N.

The HM5 software reportedly defines the intra chroma PU independent of luma, but this is deviating from the WD text. Additionally, it was proposed to modify the coding order

Furthermore, a structure for cases of 4:4:4, 4:2:2 and 4:0:0 chroma sampling were proposed.

Conclusion: It is necessary to align the text and software (and the software has been more well established thus far), but there is no argument for making the proposed modification of coding order, 4:4:4, etc. Colour formats not currently fully addressed in the design.

JCTVC-H0638 Cross-check report on PU structure for intra NxN (JCTVC-H0202) [I.-K. Kim (Samsung)] [late]

JCTVC-H0269 AHG15: Independent control of Max CU and LCU size for small LCU [J. B. Choi, J. H. Kim, K. H. Lee, J. H. Park, C. Kim (Samsung)]

The LCU sizes have a significant impact on the HEVC codec data flow and architecture. The LCU size of 64x64 has been selected as a good trade-off between coding gain and complexity. Smaller LCU sizes such as 16x16 have been used in several previous standards. A modification of the min and max CU size was proposed in the high level syntax to compensate for coding loss caused by using a smaller LCU size. The results reportedly show -0.3/-0.3/-0.4 for AI HE, -0.6/-0.5/-0.4 for RA HE, and -0.9/-0.6/0.0 for LD HE impacts, compared to 32x32 LCU, and -1.0/-1.1/-1.3 for AI HE, -2.1/-1.5/-1.5 for RA HE, and -2.7/-1.4/2.5 for LD HE, compared to using a 16x16 LCU.

It was suggested to modify the max/min CU sizes independent of the BPU size – e.g. LCU could be smaller than BPU.

Gain was reported when compared to HM encoding with 32x32 LCU = BPU, and keeping BPU = 64x64 (not compared to LCU = BPU = 64, which are the common test conditions).

However, it was asked why one would use a smaller LCU than the BPU, and commented that this may have implications on slice definition. There was no support for this from other experts.

JCTVC-H0623 AHG15: Crosscheck of JCTVC-H0269 on independent control of Max CU and LCU size for small LCU [Y. Jeon, B. Jeon (LG)] [late]

5.11 Motion compensation operation and interpolation filters

A BoG coordinated by T. Chujoh was requested to review the 5 proposals and 3 cross-checks in this area. The BoG report was submitted as H0729.

JCTVC-H0729 BoG report on motion compensation operation and interpolation filters [T. Chujoh]

In regard to JCTVC-H0180, the BoG indicated that the quality of the current interpolation filters in the HM has been verified.

In regard to JCTVC-H0610, the BoG indicated that the analyses of the filter coefficients are very useful.

In regard to JCTVC-H0569, the BoG recommended further study if a profile is defined that does not include SAO and ALF.

In regard to JVTVC-H0304, the BoG noted that the contribution was missing at the time of the BoG discussion.

In regard to JCTVC-H0401, the BoG recommended that its experiment should be conducted, and recommended further study.

In regard to JCTVC-H0546, the BoG indicated that the point of proposal has been understood, and that there might be some benefits for hardware implementation, and recommended further study.

5.11.1 Interpolation filters and MV precision (ref CE3)

JCTVC-H0180 Non-CE3: Phase adjustment of interpolation filter [T. Chujoh, T. Yamakage (Toshiba)]

JCTVC-H0610 Non-CE3: Cross-check for phase adjustment of interpolation filter (JCTVC-H0180) by Samsung [E. Alshina, A. Alshin, J. H. Park (Samsung)] [late]

JCTVC-H0569 Non-CE3: An Adaptive Interpolation Filtering Technique for Improved Subjective Quality in the Low Complexity Configuration [F. Kossentini, N. Mahdi, H. Guermazi, M. Horowitz, S. Xu (eBrisk Video Inc.)]

JCTVC-H0207 Non-CE3: Crosscheck of JCTVC-H0569 : an AIF for low complexity configuration [J. Park, Hendry, B. Jeon (LG)]

5.11.2 Prediction methods

JCTVC-H0401 Differentiated weighting parameter sets for weighted prediction [J. Xu (Sony), A. Tourapis (Magnum), A. Tabatabai (Sony)]

JCTVC-H0546 On weighted prediction precision [M. Coban, M. Karczewicz (Qualcomm)]

JCTVC-H0643 Cross-check of weighted prediction precision reduction (JCTVC-H0546) [A. Tanizawa, T. Chujoh, T. Yamakage (Toshiba)] [late]

5.12 Motion and mode coding

JCTVC-H0709 BoG Report on MV Coding [B. Bross]

Contributions relating to motion and mode coding were reviewed in a BoG coordinated by B. Bross. Notes regarding the contributions reviewed and the discussions held in this BoG were included in the BoG report.

The BoG recommended adopting the following:

- Merge estimation region syntax (JCTVC-H0082)
- One merge candidate list for all partitions inside a 8x8 CU (JCTVC-H0240 Variant 2 conditioned on log2_parallel_merge_level_minus2 > 0 as described in H0082 section 6)
- Setting the merge TMVP refidx to 0 for the non-first partition (JCTVC-H0278 / JCTVC-H0199)
- Removing non-scaled bi-predictive merging candidates (JCTVC-H0250 / JCTVC-H0164)
- Clipping scaled MV to 16 bit and adjust it according to profile/level decisions (JCTVC-H0216 / JCTVC-H0555)
- Removing the list empty check and the duplicate check in AMVP for zero motion vector (JCTVC-H0239)
- Removing redundant spatial candidates check in AMVP (JCTVC-H0316 first part)
- Fix AMVP non-scaled/scaled candidate WD/HM mismatch by correcting the WD (JCTVC-H0462)
- Motion prediction at entropy slice boundary (JCTVC-H0362)
- Limiting Collocated Temporal Reference to One Per Picture (JCTVC-H0442)
- Modification of bi-prediction syntax CE9 BP08 (JCTVC-H0111)

Further investigation was recommended on

- Improvement to parallel merge estimation JCTVC-H0082 (JCTVC-H0090)
- Effect of Setting the merge TMVP refidx to 0 for the non-first partition on NxN partitions (JCTVC-H0278, JCTVC-H0092, JCTVC-H0214, JCTVC-H0430)
- CU-based parallel inter mode (JCTVC-H0279)
- Slice level enable_temporal_mvp_flag and marking process (JCTVC-H0570)
- AMVP non-scaled/scaled candidate WD/HM mismatch by changing HM (JCTVC-H0462)

In the discussion of the BoG report in Track A, regarding H0082 and H0090, it was agreed to adopt H0082, but reluctance was generally expressed regarding the potential for H0090 due to the desire to keep the decoder impact to a minimum for enabling this encoder parallelism.

There was also some Track A discussion of H0111 and H0431 in the context of discussion of the BoG report, although the group ultimately decided to agree with the BoG recommendation in that regard. Remarks of that discussion included the following:

- H0111 is also a customization for a particular type of encoding, which is the type of encoding done by the HM in the context of uni-directional biprediction. More extensive searching in the HM context could give 0.7% improvement of GPB (with 30% increase in runtime), and encoder-only modification without more extensive searching could give 0.2%, and the proposed modification give 1% – all in the LB context. To some extent the question may be how important we consider the LB usage case to be.
- Another proposal H0431 suggested to separate the context models for the zero value of the motion vector differences into three cases: uniprediction, List 0 in bipred, and List 1 in bipred. It seems to have about the same gain when used the same way, but appears to be a more general approach rather than a customization to one specific encoding method which *always* sets the list 1 motion vector to 0 (by measuring statistics rather than forcing one value all the time). The text for this proposal had some problems.

It was indicated that text was nearly fully developed for the actions recommended in the BoG report, and that such text would be uploaded as a revision of the report. Decision: Adopt BoG recommendations as described above.

Regarding further investigation, the BoG had requested for the JCT-VC to decide whether a continuation of the prior CE9 should be established versus having all further study should be performed in an AHG.

Although further study of some items was encouraged, there seemed to be no need for a CE on this topic for the next meeting cycle.

5.12.1 Parallel skip/merge

JCTVC-H0082 AHG10: Configurable and CU-group level parallel merge/skip [M. Zhou (TI)]

JCTVC-H0580 AHG10: Crosscheck of TI Configurable and CU-group level parallel merge/skip (JCTVC-H0082 combination case) [T. Ikai (Sharp)] [late]

JCTVC-H0220 AHG10: Cross-check report of TI configurable and CU-group level parallel merge/skip (JCTVC-H0082) by Panasonic [T. Sugio, T. Nishi (Panasonic)] [late]

JCTVC-H0369 AHG10: Cross-check of configurable and CU-group level parallel merge/skip (JCTVC-H0082) [J. Xu (Microsoft)] [late]

JCTVC-H0681 AHG10: Cross-check of TI configurable and CU-group level parallel merge/skip (JCTVC-H0082) by Sony [J. Xu, A. Tabatabai (Sony)] [late]

JCTVC-H0090 **AHG10: Unified design on parallel merge/skip [Y. Jeon, B. Jeon (LG), M. Zhou (TI), X. Wen, O. C. Au (HKUST), H. Y. Kim (ETRI), K. Y. Kim (KHU)] [late]**

JCTVC-H0591 **AhG10: Cross-verification of JCTVC-H0090 on unified design on parallel merge/skip [V. Seregin, X. Wang, J. Chen (Qualcomm)] [late]**

JCTVC-H0092 **Non-CE9: Removing PU dependency in TMVP reference index derivation [Y. Jeon, B. Jeon (LG), V. Seregin, X Wang, J. Chen, M. Karczewicz (Qualcomm)]**

JCTVC-H0087 **Non-CE9: Cross-verification of removing PU dependency in TMVP reference index derivation (JCTVC-H0092 from LGE and Qualcomm) [M. Zhou (TI)]**

JCTVC-H0199 **Non-CE9: Derivation process of reference indices for temporal merging candidates [H. Nakamura, S. Fukushima (JVC Kenwood)]**

JCTVC-H0218 **Non-CE9: Cross-check report of JVC Kenwood modified derivation process of the reference index for temporal merging candidate (JCTVC-H0199) by Panasonic [T. Sugio, T. Nishi (Panasonic)] [late]**

JCTVC-H0214 **Non-CE9: Modification of derivation process for the reference index for temporal merging candidate [T. Sugio, T. Nishi (Panasonic)]**

JCTVC-H0093 **Non-CE9: Crosscheck of Panasonic proposal on TMVP refIdx derivation in merge/skip (JCTVC-H0214) [Y. Jeon, B. Jeon (LG)]**

JCTVC-H0247 **AHG10: Unified design on parallel merge/skip [H. Y. Kim (ETRI), K. Y. Kim (KHU), Y. Jeon, B. Jeon (LG), M. Zhou (TI), X. Wen, O. C. Au (HKUST)] [late]**

JCTVC-H0635 **Cross verification of AHG10: Unified design on parallel merge/skip with reduced candidates [C. Kim (Samsung)] [late 02-02]**

JCTVC-H0278 Non-CE9: CU-based parallel merge mode [J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)]

JCTVC-H0592 Non-CE9: Cross-verification of JCTVC-H0278 on CU-based parallel merge mode [V. Seregin, X. Wang, J. Chen (Qualcomm)] [late]

JCTVC-H0649 AHG10: Cross Check for JCTVC-H0010 PME A [X. Wen, O. Au (HKUST)] [late 02-02]

JCTVC-H0676 Cross verification of crosscheck of AHG10 (JCTVC-H0010) HM5 PME B [Jongbum Choi (Samsung)] [late 02-02]

5.12.2 MV and mode coding

JCTVC-H0077 Non-CE9: Merge candidates pruning without reference indices [S. Fukushima, K. Arakage (JVC Kenwood)]

JCTVC-H0365 Non-CE9: Cross-verification of merge candidates pruning without reference indices (JCTVC-H0077) [B. Li (USTC), J. Xu (Microsoft)]

JCTVC-H0078 Non-CE9: Simplification of AMVP spatial candidate derivation [S. Fukushima, H. Nakamura, H. Takehara (JVC Kenwood)]

JCTVC-H0340 Non-CE9: Crosscheck for JVC Kenwood simplification of AMVP spatial candidate derivation in JCTVC-H0078 [J.-L. Lin, Y.-W. Huang (MediaTek)] [late]

JCTVC-H0091 Non-CE9: Parallel Merge Candidate Derivation for Inter_NxN partition type [Y. Jeon, B. Jeon (LG), V. Seregin, X Wang, J. Chen, M. Karczewicz (Qualcomm)]

JCTVC-H0219 Non-CE9: Cross-check report of parallel merge candidate derivation for Inter_NxN partition type (JCTVC-H0091) by Panasonic [T. Sugio, T. Nishi (Panasonic)] [late]

JCTVC-H0133 **Non-CE9: Merge candidates pruning without TMVP [H. Takehara, K. Arakage, S. Fukushima (JVC Kenwood)]**

JCTVC-H0139 **Non-CE9: Cross-verification of Merge candidates pruning without TMVP (JCTVC-H0133 from JVC Kenwood) [Y. Suzuki (NTT Docomo)]**

JCTVC-H0164 **Non CE9: Removing non-scaled bi-predictive merging candidates [Y. H. Tan, C. Yeo, H. L. Tan, Z. Li (I2R)]**

JCTVC-H0216 **Non-CE9: Modification of derivation process for MVP candidate in AMVP/Merge [T. Sugio, T. Nishi (Panasonic)]**

JCTVC-H0086 **Non-CE9: Cross-verification of modification of derivation process for MVP candidate in AMVP/Merge (JCTVC-H0216 from Panasonic) [M.Zhou (TI)]**

JCTVC-H0239 **Non-CE9: Simplification on AMVP list construction [S.-C. Lim, H. Y. Kim, J. Lee, J. S. Choi (ETRI)]**

JCTVC-H0634 **Non-CE9: Cross-check report of ETRI simplification on AMVP list construction (JCTVC-H0239) by Panasonic [T. Sugio, T. Nishi (Panasonic)] [late]**

JCTVC-H0240 **Non-CE9: Throughput improvement for merge/skip mode [H. Y. Kim (ETRI), K. Y. Kim, S. M. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee, S. Cho, J. S. Choi (ETRI)]**

JCTVC-H0629 **Non-CE9: cross-check of H0240 on throughput improvement for merge/skip mode [P. Onno (Canon)] [late]**

JCTVC-H0250 **Non-CE9: Removal of non-scaled merge candidate [O. Bici, J. Lainema, K. Ugur (Nokia)]**

JCTVC-H0368 **Non-CE9: Cross-check of removal of non-scaled merge candidate (JCTVC-H0250) [J. Xu (Microsoft)]**

JCTVC-H0279 **Non-CE9: CU-based parallel inter mode [J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)]**

JCTVC-H0585 **Non-CE9: cross-check of JCTVC-H0279 on CU based parallel Inter [J. Jung (Orange Labs)] [late]**

JCTVC-H0316 **Non-CE9: Simplification of AMVP [L. Zhao, X. Guo, S. Lei (MediaTek), S. Ma, W. Gao (PKU), D. Zhao (HIT)]**

JCTVC-H0606 **Non-CE 9: Cross-Check of H0316 on simplification of AMVP [Ankur Saxena, F. Fernandes (Samsung)] [late]**

JCTVC-H0429 **Non-CE9: Moving fifth spatial MV candidate after TMVP for merge mode [V. Seregin, X. Wang, J. Chen, M. Karczewicz (Qualcomm)]**

JCTVC-H0341 **Non-CE9: Crosscheck for Qualcomm merge list reordering in JCTVC-H0429 [Y.-W. Chen, Y.-W. Huang (MediaTek)] [late]**

JCTVC-H0430 **Non-CE9: Single TMVP for merge mode [V. Seregin, X. Wang, J. Chen, M. Karczewicz (Qualcomm)]**

JCTVC-H0582 **Non-CE9: Crosscheck of JCTVC-H0430 on single TMVP for merge mode [Y. Jeon, B. Jeon (LG)] [late]**

JCTVC-H0431 **Non-CE9: Splitting contexts for MVD coding [V. Seregin, J. Chen, X. Wang, M. Karczewicz (Qualcomm)]**

JCTVC-H0640 **Cross-check report on Splitting contexts for MVD coding [I.-K Kim (Samsung)] [late]**

JCTVC-H0442 **Limiting Collocated Temporal Reference to One Per Picture [T. Hellman, W. Wan (Broadcom)]**

JCTVC-H0548 Signalling of collocated picture for HEVC [Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)]

This contribution was reviewed in Track A (on 6 Feb.) rather than in the BoG that studied the other related contributions.

In the current working draft of HEVC, a flag, collocated_from_l0_flag, is used to explicitly indicate that the collocated picture is a picture specified in either list0 or list1. In this proposal, it was proposed to remove collocated_from_l0_flag for the low delay case because this flag was asserted to be redundant.

If ref_pic_list_combination_flag is equal to 0, the collocated_from_l0_flag would not be present in the syntax. This seemed like a low-priority case to consider for syntax optimization at this stage.

Furthermore, it was proposed to add a flag at the sequence level to indicate that only one picture's motion information (i.e. the most recent coded reference picture) is kept at any given point in the decoding process for collocated picture purposes, instead of keeping the motion information for multiple pictures as in the current working draft. This was suggested to save memory for low delay applications without any performance impact if multiple reference pictures are used. Simulation results reportedly show that there is no PSNR change for every slice while saving one bit per slice.

It was also proposed to remove the collocated_ref_idx when the SPS-level flag is true – as the collocated picture would be identified implicitly.

No semantics were supplied for the proposed syntax.

It was remarked that unless we mandate setting the SPS-level flag in some profile, decoders would be required to provision for the extra memory capacity anyway.

No action was taken on this proposal.

JCTVC-H0695 Cross check report of Motorola Mobility proposal JCTVC-H0548 [Y. He (InterDigital)] [late 02-03]

JCTVC-H0570 AHG14/AHG15/non-CE9: Loss robustness issue in TMVP disabling [V. Wahadaniah, C. S. Lim (Panasonic)]

JCTVC-H0243 Simplification of spatial motion vector scaling process [I.-K Kim, J. H. Park (Samsung)]

JCTVC-H0362 Motion prediction at entropy slice boundary [B. Li (USTC), J. Xu (Microsoft), H. Li (USTC)]

JCTVC-H0462 Spatial Motion Vector Predictor Mismatch and Possible Unintended Behavior [B. Heng, P. Chen, W. Wan (Broadcom)]

JCTVC-H0555 Range restriction of motion vector predictor [J. Chen, M. Coban, M. Karczewicz (Qualcomm)]

5.13 High-level syntax and slice structure

5.13.1 High-level systems usage of bitstreams

JCTVC-H0423 Indication of the temporal structure of coded video sequences [M. M. Hannuksela, S. M. Gopalakrishna (Nokia)]

The contribution discusses the topic of describing the temporal structure of coded video sequences, which was proposed earlier in documents JCTVC-D200 and JCTVC-E279. A primary use case for knowing the temporal structure *a priori* is to assist trans-raters and bitstream extractors in pruning the coded video sequence.

By referring to the reference picture set index, the proposal is asserted to provide a more accurate description of the temporal structure than what was proposed in JCTVC-D200 and JCTVC-E279. Furthermore, by specifying the temporal structure in the sequence parameter set, it is reportedly possible to omit certain syntax elements from the slice header and hence reduce the bit count of the slice header.

The proposal can be considered to consist of the following ingredients:

- The short term reference picture set syntax structure is moved from PPS to SPS.
- A "structure of pictures" (SOP) description syntax structure is added in the SPS. The syntax structure describes a SOP in decoding order.
- A coded video sequence can be described as part of the SPS with reference to described SOPs.
- When the SOP description is used, the slice header includes a SOP index referring to a particular SOP description and a picture index within the SOP structure. Certain syntax elements of the slice header are excluded provided that the SOP description is used.

It is asserted that up to about 3% bit rate savings may be possible at a selected low bit rate and high frame rate relating to the test case "dyadic and nested temporal scalability for high frame rate" in the common test conditions specified in JCTVC-G1036, while typical bit rate savings are expected to be an order of magnitude smaller.

It was noted that, when used, having such a structure established in the SPS would prohibit adaptive structuring decisions within the CVS. If it is sent at the picture level (e.g. in SEI), an encoder could make dynamic changes.

A participant commented that a possible approach could be to have syntax in the SPS which establishes a default behaviour that can be overridden at the PPS or slice level.

A suggestion was to put this syntax in the PPS instead of in the SPS.

The proposal would remove from the slice header the slice_type, pic_order_cnt_lsb, and all reference picture set syntax. Long-term reference pictures would not be supported when the SOP syntax is used.

The proposal seemed interesting to the group.

Some modifications were made in a revision of the contribution, which put the syntax in the PPS to enable greater flexibility.

In subsequent discussion, placing the multiple SOP descriptions and RPSs in the SPS was suggested.

In subsequent discussion, it was commented that the value of this information may be limited (e.g. for trans-raters and bitstream extractors) if it is not guaranteed that the pictures in the bitstream will use it.

Just establishing descriptive information about the characteristics of a CVS could be accomplished with VUI or SEI or file/system-level metadata, whereas this also uses those characteristics to improve coding efficiency. The coding efficiency improvement, at least in typical uses, seemed minimal/negligible.

The proposed degree of rearchitecting of normative high-level syntax for this purpose seemed unnecessary. Some metadata approach (perhaps as VUI with a presence flag) was suggested as the appropriate way forward.

Moving the multiple-RPS sending from the PPS to the SPS was suggested, which seemed like a good idea. Decision: Agreed. (J. Samuelsson volunteered the editing effort.)

The metadata approach was worked on offline, and a revision was uploaded (-v4). It proposed an SEI message syntax. Decision: Adopted.

The additional suggestion was made to include the display orientation SEI message as has been currently planned for inclusion in AVC in both parent bodies (see prior JCTVC-G079, VCEG-AR12, and MPEG m23499 and ISO/IEC 14496-10/PDAM 1). Decision: Adopted.

JCTVC-H0496 On bitstreams starting with CRA pictures [Y. -K. Wang, Y. Chen, M. Karczewicz (Qualcomm)]

This document re-proposed the proposal in JCTVC-G319. In the current HEVC design, "clean random access" (CRA) pictures are identified by a new NAL unit type. It is anticipated to be very common that a device with a conforming decoder would perform random access at a CRA picture. However, a bitstream starting at a CRA picture is considered non-conforming, thus a formally-conforming decoder may not actually be able to properly handle such bitstreams.

In this proposal, it was proposed to specify that a bitstream starting from a CRA picture could be conforming. Such a conforming bitstream may or may not contain "leading pictures" associated with the CRA picture. A leading picture associated with a CRA picture is a coded picture that follows the CRA picture in decoding order but precedes the CRA picture in output order. The proposed normative changes include: 1) skipping the decoding and output of the leading pictures associated with the starting CRA picture, when present; and 2) HRD modifications to specify bitstream conformance conditions to be fulfilled by a conforming bitstream starting with a CRA picture, regardless of whether the leading pictures associated with the CRA picture are present.

It was commented that bitstream conformance may be a bit tricky to specify. A suggestion was to specify for a reference decoding process to be applied to the "leading pictures" as in the prior recovery point SEI message description, with enforcing conformance of the bitstream when that operates, and then discarding the final decoded picture without output of the "leading pictures".

A modification of the buffering period SEI message was proposed, to assist with the HRD CPB flow modification that is introduced if the "leading pictures" are removed from the bitstream.

It was asserted that there should be no problem with the case where the "leading pictures" are not removed from the bitstream.

It was first agreed that, in spirit, we would like to adopt this – except for the modification of the buffering period SEI message).

It was asked whether, if we allow a bitstream to start with a CRA picture, there is still a purpose for IDR pictures. Further study of that question was encouraged.

It was noted and agreed that a specification of SPS activation from a CRA picture is needed, and that POC needs to be established for the CRA picture.

It was suggested that "non-existing" is a better word than "missing".

Decision: Adopt (modified version, with SPS activation, with setting of MSBs of POC to zero for the starting CRA picture, and with a note to say that the aspects relating to "non-existing" pictures are unnecessary for obtaining correct output and are only specified for purposes of establishing bitstream conformance – i.e., decoders may simply discard all leading pictures without any attempt to decode them).

JCTVC-H0567 AHG15: Syntax controlled output process [J. Samuelsson, R. Sjöberg (Ericsson)]

This document proposes to add two syntax elements to the slice header to control the output process. A new output process was proposed to replace the "bumping" process, and it was claimed that the use of the proposed output process controlled by syntax elements in the slice header reduces unnecessary picture output delay. Further, it was claimed that the syntax-controlled output process is better suited for temporal scalability, since the encoder would not need separate decoder picture buffer (DPB) models for each temporal layer and since network nodes and decoders could rely on the proposed temporal layer switching information. The document describes how the flexible and efficient DPB usage provided by the "bumping" process is maintained by the proposed output process. A restriction was proposed to prohibit those cases that make the DPB status inconsistent among different temporal layers and that violate the concept of temporal layer switching points. It was also proposed that max_dec_frame_buffering and max_num_ref_frames can have different values for different temporal layers. The document also contains a proposed sequence parameter set (SPS) flag that it was asserted could be used to indicate the most common case of output process usage, when both output delay and DPB size is minimized. With the proposed SPS flag, the total bit rate increase for the common test conditions was reported to be one bit per sequence.

The contribution proposes having different max_dec_frame_buffering and max_num_ref_frames (if it exists – see below) for different temporal layers. It was commented that num_reorder_frames and max_latency_increase should be treated this way too. Decision: Agreed (to be expressed in a loop in SPS syntax).

It was commented that the bumping process should use num_reorder_frames and max_latency_increase, not just max_dec_frame_buffering. Decision: Agreed (depending on potential later decisions on related issues).

It was commented that we may no longer need max_num_ref_frames at all, since we no longer have a sliding window reference picture marking process. Decision: Remove it.

The contribution proposed to define a variable called OutputDistance for each picture (with a value sent at the slice level) and introduce a flag at the SPS level that can set that variable to 0 always, and to omit the slice-level syntax when the flag is set to 1. It was reported that the "always 0" case would be sufficient for most usage (and would be sufficient for our CTC).

It was asked whether the new syntax could be pushed up to the APS or PPS level, rather than residing in the slice header, and this seemed feasible.

It was remarked that this is only for output order based decoding, as it would not be needed for timestamp-based decoding operation.

Some participants expressed the view that such picture-level output control (using slice/APS/PPS-level syntax) did not seem really necessary and would be "overkill" (when considering the recent improvement in other high-level syntax for handling latency).

Further study was encouraged.

JCTVC-H0500 Bit depth of output pictures [Y. Chen, Y. -K. Wang, X. Wang, I. S. Chong, M. Karczewicz (Qualcomm)]

This document re-proposed the proposal in JCTVC-G328.

In the current HEVC design, the decoded picture and the output picture always have the bit depth as signalled in the bitstream (e.g., 10 bits), regardless of the bit depth of the hypothetical encoder input video (e.g., 8 bits). In this document, it is proposed that: 1) a conforming decoder would output a decoded video sequence with a target output bit depth (signalled in the bitstream); and 2) if the output bit depth is lower than the bit depth of the decoded pictures, it is asserted that better memory consumption can be achieved in a way that if a picture is never or no longer used for reference, it could be converted to a lower bit depth immediately.

It was intended for the proposal to affect the DPB capacity for picture storage – to make it dependent on the bit depth of the stored pictures. This part of the text was, however, missing from the proposal. The practicality of an actual decoder taking advantage of this was questioned.

The decoder would be required to perform bit depth downconversion by truncation. It was remarked that prohibiting more sophisticated downconversion may be undesirable.

Further study was encouraged.

5.13.2 Adaptation parameter sets and multi-slice operations

5.13.2.1 Partial update

The proposals in this category were reviewed with the assistance of summary information prepared by Y.-K. Wang, and recorded as follows.

	Method summary	**Cons**
H0069	Linked APSs – conditionally referencing to another APS	- Cross-APS dependency – error resilience problem - Not easy to specify
H0070	Conditional replacement	- Cross-APS dependency – error resilience problem - Inefficiency when to-be-overwritten content may be re-usable
H0119	Conditionally referencing to another APS for QM parameters	- Partly solves the partial update problem - Cross-APS dependency – error resilience problem
H0255 - 1	Multiple APS IDs in SH	- Multiple APS IDs in SH - SH syntax not future-proof (syntax change needed when in the future stuff goes into APS)
H0255 - 2	Allowing explicitly signaling different types of APS parameters in SH that can override the one in APS	- Complex SH syntax - Inefficiency when content added to SH may be re-usable
H0381	A “copy” flag for each type of APS params, which allows copying that type of APS parameters from another conditionally referenced APS	- Cross-APS dependency – error resilience problem - Complex APS syntax
H0505 - 1	Each APS NAL unit contains only one type of APS params; Grouping of multiple APS IDs and PPS ID in GPS; References only GPS ID in SH	- Each APS NAL unit contains only one type of APS params - Needs GPS
H0505 - 2	Similar as above, but each APS NAL unit may contain multiple types of APS params	- Needs GPS

After discussion at the summary level, it was suggested to focus on H0069 (which is roughly the BoG output from the last meeting), H0381, and H0505. It was remarked by the contributor of H0119 that its intent was consistent with H0381, so that it might not need to be considered separately.

H0381 seems like a straightforward generalization of H0069, while H0505 seems like a larger degree of restructuring.

For the GPS approach in H0505, the PPS ID is moved from the SH to the GPS. Possibly the SPS ID is also moved from the PPS to the GPS. It was commented that, hypothetically, the PPS ID could be put into the APS when otherwise using H0069 or H0381 as well.

It was remarked that the text for H0381 was inadequate, as the semantics are missing.

In initial discussions, it seemed that we were closest to agreeing on H0069, but further discussed it later in the meeting.

There was later discussion of the use of linked lists versus conditional-refresh for updates.

Some participants advocated a linked list approach while others advocated a conditional-replacement-based approach. There was some confusion over what was intended in some of the proposals. The intent for E0381 seemed to be unclear to the group. (Another contribution H0070 and prior contribution E309 was mentioned as a use of the conditional-replacement-based approach.)

It was suggested to allow self-referencing updates, i.e. an update referencing the same APS ID, which would be a conditional-replacement-based update (resolved at the time of receipt of the APS NAL unit), while an update referencing a different APS ID would act as a pointer (resolved at activation time) rather than as a conditional-replacement-replace update (resolved at the time of receipt of the APS NAL unit).

It was remarked that the GPS concept may be simpler, in that it avoids the linked-list structuring and the possibility of misinterpretation of the timing of the copying, which could become confusing.

Later, new versions of H0069 were submitted (-v3 and –v4).

This included:

- Parameter set referencing (content established at the beginning of each picture or at the beginning of each slice)
- Conditional replacement (with the same parameter set ID)
- Invalidation (with the same parameter set ID)

The same APS ID would not be allowed to appear more than once as the list linking is followed.

It was remarked that something like the GPS concept (i.e. a list of pointers) might seem simpler than a linked list.

Further study was needed.

JCTVC-H0069 APS partial update through referencing [S. Wenger, J. Boyce (Vidyo), Ming Li, Ping Wu (ZTE)]

This contribution proposed linked APSs.

JCTVC-H0070 APS partial update through conditional replacement [S. Wenger, J. Boyce (Vidyo)]

This contribution was not suggested to be emphasized for consideration.

It uses over-writing rather than linking.

JCTVC-H0119 Non-CE4 Subtest2: Extension of Adaptation Parameter Sets syntax for scaling list matrix [J. Tanaka, Y. Morigami, T. Suzuki (Sony)]

JCTVC-H0255 On partial updating of APS parameters [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)]

JCTVC-H0381 AHG15: Partial APS update [V. Drugeon, S. Esenlik, M. Narroschke, T. Wedi, V. Wahadaniah (Panasonic)]

JCTVC-H0505 On APS partial update [Y. -K. Wang, Y. Chen, G. Van der Auwera (Qualcomm)]

5.13.2.2 Other

The proposals in this category were reviewed with the assistance of summary information prepared by Y.-K. Wang, and recorded as follows.

	Method summary	**Comments**
H0071	Merging APS into PPS + PPS partial update = No APS; Diff types of PPS params: existing, "non-adaptive" PPS params, plus existing different types of APS params	Decreases the possibility of out-of-band PPS transmission in session negotiation or announcement - Currently, the possibility of out-of-band APS transmission is not high, and not possible when some APS data change very frequently and the total number of variants is large - Moving APS data into PPS would significantly decrease the possibility for out-of-band PPS transmission.
H0132	Reported that APS loss may cause serious artifacts. Proposes to enable repeating of APS parameters in SH (either use from APS or use from SH)	- Why repeating in slice header is better than repeating the APS itself?
H0376	More params from SH to APS; Fragmentation of ALF and SAO for low delay	- Low-delay issue can be solved by allowing different slices referring to different APSs - Would fragmentation of ALF and SAO data be useful for any other purposes than low-delay support?
H0507	Allowing referencing different APSs in different slices of a picture	

H0512	APS fragmentation for QM for MTU size matching	- Not a generic APS fragmentation mechanism, only provides fragmentation of QM data - On the other hand, existing APS syntax supports to split different types of APS data into different APS NAL units

JCTVC-H0071 On the need for an Adaptation Parameter Set [S. Wenger, J. Boyce, Won Kap Jang (Vidyo)]

With the (in the authors' opinion) possible, even likely, inclusion of some form of partial parameter set update into HEVC, it was suggested that the need for an APS may not exist anymore. This document analyses the implications of moving APS parameters into the PPS and relying on a partial update mechanism for picture-adaptivity. The size of the slice header could reportedly be reduced with little or no increase in the size of the parameter sets, and the number of NAL units required for coding a picture could be reduced, saving bits for NAL unit headers, start codes or other segmentation information. However, currently in the draft are only very few table entries for APSs and a lot of entries for PPSs. If the APS content were merged with the APS content, it was asserted that either the number of table entries for the PPS needs to be reduced, or the memory requirements in the decoder would increase.

For further study.

JCTVC-H0132 On Adaptation Parameter Signalling [Y. Ye, E. S. Ryu (InterDigital)]

In this proposal the error propagation effect of losing SAO and ALF parameters of the APS was studied by analysing the case of losing only the first APS. Quality degradation in terms of both PSNR and visual quality was analysed. It was reported that error propagation due to the loss of SAO and ALF parameters is content dependent. In terms of PSNR degradation, the maximum loss is 2 dB for Y, 4 dB for U, and 5 dB for V. For all three components, the minimum PSNR loss is reportedly close to 0 dB. In terms of subjective quality, visual degradation ranges from unnoticeable for some test sequences to significant visual artefacts for others. It is reported that for those sequences where visual artefacts were observed, at which frame and for how long the artefacts appear is also content dependent; in other words, some artefacts appear early in the sequence while others appear later in the sequence, and some artefacts appear for just a few frames while others propagate throughout many frames. Based on these observations, a method to improve error resilience of adaptation parameters carried in APS was proposed.

This contribution tested HE LB encoding. The loss effects reportedly did not correlate with QP value.

The most visible artefacts tended to be chroma shifts.

The contribution proposed a flag for the slice header which would indicate sending the APS information in the slice header rather than in the APS.

It was remarked that repetition of the APS outside of the slice header (as an APS NAL unit or hypothetically in some SEI message) would seem to be a (probably better) alternative way to get the desired loss resilience.

It was remarked that LCU-based SAO and ALF may reduce the dependence on the APS.

JCTVC-H0376 Non-CE8: Low-delay support for APS [S. Esenlik, M. Narroschke, V. Drugeon, T. Wedi (Panasonic)]

Several proposals related to LCU-based Adaptive Loop Filter (ALF) and Sample Adaptive Offset (SAO) have been submitted. LCU-based syntax for ALF and SAO provides the possibility of low encoding delay for the two in-loop filters. This contribution proposed a mechanism to allow usage of APS in low delay scenarios in connection with LCU-based ALF and SAO approaches. The proposal uses the APS to carry the filtering information that is shared by multiple slices in a frame. Moreover a fragmentation scheme

was proposed. As opposed to signalling all of the filtering parameters inside the slice, the proposed low-delay APS fragmentation scheme is asserted to not suffer from reduction in the ALF and SAO coding gain in the case where a frame is partitioned into multiple slices.

H0507 was suggested to have a similar spirit and to perhaps be a more generic approach.

JCTVC-H0507 Referencing different APSs in the same picture [S. Wenger (Vidyo), Y. -K. Wang, I. S. Chong (Qualcomm)]

This contribution proposed the option to activate more than one adaptation parameter set (APS) per coded picture. As a result, at least some of the coding tools having parameters that are carried by the APS (such as loop and deblocking filters, SAO, and quantization matrixes) can be adapted to different content in a picture, by appropriately placing slice headers into the picture referencing different APSs (or changing the APS content while re-using the same APS ID).

The H0376 and H0507 proposals are interesting, but seem to depend on other decisions that were yet to be made. Further study was encouraged.

JCTVC-H0512 APS fragmentation [Y. Chen, Y. -K. Wang, R. Joshi, M. Karczewicz (Qualcomm)]

This contribution ws a follow-up proposal of JCTVC-G658. In JCTVC-G658, it was proposed that the quantization matrices be signalled in the adaptation parameter set (APS). To solve the problem that an APS can be larger than the maximum transmission unit (MTU) size, it was proposed that the APS could be fragmented into multiple NAL units, each of which can be independently parsed and applied. The problem was reportedly confirmed to be a valid problem at the previous meeting. In this proposal, the same idea was proposed again, based on the updated syntax element support for the quantization matrix signalling in the APS, such that an APS, if it contains information for quantization matrix, may contain only a subset of the total number of quantization matrices.

It was commented that it appeared that the suggested functionality seems achievable using some of the other proposed approaches.

JCTVC-H0667 Implementation issues with frequent slices [C. Fogg, A. Wells (Ambarella)] [late 02-04]

Rather than limit the frequency of HEVC slices, a potentially viable scheme would be to restrict changes to subsets of slice header elements that are typically nearly constant in applications but have an asserted heavy impact upon implementation when changed. An analysis was included to identify those subsets. Based on the results presented, it was proposed that profiles and levels limit deblocking control to no more than four modifications per frame. Finally, it was suggested to move slice header element sets identified in the contribution as being fairly static into a slice parent-level syntax structures (e.g. APS or PPS) that have suitable frequency restrictions.

Deblocking loop filter control and, to a lesser extent, reference picture list modification were identified as relatively important.

It was also mentioned that, depending on design choices, SAO and ALF parameters may be an additional source of difficulty.

5.13.3 SPS and PPS syntax cleanup

JCTVC-H0288 Syntax on picture size signalling [Y. Park, C. Kim, J. H. Kim, J. H. Park (Samsung)]

This contribution proposes a design for picture size signalling in the SPS. The proposal was to send, as ue(v), an indication of the number of bits used to code the width and height. This was motivated by a desire to save bits on the picture size expression syntax. No action was taken on this.

See also the AHG15 report discussion notes.

JCTVC-H0485 Picture size signalling and cropping operation [K. Suehring, B. Bross (Fraunhofer HHI)]

This contribution proposed a modified picture size coding scheme based on coding units and a cropping operation. Bit rate savings were reported for typical picture sizes. The contribution also analysed memory requirements for cropping operations inside and outside the coding loop.

The contribution proposed to perform the cropping outside the coding loop (which is agreed as documented above). No further action was taken.

JCTVC-H0654 High level syntax [J. Lou, Y. Yu, L. Wang (Motorola Mobility)] [late]

This document proposed some modifications of the sequence parameter set, picture parameter set and slice header syntax. It proposed to remove some syntax elements when max_num_ref_frames is equal to 0.

It was noted that the proposed PPS modifications would introduce a parsing dependency on the SPS content. Also, there was a parsing problem with the first modification proposed for the slice header level. The last modification proposed in the slice level would be a no-op. The remaining modification would save 1 bit in the case of max_num_ref_frames = 0.

It was acknowledged that we have a bit of recognizable redundancy in some of these syntax areas. However, it seemed that the issue addressed by this proposal was a relatively low importance matter – such low-level cleanups can be deferred.

JCTVC-H0380 AHG15: SPS and PPS syntax modifications [V. Drugeon, T. Wedi, M. Narroschke, V. Wahadaniah (Panasonic)]

This contribution proposed several modifications of the SPS and PPS syntax. In particular, modifications were proposed by noting some constraints in place for:

- block size signalling (MinTr <= MinCU <= MaxCU, MinTr <= MaxTr <= MaxCU)
- PCM related syntax (MinCU <= MinPCMCU <= MaxPCMCU <= MaxCU)
- slice granularity (currently 2 bits in PPS, proposed to move this SPS and change its coding)

It was commented that it seems desirable to keep the ability to change slice granularity flexibility at the PPS level (e.g. to use a coarser granularity for higher temporal layers).

However, it seemed that the issue addressed by this proposal was a relatively low importance matter – such low-level cleanups can be deferred.

JCTVC-H0313 AHG15: On Signalling of Several Syntax Elements in SPS [X. Li, J. An, X. Guo, S. Lei (MediaTek)]

In this proposal, the signalling of the maximum coding unit (CU) size, minimum transform unit (TU) size and maximum RQT depth information in the sequence parameter set (SPS) were discussed. Considering the constraints of CU and TU sizes in current HEVC, somewhat different signalling methods were proposed. It was asserted that the proposed methods can not only save bits in SPS, but also avoid potential incorrect settings of encoding parameters.

The contribution discussed log2_diff_max_min_coding_block_size, log2_min_transform_block_size_minus2, log2_diff_max_min_transform_block_size, max_transform_hierarchy_depth_inter and max_transform_hierarchy_depth_intra.

It was commented that the proposed FLC approach may limit future extensibility.

However, it seemed that the issue addressed by this proposal was a relatively low importance matter – such low-level cleanups can be deferred.

JCTVC-H0343 Redundancy removal of syntax [T. Lee, J. Park (Samsung)]

The value of log2MinCUDQPSize is required to be less than or equal to the CU size specified by the value of slice granularity. It was suggested to modify max_cu_qp_delta_depth syntax to make this implicit in the encoding.

It was suggested that ticket #310 resolves this issue (differently but adequately).

Placing the slice address at the beginning of the slice header had been adopted. By using a first_slice_in_pic_flag, it was proposed to remove some redundancy of coding the entropy_slice_flag. This would probably save one bit per picture.

It was proposed to condition a syntax element (5_minus_max_num_merge_cand) on not being an entropy slice. It seemed apparent that this is a justifiable cleanup.

However, it seemed that the issue addressed by this proposal was a relatively low importance matter – such low-level cleanups can be deferred.

5.13.4 Switching granularity

JCTVC-H0391 AHG15: Slice-Level Control of In-Loop Filter [R. Srinivasan, C. Ghone (TI)]

The current draft of HEVC and the HM5.0 code support turning off the loop-filter across all slices in a picture. However, for better video quality, it was suggested to be desirable to be able to turn off loop-filter across a subset of a few slices only. One such scenario is "gradual decoder refresh". Here, the video data is "refreshed" (compression is done independently of previous frames that might not be available to the decoder) one slice at a time. In this case, it is desirable to turn off the loop-filter only for a slice that is next to a "refreshed" slice, so that the "refreshed" slice does not depend on "non-refreshed" data. It was suggested that loop-filtering across slices should be allowed for all other data so as to not compromise on video quality. This was asserted to not be possible with the current draft of HEVC. This contribution proposed a syntax change to allow for control of the loop filters to be made available at each slice.

The contribution seemed to have been based on some prior version of the WD. The requested functionality was actually already in the current WD, except with respect to SAO, which is currently restricted to be static within the picture. No action was taken on this at the moment.

Decision: We should have similar control capability as in AVC – able at slice level to turn off deblocking entirely, or only at boundaries (top/left), or not turned off. When disabled at the SPS level, no filter control should be sent at the slice header level. When deblocking is turned off only at slice boundaries, ALF and SAO should also be turned off at slice boundaries.

JCTVC-H0392 AHG15: Enable picture-level CU/TU size signalling in HEVC [N. Srinivasamurthy, K. Prasad, Y. Dutt, M. Zhou (TI)]

This contribution proposed to allow flexibility in Max CU and TU size for different pictures of a coded video sequence. CU and TU tree size is indicated in the syntax of the sequence parameter set. This means that inter and intra frames need to have the same minimum and maximum CU and TU size. It was asserted that often, in DSP and HWA implementation, one may prefer to use different CU and TU tree sizes for inter and intra frames, for performance and implementation reasons. In this submission, it was proposed that the syntax elements that control CU and TU tree size should be conditionally sent at the PPS level also.

It was asked whether there was substantial overhead for having "always splitting" operation with a particular LCU size. The full implications of the proposed flexibility seemed to need further study. Further study was encouraged.

5.13.5 Tiles

A BoG (coordinated by M. Horowitz) was requested to review contributions in the tiles and wavefronts categories).

JCTVC-H0727 BoG report: tiles and wavefront parallel processing [M. Horowitz]

This BoG report contained notes including recommendations to JCT-VC on the topic of tiles, wavefront parallel processing and entropy slices. Some of the BoG recommendations are recorded in notes for particular documents as found below.

In later discussion, the following additional actions were taken.

- Decision: Wavefront syntax for PPS should be placed in SPS with ability to override in PPS (not just placed in the PPS).
- Decision: Regarding WPP and tile mixtures, send two flags in SPS with three allowed combinations
    - 0,0 = multiple tiles not allowed and no WPP allowed
    - 0,1 = multiple tiles allowed, no WPP allowed
    - 1,0 = multiple tiles not allowed, WPP is allowed

JCTVC-H0737 Text for tiles, WPP and entropy slices [Y. -K. Wang (Qualcomm), A. Segall (Sharp), M. Horowitz (eBrisk), Hendry (LG Electronics), W. Wade (Broadcom), F. Henry (Orange), T. Lee (Samsung)]

The relation to the H0556 related aspects was discussed.

JCTVC-H0179 Storage reduction for dependent tiles [E. François (Canon), S. Pautet]

The BoG recommended adoption, and the JCT-VC agreed, subject to the assumption that dependent tiles remained in the design. However, it was subsequently decided that dependent tiles would not remain in the design (as noted below), so the adoption decision became moot.

JCTVC-H0658 AHG4: Crosscheck for Canon storage reduction for dependent tiles in JCTVC-H0179 [T.-D. Chuang, Y.-W. Huang (MediaTek)] [late]

JCTVC-H0203 AHG4: Further latency reduction of CABAC initialization for dependent Tiles [Hendry, S. Jeong, S. Park, B. Jeon (LG)]

The BoG did not reach a consensus on adoption of this. It was designated for further study.

JCTVC-H0414 Cross-check of "AHG4: Further latency reduction of CABAC initialization for dependent Tiles" (JCTVC-H203) [M. Horowitz, S. Xu (eBrisk)]

JCTVC-H0329 AHG4: Crosscheck for LG further latency reduction of CABAC initialization for dependent tiles in JCTVC-H0203 [C.-W. Hsu, Y.-W. Huang (MediaTek)] [late]

JCTVC-H0348 Simplification on tiles and slices [T. Lee, B. Choi, J. Park (Samsung)]

The BoG did not reach a consensus on adoption of this. No action was taken on it.

JCTVC-H0593 Cross-verification of JCTVC-H0348 on simplification on tiles and slices [V. Seregin, M. Coban (Qualcomm)] [late]

JCTVC-H0270 AHG4: Avoiding lower left LCUs at dependent tile column boundaries [C.-W. Hsu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)]

The BoG recommended adoption. The software actually currently does what is proposed, but the WD says differently. The proposal is to do what the software does. The JCT-VC agreed with the BoG, pending a decision on dependent tile support and test results comparing coding efficiency with and without the proposed constraint. However, it was subsequently decided that dependent tiles would not remain in the design (as noted below), so the adoption decision became moot.

JCTVC-H0345 Constrained tile for parallel decoding [H. Sasai, K. Uchibayashi, T. Nishi (Panasonic)]

No action was taken on this.

JCTVC-H0463 Comments on specifying tile support in HEVC Profiles and Levels [W. Wan, T. Hellman (Broadcom)]

The BoG recommended the adoption of the constraint that a picture shall not be composed of N tiles and M wavefronts where N > 1 and M > 1. Decision: Agreed.

Most BoG participants were not supportive of allowing "dependent" tiles at all, while some thought they should be considered for some "non-main" profile(s). The gain from this feature seemed insufficient to justify letting it become a sticking point. Decision: Remove this feature from the draft.

The decision was initially made pending review of evidence of coding efficiency effect, and was later confirmed. Coding efficiency test results for dependent tiles were later reported:

- In most tests, the gain from dependent tiles was reported as not too significant.
- For Classes A and B with four tiles structured as columns, the gain was reported as averaging about 0.4-0.5%.
- For Class E Low-Delay B (720p60 as for videoconferencing) with 12 tiles per picture, the reported gain was reported as averaging 4-5%. In discussion, was remarked that due to the high frame rate and low scene activity for these sequences, the bit rate at which they are encoded is extremely low.
- The use cases for tiles were discussed. It was remarked that typical use would be to use encoder parallelism in a way that would not use dependent tiles, and that typical use would not use very many tiles per picture. The use case for dependent tiles would not be parallel encoding, but rather for single-chip memory bandwidth reduction for motion search with higher coding efficiency. Since the purpose of dependent tiles is primarily a matter of coding efficiency.
- Overall, this did not seem to be a sufficient justification for retaining the feature.

The BoG recommended the study of whether in-loop deblocking is sufficient to eliminate visual artefacts when SAO and ALF are active, but do not filter across vertical and/or horizontal tile boundaries. The JCT-VC agreed.

The BoG recommended that a maximum number of tile columns constraint be considered when defining profile(s) and levels. The JCT-VC agreed.

With respect to the availability of the slice header in the context of a single-core decoder wishing to reconstruct LCUs in picture scan order, two prospective solutions were identified by the BoG:

1. To mandate that all LCUs in a slice shall lie at or "beyond" the first LCU of the slice in the picture raster scan (i.e. this constraint would not prevent multiple tiles to be contained in one slice),

   Note: It was remarked that the presence of an "entry point" identifying the start of each independent tile in the slice should be mandated.

2. Or to mandate that slices shall not cross tile boundaries (i.e., a constraint that would prevent multiple tiles from being contained in one slice). Note that this constraint implies the constraint above.

The BoG recommended constraint #1. The BoG was unable to reach consensus regarding a position on constraint #2, and the BoG recommended further discussion on this topic.

In later Track A discussion, it was suggested to mandate that either all slices within a tile shall be complete or all tiles within a slice shall be complete. Decision: The JCT-VC adopted this suggestion rather than the above input from the BoG. (Note that this does not prohibit a bitstream from having both characteristics mixed within a picture.)

It was remarked that our encoding software needs to be able to operate with this constraint in effect – e.g. there could be a parameter that controls the encoder to encode slices in units of tiles. M. Horowitz volunteered to at least scope the effort for such a modification.

JCTVC-H0520 Tile groups [Y. -K. Wang, A. K. Ramasubramonian, Y. Chen, M. Coban, M. Karczewicz (Qualcomm)]

No action was taken on this.

JCTVC-H0521 Flexible tile dependency and loop filter control [Y. -K. Wang, J. Chon, Y. Chen, I. S. Chong, M. Coban, M. Karczewicz (Qualcomm)]

No action was taken on this.

JCTVC-H0556 AHG4: Harmonized method for signalling entry points of tiles and WPP substreams [Hendry, S. O. Jeong, S. W. Park, B. M. Jeon (LG), K. Misra, A. Segall (Sharp)]

The BoG recommended adoption. Some aspects were further discussed (byte alignment, need for type flag), and the outcome was documented by H0737. Decision: Adopted (details clarified/refined as documented in H0737).

JCTVC-H0370 Crosscheck of LGE/Sharp proposal for byte-aligned substreams and harmonized entry points (JTCVC-H0556) [F. Henry, G. Clare (Orange)]

JCTVC-H0293 Syntax on parallel processing information signalling [S. S. Jeong, Y. Park, C. Kim, J. H. Kim, J. H. Park (Samsung)]

The BoG recommended investigating the placing of WPP parameters into the SPS in a manner consistent with the way tiles parameters are signalled. Such further study was encouraged.

5.13.6 Wavefront parallel processing

JCTVC-H0226 On derivation of luma QP predictor for Wavefront Parallel Processing [S. Shimada, K. Kazui, J. Koyama, A. Nakagawa (Fujitsu)]

The BoG agreed that there was an issue, and recommended, as a solution, to inherit the QP prediction value at the left edge from the slice header in which the LCU belongs (as is done for independent tiles). Decision: Adopted as recommended by BoG.

JCTVC-H0328 AHG4: Crosscheck for Samsung simplification on WPP in JCTVC-H0349 [C.-Y. Tsai, Y.-W. Huang (MediaTek)] [late]

JCTVC-H0513 On parallel processing schemes [Y. -K. Wang, M. Coban (Qualcomm)]

The BoG recommended to disallow the combination of WPP and entropy slices. Decision: Agreed.

The BoG could not reach consensus regarding recommending to disallow the combination of tiles and entropy slices, and recommended further discussion. Decision: In Track A, it was agreed to disallow the combination of tiles and entropy slices.

JCTVC-H0517 On wavefront parallel processing [Y. -K. Wang, M. Coban (Qualcomm)]

The BoG recommended that the WPP entropy coding synchronization point be fixed to be the second LCU in the above LCU row. H0349 recommended the same idea. This will require the removal of the entropy_coding_synchro syntax element and an accompanying modification to the decoding process. The proponents are asked to work together to propose how the entropy_coding_synchro syntax element would be removed. Decision: Agreed (subject to producing the specific details).

The BoG recommended for the proponents to evaluate the overhead due to the addition of entry points as an alternative.

The BoG recommended CABAC flushing at the end of each LCU row to be mandated. The idea is also included in H0349. This adoption will require the removal of the cabac_istate_reset_flag syntax element and an accompanying modification to the decoding process. Decision: Agreed (subject to producing the specific details).

The BoG recognized a need to investigate whether the value of having byte alignment is worth the 0.6% BD bit rate average loss (across all sequences) that is incurred for an alternative approach of mandating byte alignment at the end of each LCU row.

JCTVC-H0349 Simplification on WPP [T. Lee, J. Choi, J. Park (Samsung)]

The BoG recommended adoption of the ideas in this proposal, which were identical to those proposed in items 2 and 3a of H0517. See actions noted above.

5.13.7 Entropy slices

JCTVC-H0515 On entropy slices [M. Coban, Y. -K. Wang, J. Chon, M. Karczewicz (Qualcomm)]

Various aspects were discussed. No action was taken on this.

JCTVC-H0642 Cross-verification of JCTVC-H0515 on Entropy Slices [T. Lee, J. Park (Samsung)] [late]

5.13.8 NAL unit header

No particular contributions were noted to be specific to this topic.

5.13.9 Random access

5.13.10 Decoded picture buffering and reference picture signalling

A BoG (coordinated by J. Boyce) was requested to review this category of contributions and the AHG21 report.

JCTVC-H0715 BoG report on Decoded picture buffering and reference picture signalling [J. Boyce]

The BoG met on Feb 3 and Feb 4.

The documents were classified into the following categories.

- POC (4)
- Reference picture lists unification/combination (7)
- Long term reference pictures (5)
- Other reference picture list topics (10)

The BoG recommended to adopt:

- JCTVC-H0137 Proposal #1, to add a condition to send ref_idx_list_curr in ref_pic_list_combination( ).
- JCTVC-H0138 Unification of reference picture list modification processes, to make list 0 and list 1 modification the same as list c modification.
- JCTVC-H0200 Proposal #1, changing element 'delta_poc_lsb_lt_minus1[i]' to 'delta_poc_lsb_lt[i].
- JCTVC-H0531 For long term reference pictures, add delta_poc_msb_present_flag, so the same POC LSB may be used for multiple long term reference pictures.
- JCTVC-H0412 Add SPS flag to indicate that all slices in each picture of the CVS use identical reference picture lists, and removing other syntax elements when the flag is set.
- Unless H0449 is adopted (which it was, as recorded below), JCTVC-H0565 Add restriction to DeltaPocS0[idx][i] to fix a bug such that if there is more than one short term reference picture with the same POC LSB value, it is not clear which one is referenced when changed to long term.

The BoG also proposed an output document, edited by Yan Ye, on reference picture related test conditions to update/replace JCTVC-G1036, adding conditions for reference picture list reordering and using different list ordering for different slices in the same picture – to become H0725.

One document was reported to have remained open from the BoG, JCTVC-H0449. The interaction of this with H0531 was discussed.

(Discussion of H0449 was chaired by J. Boyce.)

Regarding H0449, it was suggest that this could be combined with H0531.

It was suggested to provide new text for H0449 integrated with H0531. This was later provided and reviewed by the group, as noted below.

The BoG also discussed the possibility of absorbing the ref pic_list_combination() syntax into ref_pic_list_modification(), and further study on that issue was encouraged.

Further discussion of text integration of H0449 and H0531was chaired by J. Boyce.

Text was provided to combine H0449 with H0531, later uploaded as a revision to H0531.

Further study was suggested to determine whether the specification decoding process text could be rewritten to avoid the use of POC MSBs.

The contributor of H0531 volunteered to integrate the H0449 constraint in the encoder as part of the integration of H0531 into the HM reference software.

The intention is that the restriction sentence should belong in Annex C.

Decision: Adopt BoG recommendation with integration of the constraint proposed in H0449.

JCTVC-H0725 BoG output: Common conditions for reference picture marking and list construction proposals [Ye-Kui Wang, Miska M. Hannuksela, T. K. Tan, R. Sjöberg, Y. Ye] [late]

Proposed by BoG and approved.

JCTVC-H0137 AHG21: Reference picture lists combination syntax [Y. Ye, Y. He (InterDigital)]

JCTVC-H0653 AHG21: Cross-verification of reference picture lists combination syntax from InterDigital (JCTVC-H0137) [L. Guo (Qualcomm)] [late]

JCTVC-H0138 AHG21: Unification of reference picture list modification processes [Y. He, Y. Ye (InterDigital)]

JCTVC-H0679 AHG21: Cross-check of H0138 on Unification of reference picture list modification processes [E. Francois (Canon)] [late]

JCTVC-H0196 AHG21: Comments on signalling of short-term reference pictures [Hendry, S. Jeong, S. Park, B. Jeon (LG)]

JCTVC-H0200 AHG21: Comments on Signalling of Long-term Reference Pictures [Hendry, S. Jeong, S. Park, B. Jeon (LG)]

JCTVC-H0412 **AHG21: Reference picture list restrictions [R. Sjöberg, J. Samuelsson (Ericsson)]**

JCTVC-H0426 **AHG21: Removal of reference picture list modification [M. M. Hannuksela, S. M. Gopalakrishna (Nokia)]**

JCTVC-H0433 **AHG21: Reference Picture Set Signalling Method [Sachin Deshpande, K. Misra, A. Segall]**

JCTVC-H0449 **AHG21: A constraint to simplify and improve the robustness of POC computation [G. J. Sullivan (Microsoft)]**

JCTVC-H0466 **AHG21: Unified reference list for single-directional prediction [V. Wahadaniah, C. S. Lim (Panasonic)]**

JCTVC-H0467 **AHG21: Signalling periodic reference picture lists [V. Wahadaniah, S. M. T. Naing, C. S. Lim (Panasonic)]**

JCTVC-H0468 **AHG21: Flexible signalling of long term reference pictures [V. Wahadaniah, C. S. Lim (Panasonic)]**

JCTVC-H0531 **AHG21: Comments on Signalling of Reference Pictures [Sachin Deshpande, A. Segall (Sharp)] [late]**

JCTVC-H0565 **AHG21: Short-term reference picture range [J. Samuelsson, R. Sjöberg (Ericsson)]**

JCTVC-H0257 **Cyclic POC [J. Koyama, K. Kazui, S. Shimada, A. Nakagawa (Fujitsu)]**

JCTVC-H0292 **Syntax on List Combination [Y. Park, T. Lee, J. H. Kim, J. H. Park (Samsung)]**

JCTVC-H0482 Improvement to Intra RPS Prediction [J. Zhao, S. Deshpande, A. Segall (Sharp)]

JCTVC-H0501 Efficient POC signalling for temporal scalability [Y. Chen, Y. -K. Wang (Qualcomm)]

JCTVC-H0425 POC granularity for reference picture sets and slice header [M. M. Hannuksela, S. M. Gopalakrishna (Nokia)]

JCTVC-H0502 Signalling of long-term reference pictures in the PPS [Y. -K. Wang, Y. Chen (Qualcomm)]

JCTVC-H0504 Comments on Reference Picture Lists Combination Syntax [Hendry, Y. J. Jeon, S. W. Park, S. O. Jeong, B. M. Jeon (LG), Y. Chen, Y. -K. Wang, W. -J. Chien (Qualcomm)]

JCTVC-H0551 Parameterized RPS Models [J. Zhao, A. Segall (Sharp)]

JCTVC-H0694 Long-term picture coding [K. Suehring, H. Schwarz, T. Wiegand (Fraunhofer HHI)] [late]

5.13.11 HRD issues

No contributions particularly on this subject were noted (although HRD issues were noted to be mentioned in some other contributions).

5.14 Quantization

See also notes in the CE4 section (section 4.4.1), especially relating to H0710 and H0730.

5.14.1 QP prediction / delta QP coding

JCTVC-H0189 Non-CE4: Low-complexity dQP coding [K Sato (Sony)] [late]

QP prediction has been investigated in CE4 subtest 1. The method proposed in JCTVC-G1024 appeared to be the best spatial QP prediction in terms of coding efficiency among the proposals in the previous CE4, and it is also asserted to be rate control friendly.

At the last meeting, some expert commented that he would preferr having a simpler method such as just averaging.

This document provides results with the QP prediction method of averaging the leftQP and topQP.

Compared to CE4 subtest 1.3: The same left/top averaging method as used for inter and intra; not using mode dependency any more, resulting in a gain that is 0.4% for intra, and 0.3/0.2% for RA/LD.

JCTVC-H0204 Non-CE4: Compatible QP prediction with RC and AQ [H. Nakamura, M. Nishitani, S. Fukushima (JVC Kenwood)]

This contribution proposed a spatial QP prediction method under restricting QP references across LCU boundaries. The proposed method is based on the CE4 Subtest 1.3 and was modified to use the QP of the preceding "quantization group of coding units" (QGCU) more frequently for further rate control friendliness. In the combination with the QP prediction based on intra prediction direction in CE4 Subtest1.3, it was suggested to be expected to achieve higher efficiency improvement. The simulation results in the case of MaxCUDepthDQP=3(8x8) were reported as follows. The proposed method with the QP prediction based on intra prediction direction reportedly provided 0.5%, 0.4%, 0.3%, 0.3%, 0.2%, 0.3% and 0.3% luminance BD bit rate gains for AI HE, AI LC, RA HE, RA LC, RA HE10, LD HE, and LD LC configurations, respectively. The proposed method without the QP prediction based on intra prediction direction provided 0.3%, 0.3%, 0.3%, 0.3%, 0.2%, 0.3% and 0.3% luminance BD bit rate gains for AI HE, AI LC, RA HE, RA LC, RA HE10, LD HE, and LD LC configurations, respectively.

There is a difference compared to H0189: A non-available value (left or top) is replaced by the previous QP, and averaging is performed on whatever is remaining (i.e. if both are not available, the previous QP is averaged with itself). This scheme had slightly less rate reduction than H0189 (0.3% instead of 0.4%) for the AI case, and otherwise similar performance, but perhaps a bit more regular data flow.

Decision: Adopted.

JCTVC-H0194 Non-CE4: Cross-verification report for modified spatial QP prediction based on intra prediction direction by JVC Kenwood (method 1 of JCTVC-H0204) [H. Aoki, K. Chono (NEC)]

JCTVC-H0601 Non-CE4: Crosscheck report of Compatible QP prediction with RC and AQ (JCTVC-H0204) [M. Shima (Canon)] [late]

JCTVC-H0289 Non-CE4: Spatial QP prediction based on motion vector predictors (AMVP) [P. Andrivon, P. Bordes (Technicolor)]

This contribution presented results of spatial QP prediction based on:

- Test 1: motion vector predictor cues (in Inter),
- Test 2: a combination of test 1 and an intra direction based method (JCTVC-G1204 Subtest 1.3),
- Test 3: a non-mode-dependent QP prediction (above and left QGCU averaging if within LCU otherwise last coded QP).

Simulations results reportedly showed on average 0.2% to 0.5% BD bit rate gains for test 1 and test 2 in RA, LB and AI cases, respectively, under the test condition defined in CE4 Subtest 1 (AVC like).

Compared to the non-mode-dependent QP prediction (test 3), the gains are equivalent.

Test 3 is same as H0189.

JCTVC-H0525 Non-CE4: Cross-verification report for spatial QP prediction based on motion vector predictors (JCTVC-H0289) [H. Aoki, K. Chono (NEC)] [late]

JCTVC-H0188 On the syntax of ChromaQpOffset [K Sato (Sony)]

At the 7th JCT-VC meeting, ChromaQpOffset, the same as the one in AVC, was adopted. This document proposed two modifications:

- Moving ChromaQpOffset from PPS to APS
- Changing the names as "Cb_QP_Offset" and "Cr_QP_Offset"

JCTVC-H0400 Chroma QP extension [J. Xu (Sony), A. Tourapis (Magnum), E. Maani, K. Sato (Sony)]

In HM5.0, Chroma QP can only take values in the range of [0, 39]. This contribution proposed to extend the range of Chroma QP values to [0, 51]. The proponent asserted that this change enhances the functionality, flexibility and friendliness of HEVC for various potential applications, such as rate control at low bit-rates, including the flexibility to obtain the desired performance balance point between luma/chroma, and for handling video sources with different colour formats (e.g. RGB). The contribution proposed the formula QPCx = Clip(0, 51, QPY + Cx_QP_offset).

The initial Track B recommendation was to adopt the chroma QP mapping from H0400, change the names as suggested in H0188, and keep the offset values in PPS (as these seem not to need frequent switching). This was further discussed in a plenary discussion, and further study was recommended with no immediate action.

This, as proposed, could be a significant change to the balance between luma and chroma in our common test conditions. No subjective testing had been done. In the reported experiment results, the balance between luma and chroma fidelity was changed substantially. It was remarked that the non-linear mapping has been used in standards for avoiding colour artefacts at low bit rates for a long time. It was suggested to be questionable whether the suggested default value is appropriate. Further study was suggested to identify whether this really adds the desired flexibility for rate control without having impact on subjective quality.

5.14.2 Quantization matrices

JCTVC-H0237 Non-CE4 Subtest 2: Improvement on quantization matrix signalling [S.-C. Lim, H. Y. Kim, J. Lee, J. S. Choi (ETRI)]

This contribution presented a proposed modification of quantization matrix signalling. The proposed method restricts quantization matrix signalling by minimum and maximum TU sizes and sends a flag that indicates whether to use the default matrix or non-default matrix for each SizeID and MatrixID.

Not to signal unnecessary quant matrices is something reasonable to do. It was agreed that this should be discussed in the BoG on quant matrices as it is related to compression (e.g. if a method would be used where a larger matrix is derived from a smaller one this would not be an issue)

The contribution was partially related to HL syntax issues (other proposals on partial update of APS, e.g. H0255); derivation based on max TU size might only be desirable if that parameter itself is part of APS.

However this was not discussed in the breakout group, but rather was reviewed in Track B again.

One expert suggested that instead of this method, an implicit signalling as in AVC could be used, where the value zero of the first matrix coefficient indicates that the default matrix is used.

Decision: Use a method as in AVC, i.e. first value zero means that the default matrix is used and allow to do this selectively for each TU size. (If the list is not present, the QM is implicitly flat; if it is present but the first entry is zero, it is default. The number of QM lists in the APS does not depend on the minimum and maximum TU sizes.)

JCTVC-H0387 Non-CE4: Handling large size quantization matrices [S. Liu, X. Zhang, S. Lei (MediaTek)]

This contribution reported on studies and results about methods for handling large size quantization matrices. First, the relationship between BD bit rates and the number of quantization matrices to code is discussed. Then, a couple of mechanisms for deriving large size (16x16 and 32x32) quantization matrices were proposed. In the first method, it is propose to derive 16x16 quantization matrices by up-sampling 8x8 quantization matrices using interpolation, and derive 32x32 quantization matrices by up-sampling 16x16 quantization matrices by repetition. In the second method, it was proposed to derive 16x16 and 32x32 quantization matrices by up-sampling 8x8 quantization matrices, using interpolation for low frequencies and repetition for higher frequencies. In both methods, large size quantization matrices may be skipped from coding. Experiments were conducted based on CE4 subset2 anchor software. Taking "Symmetry1" as an example, results reportedly show that in the worst case (i.e. quantization matrices are updated each picture) by skipping coding 16x16 and 32x32 quantization matrices, the average BD bit rate savings are 4.6% AI-HE, 22.1% RA-HE and RA-LC, 28.8% for LB-HE, compared with a current anchor. Maximum error and average error of derived quantization matrices compared with original quantization matrices were 19 and 2.0, respectively. By skipping coding only 32x32 quantization matrices, the average BD bit rate savings were reported as 3.2% AI-HE, 14.7% RA-HE and RA-LC, 20.6% for LB-HE, compared with a current anchor. Maximum error and average error of derived quantization matrices compared with original quantization matrices were reportedly 9 and 0.5, respectively.

The results related to a configuration where it is assumed that the matrix is transmitted for each picture.

The approach is re-using the frequency profile of small TU size for the large ones, whereas individual weighting may be desirable (i.e. from another subsampled representation).

JCTVC-H0641 Cross-check report for MediaTek quantization matrix compression (JCTVC-H0387)) [J. Lou, L. Wang (Motorola Mobility)] [late]

JCTVC-H0453 Non-CE4 subtest 2: Signalling a subset of quantizer matrix coefficients for 32x32 quantization matrices [R. Joshi, M. Karczewicz (Qualcomm)]

Coding of a 32×32 quantization matrix requires a large number of bits. This contribution proposed signalling a syntax element for a 32×32 quantization matrix that defines a rectangular subset consisting of lower frequencies. Only the values in the quantization matrix that belong to the subset are coded, leading to a savings in bit-rate. The missing entries would be predicted or set to a constant value such as the highest allowable quantization matrix value.

Note: This is proposal is not very specific on how the values are derived exactly (e.g. by repetition is mentioned as one option). We should avoid the possibility that the scheme of how the final matrix coefficients are derived becomes too complicated for derivation on the fly. Recursive computation could also have implications on parallel compression.

JCTVC-H0460 High-level Syntaxes for the Scaling List Matrices Parameters and Parametric coding [M. Haque, E. Maani, A. Tabatabai]

This document presented a referencing of parametric models being part of the scaling list matrix coding, as envisioned with APS referencing. This contribution describes a group of scaling list parameters that can be used to model a class of scaling list matrices and become part of the scaling_list_param() sets.

It also shows some results of parametric model based coding of scaling matrices and states that it should be up to the encoder's choices on how accurately the scaling matrices to be re-produced at the decoder-side by sending either none or a very limited amount of prediction errors.

The proposal was asserted to use a relatively simple representation by parametric surface model. Derivation of parameters on the fly may be possible in hardware (which should perhaps be studed), but

many decoders may be using full reconstruction, such that the purpose of memory reduction would not really be achieved.

JCTVC-H0602 Non-CE4: Crosscheck report of High-level Syntaxes for the Scaling List Matrices Parameters and Parametric coding (JCTVC-H0460) [M. Shima (Canon) [late]

JCTVC-H0461 On HVS only Default Scaling List Matrices [M. Haque, A. Tabatabai, J. Xu, C. Auyeung (Sony)]

This document presents comparative results when the default AVC 4x4 and 8x8 scaling list matrices in HM5.0 are replaced by HVS model based scaling list matrices. Performance evaluation of the results reportedly showed relative improvement compared with the HM5.0 4x4 and 8x8 default matrices.

This points to a potential problem in misalignment of the DC coefficient weighting in default matrices due to the fact that current matrices for 4x4 and 8x8 were chosen, somewhat arbitrarily, to be taken from AVC at the last meeting.

For some test sequences, better subjective quality was claimed.

It was also reported from the CE on transform skipping that there is apparently a problem with the current default matrices. (It may be advisable to check this statement.)

A cross-checker has performed subjective assessment of some sequences and also supported the assertion that this gives a slight subjective quality improvement.

Decision: Adopt the 4x4 and 8x8 default matrices proposed in H0461.

JCTVC-H0696 Cross-check of JCTVC-H0461 on HVS only Default Scaling List Matrices E. Francois (Canon) [late 02-01]

JCTVC-H0477 On Just Noticeable Distortion Quantization in the HEVC Codec [Matteo Naccari, Marta Mrak (BBC)]

This contribution presents the application of a quantization tool that was asserted to exploit masking phenomena related to the human visual system (HVS) in HEVC. In particular, a pixel intensity masking phenomenon is considered in this contribution which is asserted to lead the HVS to be less sensitive in image areas where the average pixel intensity is either low or higher. The pixel intensity masking contributes to the HVS just noticeable distortion (JND) which was asserted to correspond to the maximum distortion level that can be introduced in an image area without being noticeable by human observers. In this contribution, a mapping between the average block pixel intensity and the JND level is considered and used to modulate the step in the HEVC quantizer for each transform unit (TU). In this way for each image block being coded, the quantization level is asserted to be perceptually adapted to its content. The JND varying quantization step would be communicated to the decoder to enable it to properly decode the received bitstream. However, it was noted that communicating the varying quantization step for each TU would increase the coded rate. To avoid this need for extra data communication, this proposal presents a method to estimate the JND level at the decoder. Furthermore, also the mapping between the average TU pixel intensity and the JND levels would need to be communicated to the decoder. To this end, this proposal presents a method to parameterize the JND profile and transmit it to the decoder. The methods presented in this contribution had been integrated in the HM-5.0 codec and the reconstructed video had been viewed to assess its subjective quality. It was reported that, for high bit rates, the contents coded with JND quantization achieved the same subjective quality of their respective anchors with bit rate reductions up to 25%.

The proposal requested to signal a JND profile and proposed how to derive the local QP parameter from the local intensity.

Results at higher QPs would be more interesting (e.g. QP22 is already close to visually lossless quality). Typically the rate difference at the same quality is less at high QP values.

Results for all-intra coding were requested.

Some experts expressed interest to receive further information.

After subjective viewing, several experts expressed interest that this should be further investigated (in an AHG on quantization). The implicit derivation of the QP from JND model should be compared against explicit signalling (delta QP). Furthermore, possibilities to make the JND-based mapping variable by parameters should be considered.

JCTVC-H0682 Cross-check of BBC proposal on "On Just Noticeable Distortion Quantization in the HEVC Codec" (JCTVC-H0477) [J. Wang, X. Yu, D. He (RIM)] [late 02-02]

JCTVC-H0495 Quantization matrices for 4x4 and 8x8 TUs matching HEVC integer transforms [J. Lou, J. Kim, L. Wang (Motorola Mobility)]

This document proposed to change the default quantization matrices for 4x4 and 8x8 TUs matching HEVC integer transforms.

Arguments were given about the difference between the basis functions of the transform between AVC and HEVC, and also regarding the DST-like transform. However, the new matrices were simply derived from a numerical analysis, with no subjective investigation.

One expert said that his company has visually investigated the appropriateness of default matrices for the DST case and did not find a problem. The original contributor of the DST proposal said that it might even be possible to re-design the DST for usage with the same default matrices as a DCT if necessary. (It was designed only w.r.t. flat quantization weighting so far.)

Currently, no problem was clearly evident, and so no action was taken on this.

JCTVC-H0522 Weighted predictive coding for Quantization matrices [J. Zheng (HiSilicon), J. Chen (UCLA)]

It had reportedly been agreed to use an AVC-like approach as a starting point to compress the quantization matrices. In the current HEVC design, quantization matrices can be as large as 32x32. The AVC-like approach does not have some prediction features that were asserted to be useful for coding these matrices. In practical application, the whole set of matrices may be loaded when a scene cut or random access point occurs. It is also suggested to be possible to change one or more sizes of quantization matrices within one scene. A weighted predictive method was investigated this proposal for quantization matrices coding to reduce the number of bits used for quantization matrix encoding. Compared with the AVC quantization matrix compression method, the proposed method can reportedly achieve a 3.87x compression ratio in lossless quantization matrix coding.

It was remarked that prediction over time, as investigated here, may not be desirable in the case of data losses, and may also not be useful in random access scenarios. It was suggested by the proponent that similar prediction concepts could be applied over the different matrix sizes.

No action was taken on this.

JCTVC-H0700 Non-CE4: Crosscheck report of weighted predictive coding for Quantization matrices (JCTVC-H0522) [M. Shima (Canon)] [late 02-06]

JCTVC-H0523 On partial updating the set of quantization matrices [J. Zheng (HiSilicon), J. Chen (UCLA)]

It was reported that the quantization matrices in an HEVC video stream use a substantial amount of overhead, especially when the quantization matrices are updated and used in small picture size sequences, even with use of the quantization compression method in the current HM5-QM and setting the matrices to only be loaded at a long refresh interval. The quantization matrices update interval and the number of matrices that need to be changed will impact the ratio of generated QM bits against video data bits in the bitstream. However, the updating frequency and the updating pattern may both be data dependent.

In practical application, a quantization matrix may need to be reloaded entirely when a scene change occurs, but it was sugggested that in some cases, partially updating the quantization matrices may make sense. This contribution provided software to simulate quantization matrix updating. The updating interval and partial updating were supported in this software.

It was clarified that this is not a technical proposal. The contributed software was suggested to be used in future quantization matrix CE work, such that updates can be performed less frequently.

5.14.3 Dequantization

JCTVC-H0312 Non-CE4: Clipping of Transformed Coefficients before De-Quantization [X. Li, X. Guo, S. Lei (MediaTek)]

This was presented together with H0541.

JCTVC-H0366 Non-CE4: Cross-check of clipping of transformed coefficients before de-quantization (JCTVC-H0312) [B. Li (USTC), J. Xu (Microsoft)]

JCTVC-H0541 Non CE4: Limiting dynamic range when using a quantization weighting matrix [Louie Kerofsky, A. Segall (Sharp)]

This contribution examined dynamic range issues related to quantization weighting matrices as identified in JVTVC-G1044. This contribution reported that under extremely low weight and QP values, levels exceeding 16-bits may occur and that with extremely high weights and QP values, intermediate values exceeding 32-bits may occur. This contribution proposed limiting level values prior to dequantization to 15-bits for the 4x4 block size and limiting levels to 16-bits for all other block sizes. The proposed method reportedly allows a dequantization implementation with a weighting matrix to need at most 16-bit multiplies with intermediate values within 32-bits.

This contribution was provided together with H0312, in which proposed text was provided.

In terms of the required computations, the level limit used for clipping depends on QP, TU size and bit depth.

The reported problem only appears in the context of the use of quantization matrices .

In discussion, it was remarked that this could be achieved by encoder restriction (and that a similar discussion was noted to have occurred in previous meetings), and that there is no doubt that there is a problem to be solved.

Decision: Adopt (text in H0312) as a "placeholder: to solve the problem, and further study in a quantization AHG whether this is the ultimate solution.

JCTVC-H0532 Quantization reconstruction offset [J. Wang, X. Yu, D. He, G. Martin-Cocher (RIM)]

The document proposed to include a quantization reconstruction offset on the picture level as an extra functionality for supporting grain noise coding and texture preservation.

It was asked in discussions whether this could be achieved by encoder optimization, and the answer did not seem fully clear. No action was taken on this.

JCTVC-H0736 Clarification on Tickets 313 and 315 [K. Chono (NEC), K. Sugimoto (Mitsubishi)]

This contribution identified a mismatch between text and software in regard to QP range.

Decision (SW): Fix software to match text (using an "AVC-style" QP range adjustment for bit depth).

5.15 Entropy coding

5.15.1 CABAC improvement

JCTVC-H0113 Non-CE1: Accurate initialization and conditional probability for CABAC performance improvement [E. Alshina, A. Alshin, J. H. Park (Samsung)]

Two possible ways to achieve CABAC performance improvement are studied in this contribution. The first takes into account conditional probability while updating the entropy code state. The second changes probability initialization taking into account a hierarchical encoding structure. Both algorithms were implemented on top of multi-parameter probability up-date, as studied in CE1, and were reported to provide additionally 0.2% BD bit rate.

First part: Extension to multi-parameter probability update model (for information).

Second part: More accurate initialization of CABAC: the slope and intersection would be different for the hierarchies in B slices. The contribution reports that implicitly deriving the initialization table from the slice type would be an option instead of explicit signalling (as e.g. suggested by Sharp, see CE1).

One expert suggested that there could be various structures other than the ones in common test conditions and such that implicit signalling may not always be a good solution.

The gain could be higher for small slices.

Further study (in an AHG) was encouraged.

JCTVC-H0265 Non-CE1: Dimension reduced rangeTabLPS table for the interval subdivision of the arithmetic coding engine [J. Stegemann, H. Kirchhoffer, D. Marpe, T. Wiegand (Fraunhofer HHI)]

This contribution presented a dimension-reduced rangeTabLPS table for the "M Coder" of HEVC. The table containing the precalculated values for the interval subdivision in the binary arithmetic coding engine was condensed from 64x4 = 256 to 16x8 =128 elements. The proposed idea is identical to the rangeTabLPS table which has been tested in CE1 subtest c3. In contrast to CE1, this proposal discusses the performance of the reduced table in combination with the probability estimator of the M Coder.

The size of table was proposed to be reduced by half, with no significant change in compression.

It was commented that, depending on implementation, it could be that the number of operations (in software) might be more important. Even though this may be a good idea, we should be careful about making changes at this stage that may have implications that are not well understood.

No action was taken on this.

JCTVC-H0590 Non-CE1: Cross-check of proposal H0265 on rLPSTable [V. Sze (TI)] [late 02-04]

JCTVC-H0099 On CABAC context for partition mode [T. Yamamoto (Sharp)]

This contribution reported a difference between the HM software and the WD text on CABAC context derivation for partition mode information. In order to improve the situation, it was proposed to apply bypass mode for the 3rd and 4th bins of the syntax part_mode. The proposed modification was reported to cause no impact on coding efficiency.

The proposal was to remove the context in binIdx 2 and 3, replacing by bypass coding.

Related contributions were noted to include H0545 and H0327.

JCTVC-H0545 Context modeling for asymmetric partitioning on partition mode [W. -J. Chien, X. Wang, M. Karczewicz (Qualcomm)] [late]

This contribution proposed reducing the number of contexts for partition mode for asymmetric partitioning. The number was proposed to be reduced by 3 contexts. Experimental results reportedly showed no BD bit rate changes in random access and low-delay test conditions.

The proposal was similar to H0099, but different for the third bin. The rationale is that if an encoder is not using AMP, the solution of H0099 would lose 0.2% in compression performance.

Decision: Adopt the solution of H0545 (which was agreed by contributors of H0099 and H0327).

JCTVC-H0581 Crosscheck of context modeling for parition mode (JCTVC-H0545) [T. Yamamoto (Sharp)] [late]

JCTVC-H0327 Simplification of MVP index coding and AMP mode coding [H. Li, B. Li (USTC), H. Yang, H. Yu (Huawei)]

This contribution proposed to use bypass coding of the bin for MVP index and the bins for AMP mode info. The two simplifications reportedly showed 0.0% BD bit rate change on average.

The first part was identical with H0099. The second part proposed bypass coding for the MVP index.

There was no support from other experts – and no action was taken on this.

JCTVC-H0121 Cross Check for Huawei's CABAC simplification (JCTVC-H0327) [Y. Shibahara, T. Nishi (Panasonic)]

JCTVC-H0687 Cross-check of JCTVC-H0099 on CABAC context for partition mode [W.-J. Chien (Qualcomm)] [late]

JCTVC-H0248 Clean-up of redundant CABAC memorization process [Y. Chiu, W. Zhang, L. Xu, Y. Han (Intel)]

This document proposed a clean-up of the CABAC usage in the HM5.1 reference software and in Working Draft 5 to remove a redundant invocation of CABAC state storage.

Some CABAC storage is redundant in the case of wavefront processing

It was commented that, as discussed in a breakout group, dependent tiles will most likely not be supported, and wavefront and tiles will not be used together.

This is most likely an implementation issue, and no action was taken on it, as the tiles/wavefront design is still undergoing changes and the associated text will probably need to be cleaned up in other ways anyway.

JCTVC-H0271 AHG9: CABAC with constrained outstanding bits [T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)]

This proposal was (at lesat partly) presented previously in JCTVC-F059. In the HM, there is no constraint on the number of pending bits to be produced in CABAC encoding. Theoretically, the number of outstanding bits could be very large. Practically, the number was up to 189 in the presented analysis. When a lot of outstanding bits are accumulated, a sudden increase of output bits will occur, which was asserted to complicate hardware design significantly. In this contribution, two coding interval adjustment procedures were proposed to constrain the number of continuous outstanding bits. One was to divide the coding interval into two parts at 512. The other one was to code a bypass bin. It was reported that the proposed methods cause no differences in coding efficiency and have roughly the same run time, while reducing the number of pending bits to at most 18 bits.

Up to 189 outstanding bits were reportedly observed under common test conditions. By adjusting code intervals, it was reported that this can be constrained to 18 bits. Two methods were proposed, one of which was previously proposed in the 6th meeting, where the assessment was that this is not a problem and can be solved by implementation-specific methods. The new method is said to be less complex, but still adds obvious complexity. There was no support for this by other experts, and no action was taken on this.

JCTVC-H0648 AHG9: Cross-check result of MediaTek CABAC with constrained outstanding bits (JCTVC-H0271) [K. Kazui (Fujitsu)] [late]

JCTVC-H0397 Context reduction of split_transform_flag in CABAC [J. Xu, A. Tabatabai (Sony)]

In HM5.0, there are 4 contexts for split_transform_flag. This contribution proposed to reduce the number of contexts for split_transform_flag from 4 to 1, which would means that all contexts would share one single context. Experimental results reportedly showed that BD bit rate changes are 0.0% for AI HE, 0.0% for AI LC, 0.0% for RA HE, 0.0% for RA LC, 0.1% for LD HE, 0.0% for LD LC, and 0.1% for RA HE10.

The split transform flag of RQT has 4 contexts in WD5, but space for 10 is reserved in the HM5 software (most likely only 4 are used). It was suggested that reducing this to only one context (used for all sizes) can be done with a slight reduction of compression (0.14% in LB, less in other cases).

No action was taken on this.

JCTVC-H0626 Cross-check of Sony proposal on context reduction of split_transform_flag in CABAC (JCTVC-H0397) [H. Yang, H. Yu (Huawei)] [late]

JCTVC-H0561 On CABAC Initialization [L. Guo, X. Wang, C. Muhammd, M. Karczewicz (Qualcomm)]

In the current HEVC software/WD, each slice type (I/P/B) has its own initialization value set. This contribution proposes to share the initialization values for contexts from different slice types to reduce the storage. Two methods were described. In the first method, P slices and B slices share the same initialization set. In the second method, for a subset of contexts, the same initialization values are shared for all three slice types. Experimental results under common test condition and common test condition with 1500 bytes slices were provided.

A subset of contexts was defined which has common initialization over all slice types. Two methods were described, with the number of initialization values reduced from approximately 600 to 400, and even less when the full combination is used. No significant loss in compression performance was reported (for one slice per picture and 1500 byte slices).

JCTVC-H0671 Cross-check for Qualcomm CABAC Initialization in JCTVC-H0561 [X. Guo (MediaTek)] [late]

JCTVC-H0646 Reduction of initialization tables for CABAC contexts [K. Sugimoto, A. Minezawa, S. Sekiguchi, K. Asai, T. Murakami (Mitsubishi)] [late]

This contribution proposed reducing the initialization tables for CABAC contexts. The proposed method uses only one initialization table with 253 entries instead of three tables as in HM5. Simulation results reportedly show that performance loss is 0.4%, 0.3%, 0.1%, 0.1%, 0.1%, 0.0%, and 0.0% for AI-HE, AI-LC, RA-HE, RA-LC, RA-HE10, LB-HE and LB-LC settings, respectively, using HM-5.1 in multiple 1500 byte slice mode. It was also reported that under common test conditions using HM-5.0, the loss is 0.0% for all mandatory common test conditions.

The proposal is to use only one initialization table (the third table of the current HM) for all slice types. No significant loss was reported for one slice per picture usage, with a slight loss (up to 0.4% for intra only) in case of 1500 byte slices.

Further study (in an AHG) was encouraged. Giving up flexibility in initialization may not be desirable if we are not sure what we are doing, and we need to consider whether possibly some of the current initialization is already tuned towards the test set.

JCTVC-H0251Context reduction for merge index coding [O. Bici, J. Lainema, K. Ugur (Nokia)]

In this contribution, it is proposed to use a single context for merge index coding by CABAC. The merge index consists of four bins, and HM5 assigns one context for each bin, totalling 4 contexts. In the proposed method, one context is used for the first bin and the remaining three bins are coded in bypass mode. The reported compression efficiency impact in terms of BD bit rate is 0.0% for all the RA HE, RA LC, RA HE_10, LB HE and LB LC configurations.

The current HM uses 4 contexts (1 per bin) but there is a deviation between the SW and WD.

It is suggested to assign 1 context for the first bin and bypass coding for the remaining three bins.

Decision: Adopt.

JCTVC-H0367 Cross-check of context reduction for merge index coding (JCTVC-H0251) [J. Xu (Microsoft)]

5.15.2 Throughput improvement

JCTVC-H0554 Non-CE1: throughput improvement on CABAC coefficients level coding [J. Chen, W.-J. Chien, R. Joshi, J. Sole, M. Karczewicz (Qualcomm)] [late]

This proposal targets on improving CABAC throughput by reducing context coded bins for coefficients level coding. In the current HM, three flags, *significant_coeff_flag*, *coeff_abs_level_greater1_flag* and *coeff_abs_level_greater2_flag* are coded using contexts before switching to the Golomb-Rice bypass mode coding for the remaining level. This contribution proposes coding *coeff_abs_level_greater1_flag* only for a few starting non-zero coefficients and only one *coeff_abs_level_greater2_flag* in a subset consisting of 16 coefficients, and an early switch to Golomb-Rice coding.

The coding efficiency impact of the first proposed scheme is -0.04% BD bit rate gain on average in common test conditions, and -0.10% at low QPs (1, 5, 9 and 13). It was further reported that this scheme reduces the maximum number of context adaptively coded bins by an average of 41% among all configurations, up to 44% in intra configuration at QP being 1, and averaging 10% among all configurations, up to 18% in intra configuration at QP = 22.

The coding efficiency impact of the second proposed scheme is 0.00% BD bit rate gain on average in common test conditions, and -0.05% at low QPs. It is further reported that this scheme reduces the maximum number of context-adaptively coded bins by an average of 32% among all configurations, up to 36% in intra configuration at QP being 1, and, by an average of 8% among all configurations, up to 15% in intra configuration at QP = 22.

It was further reported that all the modules and processes of the current CABAC are kept unchanged and no additional module is needed in the proposed approaches.

- Scheme 1: Proposal to code the >1 flags only until 2 coefficients with level >1 are found, code only one >2 flag in each group of 16 coefficients (earlier switch to GR code)
- Scheme 2: Up to 8 >1 flags, otherwise same as scheme 1

The proposal also included a GR table update (without that change, a loss of 0.3% occurs in the low QP range).

No significant change was apparent in compression (neither for low QP nor for normal QP).

The reported increase of throughput (due to the saved number of context coded bins) was up to 41% with scheme 1 (for QP=1) and 31% with scheme 2.

There is some additional complexity due to necessary usage of counters.

JCTVC-H0660 Non-CE1: Crosscheck for Qualcomm throughput improvement on CABAC coefficients level coding in JCTVC-H0554 [T.-D. Chuang, Y.-W. Huang (MediaTek)] [late]

Confirmed the reported results; the opinion expressed that the increase of complexity is OK as it is not in the critical path.

JCTVC-H0233 Non-CE1: CABAC bypass for coefficient data [J. Lainema, K. Ugur, A. Hallapuro (Nokia)]

This contribution proposes an alternative mode for coding transform coefficient data using CABAC bypass. The intention is to allow HEVC codecs to operate in a higher throughput mode in use cases

requiring low complexity operation – especially at high bit rates. In the case where the encoder decides to operate in high-throughput mode, the transform coefficient bins are coded in the equal probability bypass mode of CABAC. It was reported that the proposed high-throughput mode reduces the average number of context coded bins by 79% in the low QP range and 50% in the common conditions range. The effect of the approach on objective compression efficiency is reported to vary from +5.4% (RA HE) to +11.3% (LB LC) in common conditions simulations, and from +6.7% (LB LC) to +11.1% (AI HE) in the low QP range.

Two binarization schemes were suggested: "high efficiency" and "high throughput". The high-throughput mode would provide a reported savings of context coded bins up to 82% for QP=1.

The compression efficiency loss is 5-7% for HE in the normal QP range, 7-11% (highest for intra) in the low QP range. For the "normal" QP range, higher loss was reported for LC cases (and it was mentioned that perhaps RDOQ might have something to do with this).

The cross-check contribution H0378 (CE1) also covers this.

JCTVC-H0458 Non-CE1: High Throughput Coding Scheme with Rice Binarization [T. Nguyen, D. Marpe, T. Wiegand (Fraunhofer HHI)]

A demand for a high-throughput mode defined by the number of bins coded in the bypass mode of CABAC relative to the number of bins coded with adaptive context models partially exists. For that, this document proposes a coding scheme bases on the existing adaptive Rice binarization of CABAC. The benefit of the presented scheme is suggested to be the usage of existing coding tools and it was asserted that the high throughput mode can be treated as an extension of the common conditions.

For coefficients encoded by a Golomb-Rice code, the Rice parameter is derived from an absolute sum of neighbours (i.e. some additional operations) based on a local template – see H0228.

Up to 83% savings of context bins was reported. BR increases were reported as 5.5/5.0/7.2% for HE AI/RA/LD, 6.0/5.1/9.4% for LC HE AI/RA/LD in "normal" QP, and 1.9/4.2/5.0, 1.5/4.1/4.6% in low QP.

It was asked whether the % savings is the correct measure and that perhaps we should rather count the absolute number.

JCTVC-H0703 Cross-verification for HHI proposal (JCTVC-H0458) by Samsung [E. Alshina (Samsung)] [late 02-02]

JCTVC-H0510 Non-CE1: High Throughput Binarization (HTB) method with modified level coding [S.H. Kim, K. Misra, L. Kerofsky, A. Segall (Sharp)]

In this contribution, a high-throughput binarization (HTB) method for CABAC was presented.

The intention of this approach is to reduce the worst-case complexity of CABAC for low complexity use cases, keeping some form of compatibility with the existing CABAC. In addition, the proposed method provides a type of flexibility between coding performance and throughput efficiency by selectively applying HTB mode for each 4x4 coefficient block. It is reported that the proposed method reduces the number of context adaptively coded bins about 24% under the common test conditions, and about 46% in the low QP range where the complexity of CABAC is reportedly more problematic. It is further reported that the proposed approach can provide a more flexible HTB method by employing selective activation of the HTB mode in each sub-block level to enable a flexible choice between coding performance and throughput efficiency.

Depending on the number of significant coefficients, the HTB mode (two versions – CAVLC or GR, and the latter with threshold = 2 or threshold = 8), is activated.

The savings was reportedly up to 57% for QP=1, with a bit rate increase around 2%.

JCTVC-H0704 Cross-check of JCTVC-H0510: High Throughput Binarization (HTB) method with modified level coding [J. Lainema, A. Hallapuro, K. Ugur (Nokia)] [late 02-03]

JCTVC-H0718 Cross-check of JCTVC-H0510 on Non-CE1: High Throughput Binarization (HTB) method with modified level coding [W.-J. Chien (Qualcomm)] [late 02-04]

JCTVC-H0533 On CABAC bin parsing throughput [W. Zhang, P. Wu (ZTE)] [late]

According to the 7th JCTVC meeting notes, it is still desirable to improve CABAC context coded bin parsing throughput with the current design in HEVC Working Draft. However, CABAC context coded bin parsing throughput is highly related to spatial resolution, frame rate, QP, coding configurations and the resource limitations of the decoder. In this proposal, some asserted observations on CABAC context coded bin parsing throughput were provided, and a slice-based adaptive controlling mechanism of max_bin_rate was proposed to control CABAC context coded bin parsing throughput.

It was proposed that CABAC context coded bins of transform coefficients such as last_significant_coeff_x, last_significant_coeff_y(x+y), coeff_abs_level_greater2_flag (gt2), coeff_abs_level_greater1_flag (gt1), group_significant_coeff_flag and significant_coeff_flag (sig) can be grouped into several levels; and the bypass coding of CABAC would be applied to some of them according to the level indication in each slice header. It was asserted that such a controlling mechanism can also be turned off completely at the sequence level when it is not needed in order to maintain coding efficiency.

It was suggested to introduce a hard limitation to 20 Mbin/s, switching to bypass mode otherwise to maintain this. The reported bit rate increase is roughly 8-15% (for different classes) in the low QP range.

JCTVC-H0489 Complexity analysis of high throughput CABAC Entropy codecs [A. Duenas, Prashant Arora, Oscar Patino, F. Javier Roncero (Cavium)]

This contribution presents a method to analyse the complexity of high-throughput CABAC Entropy codec schemes. The contribution presents an example analysis of the current entropy codec method part of the HEVC WD5. The contribution suggests that JCT-VC establish a breakout group (BoG) in order to analyse the complexity of different options for a high-throughput CABAC entropy coder.

It was asserted that hardware implementations can process bypass bins approximately 8x faster than context-coded bins, and was noted that worst cases should be considered.

Some results of the reported analysis are tabulated below.

	Bjontegaard Delta Bit Rate ("Normal" QP Low QP)			Reduction in coded bins (Normal QP Low QP)		
Tool	Min	Max	Ave	Worst case	Ave	Proposed modification
JCTVC-H0232 (Nokia)	+3.3% +3.8%	+6.2% +9.5%	+4.4% +7.0%	76% 92%	64% 91%	Using HM 4 CAVLC binarization for all coefficient data
JCTVC-H0233 (Nokia)	+5.4% +6.7%	+11.3% +11.1%	+7.6% +8.2%	64% 80%	50% 79%	Bypass coding of HM 5 significance and level bins
JCTVC-H0458 (HHI)	+5.0% +1.5%	+9.4% +5.0%	+6.4% +3.8%	63% 81%	51% 79%	Single scan, one Rice + Exp-Golomb codeword per coefficient, modified Rice parameter derivation
JCTVC-H0510 (Sharp)	+1.5% +1.3%	+2.8% +2.9%	+2.1% +2.2%	24% 46%	20% 38%	Level of significant coefficients is coded with one of five CAVLC tables. Significance coding unchanged. Adaptive selection for controlling coding perf / throughput trade-off.
JCTVC-H0554 (Qualcomm) Scheme II	-0.1% -0.5% -0.1% -0.3%	+0.1% +0.1% +0.1% +0.1%	-0.0% -0.1% -0.0% -0.0%	6% 31% 4% 24%	5% 21% 3% 16%	Level bins coded for a few starting non-zero coefficients in each 16 coefficient group. Modified Golomb-Rice parameters update table (right shift by 1 element)

The contribution provides, as an example, that for full HD and QP=1, a worst-case bit rate of >400 Mbps could happen; however due to level constraints currently discussed, such a bit rate would never happen on average.

The bigger problem appears to be the local peaks of bins/coefficient, which could cause delay in processing, a need for buffering, etc. Therefore, looking at local peaks would be more appropriate than the average number of savings of context-coded bins.

Proposals that run everything in bypass mode have obvious higher losses, which would not be preferred solutions.

A BoG (coordinated by A. Duenas) was established with a mandate to perform further assessment of H0554 and H0510, a) maturity b) fulfillment of the purpose to limit the throughput in the expected way, while not overly penalizing the compression performance or complicating the design by adding additional methods of entropy coding, operations, etc.

JCTVC-H0728 BoG report on High throughput binarization for CABAC [A. Duenas]

Both method 2 from JCTVC-H0510 and scheme II from JCTVC-H0554 were reported to satisfy the requirements to substantially increase the throughput compared with the current scheme used on WD5. The members of the BoG identified that method 2 from JCTVC-H0510 will deliver higher throughput than scheme II from JCTVC-H0554. Based on that conclusion and the fact that Scheme II from JCTVC-H0554 offers a better trade-off between BD bit rate as well as improvements on throughput compared with method 2 from JCTVC-H0510, the group recommended adoption of H0554 Scheme II pending of satisfactory results after integration with JCTVC-H0130 and JCTVC-H0498.

Currently, the worst case is >3 bins/sample (context coded). Solution H0554 reduces this to 1.6, and H0510 reduces it to 1.25.

The combination H0554/H0130/H0498 was then verified during the meeting and uploaded in a revision of H0728. Low QP AI testing showed a small improvement (which is the test case most affected by this).

Decision: Adopt (WD text should also be checked carefully).

JCTVC-H0450 Limiting the Bin to Bit Expansion Ratio [Y. Yu, T. Hellman, W. Wan (Broadcom)]

This proposal presents an analysis of HEVC's CABAC bit to bin expansion ratio using current HM5.0 common test conditions, and reports that no performance loss would occur if an AVC-like constraint is applied. It proposes to keep a similar limit for the bit to bin ratio of CABAC in HEVC as was defined in the AVC standard.

The current WD still uses "RawMBBits" and "PicSizeIn MBs" for bin counts in NAL units, and it would be necessary to replace "MB" by "MinCU" to adjust properly for the HEVC context. Decision: Change in the WD (and also scan for other occurrences of "MB" to identify other cases that may need such adjustment).

Further investigation was encouraged on the suitability of the constants that were copied from AVC.

5.16 Transform coefficient coding

5.16.1 Significance map coding

All contributions in this category were reviewed in a BoG (H0719) coordinated by G. Martin-Cocher.

JCTVC-H0719 BoG report on significance map [G. Martin-Cocher]

The break out group reviewed contributions from CE11, and also non-CE11 contributions related to significance map and level coding. Contributions were classified as multilevel significance map contributions; simplification and harmonization of 4x4 and 8x8 significance map contributions; and parallelization and context template optimization contributions.

Recommendations from the BoG were as follows:

- Adopt JCTVC-H0131, JCVTC-H0290 second pattern, JCTVC-H0526 method B, and
- Adopt JCTVC-H0095 with variable threshold (upon report of combination with H0290).
- Plan a CE for contributions related to parallelization of the significance map (H0352, H0427, H0286 method 1).
- Further discuss JCTVC-H0399 relating to diagonal scan.
- Discuss 4x4 and 8x8 significance map simplification in regard to the JCTVC-H0100 first part, JCTVC-H0282, and JCTVC-H0284 second method.

Further remarks from the BoG:

H0100 (first part of the proposal) is to have harmonization between 4x4 and 8x8 luma + 4x4 and 8x8 chroma. 11 context reduction, one look-up table less.

H0282: no context map. 7 more contexts. No loss in normal QP, up to 0.1% loss for inter case. Can be implemented with simple logic, without look-up tables. Was studied in CE11.

H0284: one context map for 4x4 and 8x8. Option 1 keeps 4x4 chroma. Option 2: keep 4x4 luma. No losses by down-sampling. DC is different.

One expert expressed support for H0282, as a good trade-off between complexity and additional contexts.

One expert indicated that both context reduction and simple logic would be desirable, which is not achieved in H0282.

Another expert expressed that context reduction is still meaningful and H0100 proposes to reduce the number of contexts by around 10%.

Some experts expressed support for H0284. One expert expressed that having DC as a different step as in H0284 is an extra complexity.

Further study (in an AHG on harmonization of TU size independent coefficient coding) was suggested. This also includes H0379 and H0399 "item 3" and SQT/NSQT harmonization as previously tried in CE11 subtest 4. Co-Chairs for this work were suggested to include V. Sze, G. Martin-Cocher, and J. Sole.

JCTVC-H0100 Non-CE11.1: Context reduction of significance map coding [T. Tsukuba (Sharp)]

JCTVC-H0620 Non-CE11: Cross-check report [H. Sasai, K. Terada, T. Nishi (Panasonic)] [late]

JCTVC-H0131 Non-CE11: Simplified multi-level significance map coding [J. Min, Y. Piao, J. H. Park (Samsung)]

This proposal removes one check performed during the multi-level significance map coding (condition removed: if lower and right significant_coeffgroup_flag in the neighbouring groups are both 1, significant_coeffgroup_flag is also inferred as 1). No losses were reported, with some reduction in number of bins to be coded.

Decision: Adoption of JCTVC-H0131.

JCTVC-H0488 Cross-check of Samsung H0131: Simplified multi-level significance map coding [N. Nguyen, T. Ji, D. He, G. Martin-Cocher (RIM)] [late]

JCTVC-H0253 Improvement on parallelism for context derivation process of significant_coeff_flag [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)]

This contribution is the same as H0427 method 2, which is planned to be studied in CE work.

JCTVC-H0599 Cross-verification of Mitsubishi improvement on parallelism for context derivation process of significant_coeff_flag (JCTVC-H0253) [K. Chono, H. Aoki (NEC)] [late]

JCTVC-H0285 Non-CE11: Block-based significance map context selection [T.-D. Chuang, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)]

JCTVC-H0619 Non-CE11: Cross-check report for JCTVC-H0285 on Block-based significance map context selection [H. Sasai, K. Terada, T. Nishi (Panasonic)] [late]

JCTVC-H0286 Non-CE11: Parallel significance map context assignment [T.-D. Chuang, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)]

JCTVC-H0688 Cross-check of JCTVC-H0286 on Parallel significance map context assignment [W. -J. Chien (Qualcomm)] [late 02-01]

JCTVC-H0287 Non-CE11: Modified method for two-level coding of significance maps [S.-T. Hsiang, T.-D. Chuang, S. Lei (MediaTek)]

JCTVC-H0110 Non-CE11: Cross-verification of MediaTek proposal (JCTVC-H0287) [S. Fukushima, T. Kumakura (JVC Kenwood)] [late]

JCTVC-H0290 Non-CE11: Simplification of context selection for significant_coeff_flag [K. Terada, H. Sasai, T. Nishi (Panasonic)]

Decision: Adopt JCVTC-H0290 second pattern (both for 16x16 and 32x32).

JCTVC-H0357 Non-CE11: Cross-check of proposal H0290 on significant_coeff_flag context selection [V. Sze (TI)] [late 02-02]

JCTVC-H0379 Context reduction of 8x8 significance map coding by hybrid scan with mask [C. Auyeung, J. Xu, A. Tabatabai (Sony)]

JCTVC-H0621 Cross-check report for JCTVC-H0379 on Context reduction of 8x8 significance map coding by hybrid scan with mask [H. Sasai, T. Nishi (Panasonic)] [late]

JCTVC-H0383 Complexity reduction of significance map coding [C. Auyeung (Sony)]

JCTVC-H0609 Crosscheck of context reduction of significe map coding (JCTVC-H0383) [T. Tsukuba T. Yamamoto (Sharp)] [late]

JCTVC-H0411 Significant Coefficient Flag Context Models for Modular Processing [N. Nguyen, T. Ji, D. He, G. Martin-Cocher (RIM)]

JCTVC-H0702 Cross-verification for RIM (JCTVC-H0411) by Samsung [E. Alshina (Samsung)] [late 02-02]

JCTVC-H0594 Cross-check of RIM significant coefficient flag context models for modular processing (JCTVC-H0411) [J. Sole (Qualcomm)] [late]

JCTVC-H0427 Non-CE11: Support modification for parallel calculation of significant map contexts [V. Seregin, J. Sole, M. Karczewicz (Qualcomm)]

JCTVC-H0663 Non-CE11: Cross check of Qualcomm proposal JCTVC-H0427 [J. Kim, C. Kim (LGE)] [late]

JCTVC-H0432 Sub-Block Based Significance Map Region Classification [T. Ji, N. Nguyen, D. He, G. Martin-Cocher (RIM)]

JCTVC-H0359 Non-CE11: Cross-check of proposal H0432 on significant_coeff_flag context selection [V. Sze (TI)] [late 02-09]

JCTVC-H0445 Non-CE11: Low complexity parallel significance map coding [J. Sole, V. Seregin, M. Karczewicz (Qualcomm), T. Ikai, T. Tsukuba (Sharp)]

JCTVC-H0630 Non-CE11: Cross-check of Low complexity parallel significance map coding by Qualcomm and Sharp (H0445) [C. Rosewarne, M. Maeda (Canon)] [late]

JCTVC-H0476 Adjusted significant coefficient map context for Non-Square blocks [J. Kim, B. Jeon (LG)]

JCTVC-H0697 Crosscheck of LG adjusted significant coefficient map context for non-square blocks (JCTVC-H0476) [J. Kim, M. Kim (KAIST)] [late 02-03]

JCTVC-H0526 Multi-level Significance Maps for Small Transform Units [N. Nguyen, T. Ji, D. He, G. Martin-Cocher (RIM)]

This proposal is to apply the multilevel significance map to 8x8 (vertical and horizontal) by reusing the same scans of MDCS. The number of bins saved is up to 1.9%. No losses were reported.

Inferred flags don't depend anymore on the right and lower neighbours, which was anyway removed by JCTVC-H0131.

Some experts suggested that this is a good simplification/unification.

There was a request to review the working draft text, and it was noted that the semantics text needs to be improved – and established that this would be done during the meeting.

Experts expressed support for method B.

Decision: Adoption of JCTVC-H0526 method B (working draft text of H0526r2 was reviewed by B. Bross and code was reviewed by various people in the breakout).

JCTVC-H0615 Cross-check of JCTVC-H0526 on multi-level significance maps for small TU [Y. Piao, E. Alshina, J. H. Park (Samsung)] [late]

JCTVC-H0547 Significance map contexts reduction for small TU [V. Kung, K. Panusopone, L. Wang (Motorola Mobility)]

JCTVC-H0628 Cross-check of Motorola proposal on significance map contexts reduction for small TU (JCTVC-H0547) [H. Yang, H. Yu (Huawei)] [late 02-04]

JCTVC-H0678 Non-CE11: Signalling of significant_coeffgroup_flag for significance map [V. Sze, A. Osamoto (TI)] [late]

5.16.2 Last coefficient flags (x and y)

JCTVC-H0514 Chroma Context reduction for Last Coefficient Position Coding in HEVC [X. Fang, K. Panusopone, L. Wang (Motorola Mobility)]

This document described the implementation and reported the results of a proposed chroma context reduction for last coefficient position coding. Two context index assignments were proposed. The first version uses the same contexts for 4x4 and 8x8 chroma TUs and the second version uses the same contexts for all chroma TUs.

One comment was that the current design is quite regular and in common for luma and chroma coding, and concluded that we have no reason to change this.

JCTVC-H0627 Cross-check of Motorola proposal on chroma context reduction for last coefficient position coding (JCTVC-H0514) [H. Yang, H. Yu (Huawei)] [late 02-01]

JCTVC-H0537 CABAC Contexts Reduction for Last Position Coding [L. Guo, W.-J. Chien, X. Wang, M. Karczewicz (Qualcomm)]

In this proposal, a method to reduce the contexts for last position coding was proposed. First, a single context is proposed to be used for the last bins (with context) from different block sizes; Second, chroma 8x8 and 16x16 blocks share the same set of contexts for last position coding. It was reported a total

context savings of 16 (from 60 to 44) contexts was achieved. Experimental results reportedly show that there is 0.0% Y-BD bit rate change under the common test conditions.

One comment was that even though the number of contexts is lower, the regularity of the table is reduced (for luma), which may be a problem with implementations (e.g. optimized code of reference software).

Other experts expressed the opinion that the reduction of number of contexts is beneficial.

Decision: Adopt combination of H0537 luma and H0514 chroma (version with 3 contexts) – results are identical and a combined WD text was made available in a new version of JCTVC-H0514.

JCTVC-H0612 Crosscheck of Qualcomm proposal (JCTVC-H0537) on CABAC Contexts Reduction for Last Position Coding [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)] [late]

5.16.3 Coefficient level coding

All documents in this category were reviewed in a BoG (as reported JCTVC-H0724).

JCTVC-H0724 BoG report on coefficient level coding [V. Sze]

The BoG recommended to adopt the following:

- Level luma context reduction (JCTVC-H0130) (from CE)
- Simplified coeff_abs_level_minus3 coding (JCTVC-H0498 8-bit look up table with 4 parameters)

Further investigation in a CE was recommended on:

- Context assignment for parallel coefficient level (JCTVC-H0550) (0.1% loss but presumably better parallelism)
- Context Set Selection for Coefficient Level Coding (JCTVC-H0404)

It was then concluded that H0404 should not be investigated in a CE, as the benefit for doing so is not clear from the available H0724 notes.

JCTVC-H0062 Context Simplification on coeff_abs_level_greater1_flag [W. Ding, Y. Shi, B. Yin (BJUT)]

JCTVC-H0690 Cross-check of JCTVC-H0062 on context simplification of coeff_abs_level_greater1_flag [H. Yang (Huawei)] [late]

JCTVC-H0404 Context Set Selection for Coefficient Level Coding [N.Nguyen, T.Ji, D.He, G.Martin-Cocher (RIM)]

JCTVC-H0358 Non-CE11: Cross-check of proposal H0404 on coefficient level context selection [V. Sze (TI)] [late 02-09]

JCTVC-H0497 Improving coeff_abs_level_minus3 coding performance under high bit rate [J. Lou, X. Fang, L. Wang (Motorola Mobility)]

JCTVC-H0607 Cross-check of JCTVC-H0497: Improving coeff_abs_level_minus3 coding performance under high bit rate [X. Zhang, S. Liu (Mediatek)] [late]

JCTVC-H0498 Simplified coeff_abs_level_minus3 coding [J. Lou, L. Wang (Motorola Mobility)]

In the current CABAC design of HEVC, syntax coeff_ab_level_minus3 is used to represent the absolute value of a quantized transform coefficient level minus 3. Adaptive truncated Rice codes with parameters 0, 1, 2, and 3 are used. This document proposed to change the truncated Rice code with 8 bit codewords, so that memory could be saved if a lookup table is used for implementation.

This used an 8-bit codeword length limit to reduce the memory of a lookup table, and reported no loss on common conditions, although some loss at low QP (0.16 for AI HE, 0.17 AI LC, ~0.5% class F).

With parameter 4, low QP also gets gain (-0.22 for AI HE, -0.21 AI LC).

Decision: Adopt H0498, 8 bit codeword, change the Rice parameter to 4 for all cases (which causes no change for common conditions, but performs better at high bit rates).

JCTVC-H0633 Cross-verification of simplified coeff_abs_level_minus3 coding from Motorola Mobility (H0498) [L. Guo (Qualcomm)] [late 02-04]

JCTVC-H0550 Non-CE11: context assignment for parallel coefficient level coding [W. -J. Chien, J. Chen, J. Sole, M. Karczewicz (Qualcomm)]

JCTVC-H0659 Non-CE11: Crosscheck for Qualcomm context assignment for parallel coefficient level coding in JCTVC-H0550 [T.-D. Chuang, Y.-W. Huang (MediaTek)] [late]

5.16.4 Scans

JCTVC-H0284 Non-CE11: Unification of transform coefficient coding [C.-W. Hsu, T.-D. Chuang, Y.-W. Huang, S. Lei (MediaTek)]

This proposal was to use 4x4 sub-block scanning instead of diagonal scanning, also for 8x8 TUs. No noticeable change was reported in BD bit rate results.

Horizontal/vertical scans were not changed.

H0145, H0524, and H0399 also proposed the same.

Decision: Adopt the replacement of the 8x8 diagonal scan by 4x4 diagonal sub-scans.

JCTVC-H0662 Non-CE11: Cross check of Mediatek proposal JCTVC-H0284 [J. Kim, C. Kim (LGE)] [late]

JCTVC-H0145 Non-CE11: Harmonization of 8x8 TU residual scan [C. Rosewarne, M. Maeda (Canon)]

Beyond H0284, this also replaces horizontal/vertical scans of 8x8 blocks by horizontal/vertical scans in 4x4 sub-blocks. This loses 0.3% in AI, and 0.1% in RA&LD cases.

One opinion was expressed that the horizontal/vertical scans are simple to implement (unlike the diagonal), and that therefore the harmonization may not be too important for these.

JCTVC-H0595 Cross-check of Canon harmonization of 8x8 TU residual scan (JCTVC-H0145) [J. Sole (Qualcomm)] [late]

This was the same as H0284.

JCTVC-H0524 Extending 4×4 sub-block diagonal scan to 8×8 TU [J. Kim, C. Kim, J Chen, J. Sole, W. Chien, M. Karczewicz, B. Jeon (Qualcomm)]

JCTVC-H0698 Crosscheck of JCTVC-H0524 on extending 4×4 sub-block diagonal scan to 8×8 TU (JCTVC-H0524) [J. Kim, M. Kim (KAIST)] [late 02-03]

5.16.5 Sign coding

JCTVC-H0227 Non-CE11: Sign Data Hiding without RDOQ [G. Clare, F. Henry, J. Jung, S. Pateux (Orange)]

JCTVC-H0481 Multiple Sign Bits Hiding [X. Yu, J. Wang, D. He, G. Martin-Cocher, S. Campbell (RIM)]

The contribution proposed to embed multiple sign bits for TUs larger than 4x4. Specifically, as nonzero coefficients and significance maps for large transform units are encoded in 4x4 coefficient sets, for each 4x4 coefficient set that satisfies certain conditions, the sign bit of the first nonzero coefficient would be skipped from the bit stream and later inferred from the parity of the sum of all nonzero coefficients in that coefficient set. Experimental results for high efficiency settings based on HM5.0 reportedly showed an average BD bit rate change of -0.7% (AI-HE), -0.6% (RA-HE), and -0.7% (LD-HE) with average encoder runtime ratios of 105%, 102%, 102%, and decoder runtime ratios of 99%, 100%, 100%, compared to HM5.0 anchors. For LC settings where RDOQ is off, the encoder could apply a minimum distortion criterion to ensure a match between a sign bit and a corresponding parity. Experimental results reportedly showed an average BD bit rate change of -1.3% (AI-LC), -1.4% (RA-LC), and -1.0% (LD-LC) with average encoder runtime ratios of 105%, 101%, 101%, and decoder runtime ratios of 99%, 100%, 100%, compared to HM5.0 anchors. Subjective viewing of decoded sequences reportedly did not reveal observed artefacts that may be caused by the proposed technique.

The main difference compared to H0224 is that this is based on groups of coefficients – typically one coefficient per group is changed with a probability of 0.5. Better results were reported in the low-

complexity configuration. The number of coefficients that is changed could effectively be higher than in H0224.

This affects the parsing process, as the existence of the sign bit can only be determined after the significance map is decoded.

One condition is checked per 4x4 block here, compared to one per TU in the case of H0224. In the worst case, the amount of condition checking would be similar.

Proponents of H0224 would also support this proposal as a consistent extension of theirs.

Madhukar Budagavi investigated the impact on implementation complexity and potential impact on visual quality and reported back as follows: Two sequences were viewed (Kimono and Basketball Drive). For Kimono, flickering was slightly reduced, Basketball Drive looked slightly more noisy. No additional blocking artefacts were observed. From the complexity point of view, the original H0224 would have been of concern, because all sign bits were put to the end of the entire block, whereas it would be OK with H0481 where 4x4 subblocks are processed. Additional operations are finding the first and last significant coefficients (which needs somehow to be done anyway in the significance scan), computing their distance, and an XOR operation for the parity.

By appropriate setting of the threshold value, an encoder can decide to not use the method.

One expert raised a concern about throughput, but the method is apparently slightly decreasing throughput.

Decision: Adopt H0481.

JCTVC-H0503 Cross-check of RIM multiple sign bits hiding (JCTVC-H0481) [J. Sole (Qualcomm)] [late]

5.16.6 CBF

No contributions noted.

5.16.7 General/other transform coefficient coding contributions

JCTVC-H0228 Non-CE11: Proposed Cleanup for Transform Coefficient Coding [T. Nguyen, D. Marpe, T. Wiegand (Fraunhofer HHI)]

This contributiono described a scheme for parameter selection related to the coding of transform coefficient levels with CABAC. The change relies on a subset of rules for context model selection and Rice parameter derivation. All transform block sizes and shapes would apply the proposed context model selection, Rice parameter derivation method, and use the same set of context models for the respective bin index. Significance coding and level coding were proposed to be substantially changed.

The last coefficient coding was unchanged. Characteristics of the proposal were summarized as follows:

- Used the same subset of rules for context model selection and Rice parameter derivation
- Used the same subset of rules for all transform block sizes and shapes
- Used the same subset of context models for all transform block sizes and shapes
- Enabled the pre-calculation of context models selected for next scan positions with respective Rice parameter

BR reduction (HE) was reportd as 0.7% AI, 0.5% RA, 0.2% LD.

It was asked whether anything changed in the scan, and this was indicated not to be the case – the scan would be the same as in the current design (no cleanup).

It was mentioned that various things are changed in the software which are not documented in the contribution. As one example, the init value for ALF was changed. Some concerns were expressed about the possibility of reduced throughput and parallelism due to larger amount of dependencies. For example, it would be necessary to completely decode certain coefficients before the next ones could be decoded.

The memory requirement seemed likely to be higher.

Further study (in a CE) was encouraged. It was suggested to investigate the benefit of the different elements and the impact on throughput.

JCTVC-H0699 Non-CE11: Cross-check of proposal JCTVC-H0228 on transform coefficient coding [V. Sze (TI)] [late 02-03]

The cross checker indicated that this proposal introduces some additional dependencies and may provide lower throughput.

JCTVC-H0399 Harmonization of coefficient coding [J. Xu, A. Tabatabai (Sony)]

This proposal would change coefficient coding for TUs with diagonal scan. The proposed solution reportedly had coding efficiency improvement compared to HM5.0. Experimental results reportedly showed that coding efficiency gain is 0.00% for AI HE, -0.13% for AI LC, -0.12% for RA HE, -0.24% for RA LC, -0.13% for LD HE, -0.30% for LD LC and 0.08% for RA HE10.

The proposal used a 4x4 sub-scan for 8x8 blocks as in H0284

For diagonal scan: a multi-level significance scan and context models from 16x16 were also applied in 4x4 and 8x8 cases.

It was asked what is the main reason for the reported gain, and this was reportedly most likely to be due to the neighbour-based context model.

This approach was supported by several experts as a desirable harmonization, and suggested that the BoG on significance map coding should review other proposals under this aspect.

Issues raised in BoG discussions included the following: the unification across diagonal scan implies that there is no unification on the 4x4 and 8x8 cases; as the vertical and horizontal scans remain position based. One expert stated a desire to to keep the position based model for 4x4 and 8x8: that there was no need for parallelization for a better throughput. One expert stated that a position based scheme is not simpler than a template scheme. One expert requested harmonization with MDCS and noted that it is important to clean-up that part of the software. (It was mentioned that JCTVC-H0379 could be related to this harmonization.) Concerns were expressed on the dependencies created in 8x8 when applying the 16x16 pattern. Some experts want to use only smaller TUs for the worst case scenario.

Further discussion in plenary was later conducted:

Decision: (following BoG recommendation) Adopt multi-level significance map coding and contexts reusing 16x16 and 32x32 cases for coefficient group flag for the 4x4 (sub)block scans in all block sizes.

Regarding the third item: using the same significant map coding (template mask based approach) for all diagonal scans, that is for 8x8 and 4x4 diagonal scans. Some gains were reported. It was recommended that this should be further studied in a CE.

It was remarked that in general it would be more desirable to have a full harmonization including the horizontal and vertical scans which are specific now for 4x4 and 8x8 cases and that this should become part of the CE (H0379).

JCTVC-H0684 Cross-verification of JCTVC-H0399 on harmonization of coefficient coding [V. Seregin, J. Sole (Qualcomm)] [late 02-01]

The cross-verifier supported this as a desirable harmonization, and commented that it would be even better if the coding in horizontal/vertical scans would be further unified with the diagonal case.

JCTVC-H0249 Non-CE11: Coefficient sub-sampling for large transform [Y. Chiu, W. Zhang, L. Xu, Y. Han (Intel)] [late]

This contribution presented a sub-sampling process to the transform coefficients with the aim to improve the hardware design bottleneck of the worst case of the maximum number of transform coefficients to be decoded. The sub-sampling operation is applied on the transform coefficients of the high frequency band, and it results in a reduction of the number of transform coefficients. Compared to the test anchor of HM5.0, one configuration of the proposed sub-sampling technique reportedly enables the worst case of the maximum number of transform coefficient to be reduced from 1024 to 768 for the 32x32 transform, and the worst case of the maximum number of transform coefficient to be reduced from 256 to 224 for 16x16 transform with an overall 0.1% BD bit rate change along with slight reduction in both encoding and decoding CPU run time. Subjective tests reportedly showed that no obvious visual quality degradation was introduced by the proposed coefficient sub-sampling.

It was commented that this can be done non-normatively by any encoder. There was no support by other experts, and no action taken.

JCTVC-H0677 Non-CE11: Crosscheck for Intel Coefficient Sub-sampling for Large Transform in JCTVC-H0249 [Q. Huang, X. Guo (MediaTek)] [late]

5.17 Intra prediction and intra mode coding

A BoG coordinated by K. Chono was asked to initially consider the contributions in this area. This was done in two phases as reported by the BoG.

JCTVC-H0712 BoG Report on Intra mode coding cleanup and simplification [K. Chono]

It was suggested to use 35 modes overall for all PU sizes. (Decision: Adopt H0166 & H0342)

Alternatives for complexity reduction were considered: to reduce the number of modes or increase the number of MPMs, unify modes over different PU sizes, MPM sorting postponing, bypass coding (as much as possible, for remaining modes).

Both mode reduction and 3 MPM increase have the advantage of enabling fixed-length coding.

3 MPM solutions give a little bit of compression benefit (approximately 0.2-0.3%).

Assessment unveils that neither reduction of number of modes nor increasing the number of MPM provides a significant complexity reduction or simplification.

MPM sorting postponing provides a complexity reduction w.r.t. software implementation (not hardware) and was suggested by BoG (H0098 and H0428 are identical, H0175 is similar but on top of 3 MPM design).

Initial conclusions included the following:

- In spirit, we want to have an approach that uses 3 MPM and fixed-length coding of remaining modes
- Use H0075 as a basis, and look for best alternative way to encode the 3 MPMs, remaining mode numbering (such that the table is removed) adopt numbering Similar to H0407 and H0175 but 0 for DC, 1-33 directional, 34 planar and MPM sorting postponing from H0175, H0407, H0435, H0516 and H0563 – proponents report back

- Either decide for one of the 3 MPM solutions and use ordering of remaining modes as said above.
- or use 2 MPM + escape and ordering of modes planar=0, DC=1, 2-34 directional

The BoG reported its conclusions on luma intra mode coding as follows:

- 35 modes for all PU sizes
- Sequential intra prediction mode numbering (0: Planar, 1: DC, 22-34: Angular)
- Postponed MPM-sorting
- 3 MPM (JCTVC-H0326 (Scheme1) + JCTVC-H0475); "TU bypass" for mpm_idx and "FL bypass" for rem_intra_luma_pred_mode

The WD text was provided in "JCTVC-H0712-WDtext-final.doc".

Two solutions for some aspects were considered in BoG as candidates as described below in relation to H0721.

JCTVC-H0721 Intra mode coding: Combination of H0075 and H0175 [E. Francois (Canon), C. Yeo (I2R)] [late 02-05]

This contribution summarized the combined proposal from JCTVC-H0075 and JCTVC-H0175 on intra mode coding. The solution is built on top of H0075 as follows:

- 3 MPM, one of which is the planar mode
- 1 context less than in HM5
- 0.2% bit rate reduction was reported.

An alternative was a combination H0407, H0435.

The 3 MPMs are the most probable directional mode and its two closest angular directions.

0.2% bit rate reduction was reported.

Both proposals were requested to be assessed equal in terms of complexity.

Adoption of one of them was determined to be beneficial by consensus of the group.

As it did not seem possible to find technical arguments for one of the sides, and the decision appears to be to some extent random anyway, the coding efficiency was regarded with higher precision (second digit behind the decimal point), which is slightly better for the combination H0407/H0435.

Decision: Adopt combination H0407/H0435 (JCTVC-H0407_3MPM.doc).

JCTVC-H0723 Cross Verification of JCTVC-H0721 on Intra Mode Coding [G. Li (Santa Clara Univ.), L. Liu (Huawei)] [late 02-05]

5.17.1 Intra prediction

5.17.1.1 Chroma intra prediction

JCTVC-H0177 Non-CE6a: Use of chroma phase in LM mode [E. François, S. Pautet, C. Gisquet (Canon)]

This proposal provided additional results related the chroma phase issue in the luma-based chroma prediction mode (LM mode), already addressed in contribution JCTVC-G245. The issue consists in a possible misalignment of interpolated luma samples with the chroma samples. In JCTVC-G245, it has

been proposed to signal the chroma phase parameters and to adapt the luma interpolation process based on this chroma phase information.

This proposal reports further experiments and recommends a set of filters to handle four possible basic chroma phase settings. The evaluation has been made on different versions of 4:2:0 sequences, generated from 4:4:4 sequences, whose chroma components have been downsampled with specific chroma phases. Using these recommended filters, average BD BR gains up to* 0.2% Y, 4.2% U and 3.5% V are reported.

(* = the set of 4:4:4 sequences have been converted into several sets of 4:2:0 sequences with different chroma phases. One average BD BR gain is measured for each set of 4:2:0 sequences.)

It was asked whether this is practical, and how an encoder could determine the correct chroma phase.

Concern was expressed that this could make decoders more complex. It appeared that it could be relevant for professional applications. However, no action was taken on this.

JCTVC-H0475 Signalling chroma intra prediction mode [J. Kim, B. Jeon (LG)]

Discussed in BoG.

Decision: Adopt binarization scheme for chroma prediction mode from H0475 (the same as was proposed as part of H0326).

JCTVC-H0339 Non-CE6: Crosscheck for LG intra chroma mode codeword design in JCTVC-H0475 [T.-D. Chuang, Y.-W. Huang (MediaTek)] [late]

JCTVC-H0691 non-CE6.a: A joint contribution of cross-channel prediction method for chroma [K. Kawamura, T. Yoshino, H. Kato, S. Naito (KDDI), Y. Chiu, Y. Han, L. Xu, W. Zhang, H. Jiang (Intel)] [late]

This combines H0117 and H0295, no further review was necessary, as H0295 was not considered.

5.17.1.2 SDIP-related

5.17.1.3 Intra prediction complexity reduction

JCTVC-H0176 Border adaptive decimation for LM mode [C. Gisquet, E. François (Canon)]

In JCTVC-G358, additional luma-based modes were presented to improve coding efficiency. Also, in JCTVC-G126, simplifications to the OLS computations of the original luma-based modes were also presented. This present contribution merges the two concepts to evaluate the cumulative improvements. It was reported that the technique brings up to 1.3% and 1.2% BD BR gains in AI HE and 1.9% and 2.0% in AI HE 10 bits, respectively, for U and V, while reducing the encoding runtime by up to 1% and the decoding runtime by 2%.

This introduces a second LM mode, but reduces LMS computation for both.

There was no support for this among the experts.

JCTVC-H0206 Crosscheck of JCTVC-H0176 [K Sato (Sony)] [late]

JCTVC-H0244 Non-CE6: Intra-mode bypass parallelism (IMBP) [C. Rosewarne, M. Maeda (Canon)]

This contribution presented a method of encoding CU data for intra mode. The method tries to improve CU decoding performance by grouping data into chunks to achieve higher processing performance and to allow parallel processing with other CU data. Simulation results reportedly show no coding efficiency loss. This modification was implemented on top of HM-5.0 and resulted in degradations of 0.0% for IA HE, 0.0% for RA HE 0.0% for LB HE 0.0% for LP HE configurations in the Luma channel (relative to HM-5.0).

There was no support for this among the experts.

JCTVC-H0686 Crosscheck of JCTVC-H0244 on Intra-mode bypass parallelism [W.-J. Chien (Qualcomm)] [late]

JCTVC-H0464 Non-CE6a: Using averaged down-sampling reference pixels in LM parameter generation [L. Liu, Jianhua Zheng, P. Zhang (HiSilicon), G. Li, Nam Ling, Li Song (SCU)]

A different method of intra chroma from luma (LM mode) prediction was proposed. The simplification of intra LM mode reduces the number of multiplication operations for calculating parameter alpha and beta by using the averaged down-sampled reference luma and chroma samples. It was reported that 1:2 down-sampling of 16x16 PU has 0.00% change for Y and Cb, 0.02% coding loss for Cr; 1:4 down-sampling of 16x16 PU and 1:2 down-sampling of 8x8 PU has 0.00% change in Y, 0.04% and 0.05% coding loss for Cb and Cr, in all intra high efficiency tests.

There was no support for this among the experts.

JCTVC-H0490 Non-CE6a: Reduce the look-up table entries for LM mode calculation [L. Liu (HiSilicon), G. Li (SCU)]

This contribution sugggests to reduce the look-up table used in LM mode calculation from 63 entries to 56 entries or further to 32 entries. It can be derived that the entries from 1~7 are theoretically not used for the calculation of alpha. And the entries from 1~31 are seldom used in all testing sequences. Simulations were reported to show that the performance is the same as the HM5.0 anchor in all intra high efficiency tests.

For information – the contribution was noted.

JCTVC-H0624 Cross-check of JCTVC-H0464 and JCTVC-H0490 [D. Hoang (Zenverge)] [late]

JCTVC-H0491 Non-CE6a: Remove the large multiplier for LM mode calculation [L. Liu, Yongbing Lin (HiSilicon), G. Li (SCU)]

This contribution proposed a change of the chroma from luma intra prediction (LM mode). The proposed method removes the 13-bit (AI-HE) or 15-bit (AI-HE10) multipliers by 8 or 10-bit multipliers through algorithm optimization. The BD bit rate for this optimization was reported as: AI-HE: Y: 0.0%, U: 0.1%, V: 0.0% and AI-HE10: Y: 0.0%, U: 0.1%, V: 0.0%.

Several experts expressed interest, but the detailed description was not available in the first version. Further checking seemed necessary (opinions of T. Hellman, M. Budhagavi, and the crosschecker were requested). The inspection unveiled that a second multiplier is still retained such that the current benefit is

minimum, but it was emphasized that the basic direction is very useful and further investigation is recommended on whether the second multiplier could be removed as well.

JCTVC-H0549 Enabling Sub-LCU level parallel decoding [S. Kumar, H. -C. Chuang, S. Xiao, X. Wang, W. -J. Chien, M. Karczewicz (Qualcomm)]

In HEVC (HM5.0), parallel decoding options include parallel decoding of different LCU rows. A more fine grained parallelism is not possible in the current scheme due to dependencies among blocks inside an LCU. E.g. it is not possible to split an LCU row into a top half and a bottom half for parallel decoding. This contribution identifies the minimal set of dependency (in intra prediction) preventing the feasibility of aforementioned granularity of parallelism (assuming parsing and MV prediction can be done ahead of time). Simulation results show that breaking this minimal set of dependency does not have obvious impact on coding performance. Practical advantages were asserted to include better performance of any cache subsystem, arising from reduced distance between different in-flight processing units and the consequent improved locality of reference.

Parallelism is achieved by partially disallowing prediction across LCU boundaries. It was asked whether this causes artefacts. Proponents say this is not the case, but only refer to PSNR testing.

There was no support for this among the experts.

JCTVC-H0604 Cross-check of JCTVC-H0549 [T. Davies (Cisco)] [late]

5.17.1.4 Intra prediction filtering

JCTVC-H0120 Non-CE6: Improvement of Intra DC prediction for cases without neighbouring samples [A. Duenas, F. Javier Roncero (Cavium)]

This contribution proposed an intra prediction process for the cases where no neighbouring samples are available. This contribution includes adding new elements to the syntax and a decoding process that will support this new intra prediction method.

The contribution proposes to add an intra_DC_X_value parameter to the syntax (where X = luminance, Cb and Cr) that could be used on the cases where the current 128-value prediction is currently utilized to perform intra prediction. Tests considered non-common test condition cases: Low delay P with intra refresh, all intra with slices. Gain was reported as 0.6% for the first, 0.1% for the second case.

There was no support for this among the experts.

JCTVC-H0238 Non-CE6: Simplification of intra vertical/horizontal prediction [J. Lee, S.-C. Lim, H. Y. Kim, J. S. Choi (ETRI)]

This contribution presentsed a simplification of intra vertical and horizontal prediction by removing a division operation in the secondary boundary filtering process. The proposed method replaces the division operation by right shift operation in the HM, and removes a comparer in the WD. It was reported that the average BD bit rate is zero in Intra, both for High-Efficiency (HE) and Low-Complexity (LC) configurations.

Two experts (including the cross-checker) expressed support. It seemed to be an obvious cleanup. Decision: Adopted.

JCTVC-H0614 Crosscheck of ETRI proposal (JCTVC-H0238) on simplification of intra vertical/horizontal prediction [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)] [late]

JCTVC-H0465 Simplification of mode dependent intra smoothing [G. Li, Nam Ling, Li Song (SCU), L. Liu, Nam Ling, Jianhua Zheng, P. Zhang (HiSilicon)]

A method of mode dependent intra smoothing (MDIS) was proposed. The proposal for MDIS removes intra smoothing filtering for prediction units of size 8x8 pixels. It was reported that disabling intra smoothing on 8x8 prediction units except planar mode has 0.03% and 0.05% coding loss for HE and LC cases, respectively; disabling intra smoothing for all intra modes on 8x8 prediction units reportedly has 0.04% and 0.07% coding loss for HE and LC cases.

There was no support for this among the experts.

JCTVC-H0374 Cross-check of Hisilicon JCTVC-H0465 Simplification of mode dependent intra smoothing [X. Wen, O. Au (HKUST)] [late]

5.17.1.5 Angular intra prediction

JCTVC-H0109 Non-CE6: Modification/simplification of intra angular prediction [S. Matsuo, M. Takagi, S. Takamura, A. Shimizu, H. Jozawa (NTT)]

This document introduces an intra angular prediction method exploiting interpolation technique whose tap length is other than two. In the proposed method, reference samples for intra angular prediction are generated by the conventional 2-tap filter or 4-tap DCT-IF. The overall average coding gains against the HM5.0 anchor were about 0.3%, 0.8%, 0.8% (Y, Cb, Cr in HE), 0.4%, 0.2% and 0.3% (Y, Cb, Cr in LC). The maximum coding gains were about 1.8%, 2.5% and 3.4% (Y, Cb and Cr) for the sequence "BasketballDrill" in LC case. The average run-times of encoding and decoding were 99.8% and 99.5%, respectively.

The number of additional filters is large (32). This would not be in alignment with a unified design. Concern was expressed about the complexity increase. No action was taken on this.

JCTVC-H0159 Non-CE6: Cross-check of modified/simplified intra angular prediction (JCTVC-H0109) [T. Yoshino, K. Kawamura, S. Naito (KDDI)]

The cross-checker supported the proposal.

5.17.2 Intra mode coding

JCTVC-H0079 Non-CE6.c: Unified neighbouring positions for intra mode coding [S. Fukushima, H. Nakamura (JVC Kenwood)]

Discussed in BoG – concern was expressed that the current PU size must be known to determine the position, and the benefit is not really clear.

No action was taken on this.

JCTVC-H0081 Non-CE6.c: Fixed length binarization of remaining intra prediction mode [T. Kumakura, S. Fukushima, M. Ueda (JVC Kenwood)]

Discussed in BoG.

JCTVC-H0085 Non-CE6.c: Cross-verification of unified neighbouring positions for intra mode coding (JCTVC-H0079 from JVC) [M. Zhou(TI)]

JCTVC-H0098 Non-CE6: Modified definitions of intra mode and most probable mode [T. Yamamoto (Sharp)]

Discussed in BoG.

JCTVC-H0166 Non CE6: Unification of the number of intra prediction modes [H. L. Tan, C. Yeo, Y. H. Tan, Z. Li (I2R)]

Discussed in BoG.

JCTVC-H0322 Cross-check of I2R proposal on intra luma mode coding (JCTVC-H0166) [H. Yang (Huawei)]

JCTVC-H0342 Non CE6: set intra mode number to be 35 for intra 4x4 PU [C. Lai, L. Liu, J. Zheng (HiSilicon)]

Discussed in BoG.

JCTVC-H0364 Non CE6: Cross-check of 35 intra prediction modes for intra 4x4 PU (JCTVC-H0342) [J. Xu (Microsoft)]

JCTVC-H0175 Non-CE6c: Adaptations of intra mode coding [E. François, S. Pautet, C.Gisquet (Canon)]

Discussed in BoG.

JCTVC-H0717 Non-CE6: Cross-check report for Canon's proposal on intra mode coding (H0175) [X. Zheng, J. Zhou, H. Yu (Huawei)] [late 02-04]

JCTVC-H0597 Non-CE6: Cross-verification of Canon adaptations of Intra mode coding (JCTVC-H0175) [K. Chono, H. Aoki (NEC)] [late]

JCTVC-H0193 Non-CE6: Cross-check report for JCTVC-H0175 on Intra mode coding [H. L. Tan, C. Yeo, Y. H. Tan (I2R)] [late]

JCTVC-H0326 Non-CE6: Simplification of intra chroma mode coding [H. Li, B. Li, L. Li, J. Zhang (USTC), H. Yang, H. Yu (Huawei)]

Discussed in BoG.

JCTVC-H0195 Non-CE6: Cross-check report for H0326 Huawei on Chroma Intra coding [H. L. Tan, C. Yeo, Y. H. Tan (I2R)] [late]

JCTVC-H0428 Non-CE6: Postpone MPM sorting [V. Seregin, W.-J. Chien, M. Karczewicz (Qualcomm)]

Discussed in BoG.

JCTVC-H0632 Non-CE6: Cross-check of Postpone MPM sorting by Qualcomm (H0428); [C. Rosewarne, M. Maeda (Canon)] [late]

JCTVC-H0435 Intra mode coding with fixed length binarization [X. Zhang, S. Liu, M. Guo, X. Guo, S. Lei (MediaTek)]

Discussed in BoG.

JCTVC-H0493 Cross-verification of JCTVC-H0435: Intra mode coding with fixed length binarization [E. S. Ryu, Y. Ye (InterDigital)] [late]

JCTVC-H0534 Non-CE6: Modifications of intra mode coding [W. -J. Chien, J. Chen, M. Karczewicz (Qualcomm)]

Discussed in BoG.

JCTVC-H0631 Non-CE6: Cross-check of Modifications of intra mode coding by Qualcomm (H0534) [C. Rosewarne, M. Maeda (Canon)] [late]

JCTVC-H0563 Non-CE6: Intra mode coding simplification [W.-J. Chien, J. Chen, M. Karczewicz (Qualcomm)]

Discussed in BoG.

JCTVC-H0596 Non-CE6: Cross-verification of Qualcomm intra mode coding simplification (JCTVC-H0563) [S. Fukushima, T. Kumakura (JVC Kenwood)] [late]

JCTVC-H0059 Cross-verification of JVC proposal on Intra mode reduction (JCTVC-H0081) [Y. Lin (HiSilicon)]

JCTVC-H0242 DC mode as a default intra mode [I.-K Kim, T. Lee, J. H. Park (Samsung)]

In this contribution, DC mode was proposed as a default intra mode. For this purpose, complexity and hit numbers between DC and planar mode were analysed. In HM5.0, the default intra mode is assumed as planar mode in the intra mode coding process. Previously, in HM4.0, DC mode was the default intra mode. According to tests, the ratio between the number of operations for (DC prediction + DC prediction filtering) and that of planar prediction is approximately 13.3. The hit rate of planar mode becomes higher when the default intra mode is set as planar mode rather than DC mode. In a similar fashion, the hit number of the DC mode becomes higher when the default intra mode is set as the DC mode rather than the planar mode. Combined with both results, it could be concluded that the complexity of a default DC

mode case is lower (on average) than that of default planar mode case since DC mode has a higher number of hits with lower complexity than the planar mode would have. Average coding efficiency changes from this modification for each configuration were reportedly 0.0% (AI-HE), 0.0% (AI-LC), 0.0% (RA-HE), 0.0% (RA-LC), 0.0% (LD-HE), 0.0% (LD-LC) and 0.1% (RA-HE-10bit). Coding efficiency impact for Class F was -0.1%. Encoding and decoding times were reported as 100% and 99%, respectively. It was noted that a default DC mode is more efficient than a default planar mode, especially for class F since DC prediction is better than planar prediction to represent uniform regions for computer-generated video, such as screen content. Based on these results, it was proposed to use DC mode as the default intra mode in HM6.0.

Decision: Adopted.

JCTVC-H0613 Non-CE6: Cross-verification of Samsung DC mode as a default mode (JCTVC-H0242) [S. Fukushima, H. Nakamura (JVC Kenwood)] [late]

JCTVC-H0405 Bypass coding in chroma Intra modes [E. Maani, A. Tabatabai (Sony)]

Discussed in BoG.

JCTVC-H0598 Cross-verification of Sony Bypass coding in chroma intra modes (JCTVC-H0405) [K. Chono, H. Aoki (NEC)] [late]

JCTVC-H0407 Intra mode coding using logical mode numbering [E. Maani, A. Tabatabai (Sony)]

Discussed in BoG.

JCTVC-H0107 Non-CE6: Crosscheck of intra mode coding (JCTVC-H0407) [T. Yamamoto (Sharp)] [late]

JCTVC-H0516 On MPM determination and Planar mode signalling [Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)]

Discussed in BoG.

JCTVC-H0665 Cross-check of Motorola Mobility proposal on intra mode coding (H0516) [C. Yeo, Y. H. Tan (I2R)] [late]

JCTVC-H0527 Cross-check for Intra mode renaming by Sharp [E. Maani (Sony)] [late]

5.18 Transforms

5.18.1 Core transform implementation

JCTVC-H0305 The core spatial transform with fast algorithm [H. Zhu] [late 02-05]

Document was available 02-05, but no presenter was available.

5.18.2 Alternative transforms

JCTVC-H0456 Non CE 7: Experimental Results for the ROT [Z. Ma, F. Fernandes, E. Alshina, A. Alshin (Samsung)]

This contribution provided simulation results for the Rotational Transform (ROT) enabled in HM 5.0 against the HM 5.0 anchor results. The ROT was implemented using a lifting factorization with 5-bit multipliers and was applied to 8x8, 16x16 and 32x32 luma-component, intra residuals only. For the All-Intra (AI-HE) test case, the ROT provided a reported 0.6% performance gain with 142% encoder execution time relative to the anchor. Decoder execution times were reportedly identical to those of the anchor, within measurement-error margins, for all cases.

There was no need to present or discuss this contribution in detail; it had been submitted for information.

JCTVC-H0559 Non-CE 7 : Recent results for secondary transforms for intra/inter prediction residual [A, Saxena, E. Alshina, F. Fernandes, T Nishi (Samsung), Y. Shibahara (Panasonic)]

Secondary transforms for intra and inter residue have been previously proposed in JCTVC-G108 and JCTVC-G632 respectively, and had been tested in Core Experiment 7. This contribution provided some results related to the proposals, JCTVC-H0125 and JCTVC-H0126 on secondary transforms. Specifically, it was reported that the transform schemes in JCTVC-H0125 and JCTVC-H0126 provide similar or additional gains when integrated with various other tools such as SDIP in AhG16, Transform Skip Mode in CE 5, and Data Hiding in CE 11. Also, it was reported that the complexity of the 4x4 secondary transform is negligible as compared to the 32x32 transform in HM, while it can provide more than half (roughly 60%-70%) of the gain for Intra TUs that a 32x32 transform is providing in HM.

It was reported that, when 32x32 transform is disabled and secondary transform in intra coding is enabled, coding losses are 0.4% and 0.2% in AI, for 8x8 and 4x4 secondary transform. Alternatively, gain could be obtained by keeping the 32x32 and adding the secondary transform.

It was also reported that the secondary transform retains the gain together with transform skipping.

This contribution was not a concrete proposal but rather various additional testing configurations using the same technology that was already reviewed in CE7.

JCTVC-H0692 Non-CE7: Cross-check for Samsung Results for Secondary transforms in JCTVC-H0559 [A. Gabriellini, M. Mrak (BBC)] [late]

JCTVC-H0689 Cross-check of JCTVC-H0559 on the combination of secondary transform and SDIP [H. Yang (Huawei)] [late]

JCTVC-H0672 Non-CE7: Cross-check for Samsung Results for Secondary transforms in JCTVC-H0559 [J. An, X. Guo (MediaTek)] [late]

JCTVC-H0603 Crosscheck of Samsung additional results JCTVC-H0559 for proposals JCTVC-H0125 and JCTVC-H0126 [F. Henry (Orange)] [late]

JCTVC-H0685 Cross-verification of JCTVC-H0559 on boundary dependent transform [V. Seregin (Qualcomm)] [late]

5.19 Memory bandwidth reduction

JCTVC-H0052 Coding with Group of LCUs (GOC) [L. Liang, M. Li, J. Lin, N. Wang, W. Zuo (ZTE)]

This contribution introduces a coding concept called "coding with group of LCUs" (GOC) that partitions a picture, slice or tile into rows which contain more than one LCU row as a GOC and then the scan order of LCUs in the same GOC changes from raster scan to zigzag scan. GOCs are processed in raster scan within a picture, a slice, or a tile. It was argued that this allows for better bandwidth saving for ASIC encoders when struggling with limited on-chip memory. The goc_height indicating the fixed number of LCU rows in a GOC would be signalled in the sequence parameter set or in the picture parameter set. It was asserted that the GOC scheme can co-exist with slices and tiles, and it would be optional in the encoder and have a negligible impact on the decoder design. Experimental results using the compulsory configurations with one tile and one slice per picture and 3 LCU rows per GOC reportedly show that the BD bit rate gain when using GOC is 0.1% on average, and 0.2% for the class E sequences.

50% memory bandwidth was reportedly saved in motion estimation (on the encoder side). At the decoder side, the same zigzag scan can be done by using wavefront processing and a single thread (independency of diagonal blocks), which does not need to be normative.

There was no support for this among the other experts.

JCTVC-H0089 AHG7: Feasibility study results on virtual motion compensation memory bandwidth verifier (VMBV) [H. Kim, M. Zhou (TI)]

This contribution reports feasibility study results on virtual motion compensation memory bandwidth verifier (VMBV) aimed to lower the worst-case motion compensation memory bandwidth requirements, as is proposed in JCTVC-G095. To impose VMBV constraints on bitstreams, a motion compensation memory bandwidth control algorithm is implemented in the encoder motion estimation of HM5.0 to guarantee that resulting bitstreams meet the memory bandwidth budget. The control algorithm is realized by adjusting number of reference frames and CU depth and is operated on a LCU by LCU basis. The memory bandwidth measurement tool used is the one described in JCTVC-C007. In the experiment, the memory bandwidth budget was set to 4 bytes per pixel, there were 13 sequences in common test conditions consumes more bandwidth than the budget. The algorithm was able to bring all the sequences to meet VMBV constraints. However, some of sequences had relatively high loss (up to 5.3%). Although the control algorithm was suggested to be simple and not mature, the results were asserted to reveal that it is feasible to impose VMBV compliance without causing a significant burden on the encoder.

The idea of a normative restriction of bitstreams by VMBV model was discussed. Several experts expressed the opinion that this could be an interesting idea, but the concrete model would need very careful investigation. Also, it was questionable whether this might penalize the compression performance too much.

A side remark was that this could restrict the occurrence of some "evil bitstreams" which would by default not comply. It was suggested that this could also be defined more locally.

Further study (in an AHG) was encouraged.

JCTVC-H0096 AHG7: Controllable memory bandwidth reduction with bi-pred to uni-pred conversion [T. Ikai (Sharp)]

This contribution presents a bi-prediction restriction to reduce motion compensation complexity. In the proposed method the inter_4x4_enabled_flag is replaced with an inter_prediction_restriction_flag to control both PU size restriction and bi-prediction PU size restriction. If inter_prediction_restriction_flag is enabled, bi-prediction of 4x8 and 8x4 PU or 8x8 PU is prohibited depending on MinCUSize. Specifically 4x8 and 8x4 bi-prediction is prohibited when MinCUSize is 8, while 8x8 bi-prediction is prohibited when MinCUSize is 16. If bi-prediction is disabled, the related syntax inter_pred_flag is omitted from the bitstream and uni-prediction to bi-prediction conversion is performed in merge motion parameter derivation process. It was reported that average BD bit rate loss is 0.1% to 0.3% with 6% to 10% less encode time when 4x8 and 8x4 bi-prediction restriction case, while encoder only case's average loss is 0.2% to 0.8%. It is reported that BD bit rate loss is 0.9% to 3.7% with 21% to 31% less encoding time when 8x8 bi-prediction restriction case, while the encoder-only case's average loss is 1.2% to 4.6%.

This seemed similar to H0221. Practical encoders may not use 4x4/4x8/8x4 with bi-prediction at all, and if bi-prediction is not used, the merge mode may not be too useful either. Less loss in coding efficiency is observed when this is implemented in a decoder-normative way (compared to being a bitstream restriction).

JCTVC-H0421 AHG7: Cross-verification of controllable memory bandwidth reduction with bi-pred to uni-pred conversion (JCTVC-H0096 from Sharp) [M. Zhou (TI)] [late]

JCTVC-H0181 AHG7: A restriction of motion vector for small PU size [T. Chujoh, T. Yamakage (Toshiba)]

An experimental result of restriction of motion vector for small PU sizes was reported. This is a non-normative technology to reduce memory bandwidth for motion compensation. The worst cases of memory bandwidth of interpolation process are two-dimensional interpolation positions for both Luma and Chroma of bi-prediction PU. Therefore, in order to reduce the worst case of memory bandwidth, for example, an encoding method that at least one motion vector of L0 or L1 is restricted to an integer position for both luma and chroma. As an experimental result, the loss of coding efficiency is reportedly an average of 0.45% and this value is smaller than the result of prohibition of both 4x8 and 8x4 bi-prediction. Their worst memory bandwidths are reportedly almost the same.

Examples of restrictions were to prohibit bi-prediction for 4x8/8x4; MV of one of L0 or L1 such that no fractional position needs to be interpolated for chroma.

This would be a normative constraint imposed on bitstreams, but it would not change the normative specification of syntax, semantics and decoding. Such constraints could be imposed by level restrictions.

JCTVC-H0104 AHG7: Crosscheck of Toshiba memory bandwidth reduction proposal (JCTVC-H0181) [T. Ikai (Sharp)] [late]

JCTVC-H0221 AHG7: Modification of merge candidate derivation to reduce MC memory bandwidth [K. Kondo, T. Suzuki (Sony)]

This contribution proposes to replace the bi-prediction of merge candidates to uni-prediction when the block size is small (e.g. 4x4, 4x8, 8x4 and 8x8). This technique aims to avoid coding efficiency loss by restricting bi-prediction for small blocks. To restrict bi-prediction and small block is a way to limit maximum memory bandwidth. It was asserted that when a bi-prediction for small block is restricted by level, the encoder cannot choose merge candidates for bi-prediction and it is difficult to use merge and skip mode. This introduces coding efficiency loss. This proposal uses merge and skip mode by replacing the prediction direction to L0. For level 3, without the proposed method the BD BR impact is reportedly 1.1%, 1.6%, 0.8%, 1.4% and 2.3% for RA-HE, RA-LC, RA-HE10, LB-HE and LB-LC. With the proposed method, the BD BR impact is reportedly 0.8%, 1.2%, 0.6%, 0.8% and 1.4%.

Two syntax elements were suggested: Disable bi-prediction for 4x4/8x4 etc.; and Disable merge mode. It was suggested to remove the inter 4x4 enabled flag instead.

By introducing a syntax element that prohibits usage of bandwidth-intense operations for small PUs, the loss in compression efficiency is reduced.

However, no results of actual bandwidth reduction were given here.

Several experts expressed concern on the removal of the inter 4x4 flag.

Further study appeared needed in an AHG to get an assessment about:

- how much memory bandwidth is saved versus loss of compression, and by which constraints
- whether it is sufficient to impose constraints on bitstreams or is necessary to introduce syntax elements which change the decoding process
- the complexity implications, e.g. complicating the parsing process

Only then can the answer can be determined regarding what actions to take.

JCTVC-H0105 AHG7: Crosscheck of Sony memory bandwidth reduction proposal (JCTVC-H0221) [T. Ikai (Sharp)] [late]

JCTVC-H0267 AHG15: Constraint the number of motion vector for memory bandwidth reduction [C.S.Park, T. Kosuge, J.H. Kim, K.H. Lee, J.H.Park, C. Kim (Samsung)]

In HEVC, one 64x64 LCU can have 512 motion vectors in the case of all 4x4 inter partitions of bi-directional prediction. If all partitions are 4x4 inter mode and have two motion vectors for bi-directional prediction, it was asserted not to be guaranteed that one could implement a real time decoder with very high resolution video over full HD due to the memory bandwidth requirement. An SPS flag disabling 4x4 inter partitions which is disabled in default configuration (such as inter_4x4_enabled flag in SPS header) was reportedly adopted at the Torino Meeting. There was supplementary information for restricting specific block sizes to reduce memory bandwidth. However, it was asserted that the mode restriction of block size is not the only solution for memory bandwidth problem.

It was commented that a similar constraint is in AVC; however the issue be more difficult to control in the case of HEVC.

JCTVC-H0706 Cross-check report for Samsung constraint the number of motion vector for memory bandwidth reduction (128-MV restriction in JCTVC-H0267) [S.-C. Lim, H. Y. Kim, J. Lee (ETRI)] [late]

JCTVC-H0441 Motion Compensation Restrictions to Alleviate Memory Bandwidth Concerns for High Resolution Video [T. Hellman, W. Wan (Broadcom)]

This proposal recommended adding a profile-independent level limit on the types of motion compensation prediction units, to alleviate worst-case motion compensation bandwidth. It notes that the AVC standard has a level limit on the number of motion vectors per MB pair, but the proposal claims that restricting 4x8 and 8x4 PUs to uni-prediction for HD and larger-sized pictures would be a preferred method to address the same concerns for HEVC.

4x8 and 8x4 are causing the main waste of bandwidth, particularly with bi-pred.

Such constraints could be imposed just at higher levels. (The loss is smaller in classes A and B.)

Assessment reportedly shows that worst-case decoder memory bandwidth then is only 20% higher than in AVC (using the contributor's own tool for bandwidth measurement).

The loss in compression should stay acceptable.

Several experts expressed the opinion that bi-prediction with 4x8/8x4 over all levels would be the most simple and effective solution. This would not even require definition by high-level syntax flags.

JCTVC-H0600 AHG7: Level definition to limit memory bandwidth of MC [K. Kondo, Y. Morigami, T. Suzuki (Sony)] [late]

This was suggested to be considered in the context of level definition discussions.

5.20 Alternative coding modes

5.20.1 I_PCM

JCTVC-H0051 Burst transmission of I_PCM blocks [K. Chono, H. Aoki (NEC)]

This contribution presented simulation results of the burst I_PCM method proposed in JCTVC-G118. The method allows encoders to send I_PCM sample data of successive I_PCM blocks without termination associated with entropy coding process. It was asserted that this significantly enhances the throughput of transmitting PCM sample data of successive I_PCM blocks while reducing some bits of side information. Simulation results for common test sequences reportedly demonstrate that the burst I_PCM scheme does not affect the BD bit rate and time results of HM-5.0-dev-highlevel rev1712 software. Additional simulation results for a synthesized sequence reportedly demonstrate that it reduces the header bit rates of lossless coded video by 32 kbps or 2.4% without affecting encoding and decoding times.

It was confirmed and supported by crosscheckers that this is useful.

Decision: Adopted (and suggested to use simplified "version B" of the WD text, but both versions are expressing the same technical content).

JCTVC-H0611 Crosscheck of NEC proposal (JCTVC-H0051) on Burst transmission of I_PCM blocks [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)] [late]

JCTVC-H0469 Cross-check of NEC proposal H0051 on burst transmission of I_PCM blocks by Panasonic [S. M. T. Naing, V. Wahadaniah, C. S. Lim (Panasonic)] [late]

5.20.2 Transform skipping

JCTVC-H0141 Non-CE5: Improved transform skipping mode [J. Dong, Y. Ye (InterDigital)]

This contribution presented a modified design for the transform skipping mode (TSM) that was proposed in the 7th JCT-VC meeting (JCTVC-G575) and studied in core experiment (CE) 5 (JCTVC-G1205). First, the operation logic for TSM_1 and TSM_2 were modified with 16-bit implementation. Second, the number of arithmetic operations used in quantization and dequantization was reportedly reduced. Third, the look-up tables used for TSM to deal with a half-bit right shift were saved. This design was integrated into HM-5.0_tsm, which is the software base for CE5, and its R-D performance was tested under the common test conditions specified in JCTVC-G1200. The BD bit rate performance was reportedly a 0.0% to 0.1% increase on average for Classes A-E and 0.0% to 0.2% increase for Class F, compared with the baseline TSM. However, the proposal did not resolve the problems that were discussed in the context of CE5, and no action was taken on this.

JCTVC-H0657 Non-CE5: A crosscheck report on complexity reduction for transform skipping mode (JCTVC-H0141) [R. Joshi (Qualcomm)] [late]

JCTVC-H0061 Non Transform Mode for Inter Coding [Weijia Zhu, Wenpeng Ding, Yunhui Shi, Baocai Yin (BJUT)]

This contribution is related to the work of the AHG group on transform skipping, which addressed the transformation of residues. This contribution only focuses on the inter-residues situation. The inter-residues tend to be compactly represented in the DCT transform domain. But for some non-smooth residual blocks, transform skipping is a better choice. However, if all TUs adaptively select whether the 2D-DCT transform will be used according to RDO, the encoder complexity undoubtedly increases dramatically. It was reported that the major size of TUs using the proposed method is 4×4, so a scheme which only tests the proposed approach on the 4×4 TUs was proposed. This reportedly leads to a significant reduction of encoder complexity and a comparable coding performance. Simulation results reportedly show that the proposed scheme improves the coding performance of HEVC, especially for screen content sequences.

The proposal was to use only a full 2D transform or a full transform skip, for only 4x4 TUs in the inter coding case.

It was noted that a change of scaling in de-quantization can be implemented by shift.

The gain is 0.1-0.2% in common test conditions, and for Class F: 1.8% for RA, 3.7% for LD.

Encoding runtime increased 6% for RA.

No action was taken on this.

JCTVC-H0325 Cross-check of BJUT proposal on transform skip mode (JCTVC-H0061) [H. Yang (Huawei)] [late]

JCTVC-H0259 Efficient signalling of transform skipping mode [J. Kim, M. Kim (KAIST)] [late 02-04]

In this contribution, a signalling method of transform skipping modes for the non-square quadtree (NSQT) transform scheme was proposed. The proposed method for non-square transform skipping mode is to reduce the number of transform skipping modes by excluding the no-transform mode and to use a 1-bit flag to signal the transform skipping modes of 2D transform, 1D row transform and 1D column

transform. The proposed method reduces the computational complexity by limiting the number of transform skip modes to be tested from 4 to 2 according to the non-square transform types. The encoding complexity of the proposed method is reportedly reduced to 2~3% over HM5.0_tsm in the common test conditions without degrading BD bit rate performance.

The proposal is to make signalling of skipping for the NSQT case dependent on the NSQT structure (e.g. skipping vertical is more likely when vertical size is low). It seemed questionable whether this is a complexity benefit (more likely an increase of dependencies). No compression gain was reported. No action was taken on this.

5.20.3 Lossless compression

(The relevant AHG report was presented in this context. It recommended to review all contributions.)

JCTVC-H0083 AHG19: Method of frame-based lossless coding mode for HEVC [M. Zhou (TI)]

Efficient lossless coding was asserted to be required for real-world applications such as automotive vision, video conferencing and long-distance education. This contribution proposed to install a high-level flag "bypass_coding_mode_enabled_flag" in the PPS to enable a lossless coding mode by bypassing inverse quantization, inverse transform, deblocking filter, SAO and ALF, and to use sample-based angular intra prediction (SAP) in the lossless coding mode for better coding efficiency. The proposed sample-based prediction is the same as the HM5.0 block-based angular prediction in terms of prediction angles and sample interpolation, requiring no syntax or semantics changes, but differing in the decoding process in terms of reference sample selection. In the proposed method, a sample to be predicted uses its direct neighbouring samples for better intra prediction accuracy. Compared to the HM5.0 anchor lossless method which bypasses transform, quantization, de-blocking filter, SAO and ALF, the proposed method reportedly provides an average gain of 8.30% in AI-HE, 8.53% in AI-LC, 2.85% in RA-HE, 2.93% in RA-LC, 2.0% in LB-HE and 2.06% in LB-LC. For class F sequences only, the average gain is reportedly 12.23% in AI-HE, 12.55% in AI-LC, 7.11% in RA-HE, 7.28% in RA-LC, 5.72% in LB-HE and 5.84% in LB-LC. The SAP is reportedly fully parallelized on the encoder side, and can be executed at a speed of one row or one column per cycle on the decoder side.

The contribution proposed sample based prediction (SAP) using same prediction directions as currently in the HM but with sample-by-sample prediction (as it is lossless, it was asserted that this does not matter, and everything can still be LCU-based).

Compared to an HM anchor with transform and quantizer bypass, the gain is 8.3% average for AI (including class F, which shows higher gain than other classes), 2.9% for RA, 2.0% for LD

It was remarked that the HM anchor (without SAP) is the true "bypass mode", which would come practically for free, whereas SAP would require implementation of another building block which might not be desirable in a main profile where many applications might not use it.

Compression ratios were reported as follows:

	All Intra HE			All Intra LC		
	compression ratio		bit-rate saving	compression ratio		bit-rate saving
	anchor	proposed		anchor	proposed	
Class A	2,21	2,46	-10,26%	2,20	2,46	-10,48%
Class B	2,09	2,18	-4,52%	2,08	2,18	-4,69%
Class C	1,97	2,11	-6,49%	1,97	2,11	-6,76%
Class D	1,83	2,01	-8,41%	1,82	2,01	-8,67%
Class E	2,90	3,23	-10,30%	2,89	3,23	-10,47%
Class F	4,51	5,21	-12,23%	4,48	5,20	-12,55%
Overall	2,58	2,86	-8,30%	2,57	2,85	-8,53%
Enc Time[%]	105%			105%		
Dec Time[%]	93%			93%		
	Random Access HE			**Random Access LC**		
	compression ratio		bit-rate saving	compression ratio		bit-rate saving
	anchor	proposed		anchor	proposed	
Class A	2,72	2,80	-2,99%	2,72	2,80	-3,07%
Class B	2,38	2,41	-0,94%	2,38	2,41	-0,99%
Class C	2,55	2,59	-1,69%	2,55	2,59	-1,76%
Class D	2,67	2,73	-2,07%	2,66	2,72	-2,13%
Class E						
Class F	28,38	30,90	-7,11%	28,24	30,82	-7,28%
Overall	7,99	8,55	-2,85%	7,95	8,54	-2,93%
Enc Time[%]	102%			101%		
Dec Time[%]	100%			99%		
	Low delay B HE			**Low delay B LC**		
	compression ratio		bit-rate saving	compression ratio		bit-rate saving
	anchor	proposed		anchor	proposed	
Class A						
Class B	2,38	2,40	-0,77%	2,38	2,40	-0,80%
Class C	2,55	2,58	-1,45%	2,54	2,58	-1,51%
Class D	2,66	2,71	-1,66%	2,66	2,71	-1,72%
Class E	4,15	4,16	-0,28%	4,15	4,16	-0,30%
Class F	47,02	49,50	-5,72%	46,82	49,36	-5,84%
Overall	11,66	12,18	-2,00%	11,62	12,15	-2,06%
Enc Time[%]	103%			102%		
Dec Time[%]	100%			100%		

	Low delay B HE			Low delay B LC		
	compression ratio		bit-rate saving	compression ratio		bit-rate saving
	anchor	proposed		anchor	proposed	
Class A						
Class B	2,33	2,35	-1,03%	2,33	2,35	-1,07%
Class C	2,47	2,51	-1,50%	2,47	2,51	-1,54%
Class D	2,59	2,64	-1,63%	2,59	2,63	-1,68%
Class E	4,12	4,14	-0,36%	4,12	4,13	-0,38%

Class F	47,00	49,42	-5,64%	46,77	49,28	-5,77%
Overall	11,61	12,12	-2,07%	11,56	12,09	-2,12%
Enc Time[%]	97%			100%		
Dec Time[%]	90%			92%		

JCTVC-H0055 AHG19: Cross-verification of a method of frame-based lossless coding mode for HEVC JCTVC-H0083 [K. Chono, H. Aoki (NEC)] [late]

(This was initially accidentally uploaded as an "associated resource" instead of as the actual contribution, which led to a lack of awareness of its availability.)

JCTVC-H0499 Entropy coding for Lossless compression [S.H. Kim, A. Segall (Sharp)] [late]

In this contribution, a CABAC structure for lossless compression was presented. Considering the statistical difference of residual data between lossless compression and common lossy coding, the contribution proposed a simplified CABAC structure without last position coding. The proposed lossless CABAC was asserted to use a significantly reduced number of context models (about 80%) under the lossless coding conditions. It was further reported that the proposed approach reduces the number of coded bits in high efficiency configurations by 1.7% for AI HE encoding, 1.18% for RA HE, and 0.87% for LB HE when coding losslessly.

Suggestions included removing the last coding, and modifying significance map coding.

The gain is interesting, but requires modification of the entropy coder.

No WD text was in the contribution – this was later uploaded after presentation. No cross-check was available. Further study was encouraged.

JCTVC-H0528 AHG19: A QP-based enabling method for lossless coding in HEVC [W. Gao, M. Jiang, H. Yu (Huawei)]

It was asserted that lossless coding can be used in many practical applications, such as medical imaging, remote desktop sharing, online gaming, etc. In this contribution, a method was proposed for lossless coding in HEVC. The contribution proposed using QP to signal a HEVC whether a CU employs lossless coding or not. Specifically, if QP=0 for a CU, (inverse) lossless coding is applied, i.e., inverse quantization, inverse transform, de-blocking filter, SAO, and ALF are all bypassed for this coding unit (see JCTVC-G664). Furthermore, the sample-based intra prediction method (SAP), as proposed in JCTVC-H083 for lossless coding, could be used to replace the existing intra prediction method and signalled by this proposal, i.e. selected by QP=0 as well. With this signalling method, the lossless coding mode could be applied to the entire picture or to individual CUs. The HM5.0 software had been modified to incorporate this signalling method. Test results were shown to demonstrate the effectiveness of this signalling method.

The proposal was to use QP=0 to signal bypass of transform, quantization and all filtering in the loop.

Using QP=0 for the entire sequence is identical to the "anchor" used in H0083, but QP=0 could also invoke lossless coding per CU (switching off the in-loop filters would be similar as in IPCM).

JCTVC-H0530 AHG19: A lossless coding solution for HEVC [W. Gao, M. Jiang, H. Yu (Huawei), M. Zhou (TI)]

This proposal was combination in a way that QP=0 is used to signal bypass of the transform, quantization and in-loop filtering, and enabling of SAP.

It was commented that it might even be interesting to have separate control over SAP (e.g. making it switchable per PU).

Decision: The lossless mode that comes "for free" (i.e. bypassing transform, inverse quantization, and in-loop filters) was adopted.

One concern that was raised wasa whether using QP=0 is appropriate, as it might happen that QP becomes negative – e.g. when bit depth is increased. This could presumably be done as in AVC where an bit depth compensated QP value determined the selection.

Alternative solutions would be to either define the "lowest available QP value" for CU-based signalling, or have a separate syntax element (similar to I_PCM); with an enabling flag for either of these solutions at slice header / PPS / SPS / APS. This was then discussed in plenary session. Decision: Use an enabling flag in the SPS, which expresses that lowest QP value is used to switch to lossless.

The SAP and entropy coding modification H0499 could be interesting for a future "lossless profile" and should be further studied.

JCTVC-H0673 AHG19: Cross-check of H0528 and H0530 on lossless coding [Y. H. Tan, C. Yeo, Z. Li (I2R)] [late]

5.21 Encoder optimization

JCTVC-H0178 Encoder speed-up for the MV cost estimation [G. Laroche, T. Poirier, P. Onno (Canon)]

This contribution proposed a non-normative (encoder-only) change regarding the introduction of an early termination rule. This rule deals with the computation of the rate-distortion cost of the motion vector predictors at the encoder side. More precisely, a termination rule was proposed to avoid evaluating all the rate-distortion costs of the merge candidates. It was reported that with this early termination rule, an average decrease of 5% of the encoding time is observed without any impact on the BD BR measure (average BD BR gain of 0%).

The modification was indicated to be 10 lines of modification in the HM code.

It was suggested to expose this as a config file option rather than a macro-enabled feature (and, as a general rule, to have such features be switchable in this fashion).

Decision (SW): Adopt (and enable it in common conditions – but keep in mind that experiments affecting AMVP should perhaps operate with it disabled).

JCTVC-H0241 Cross-check report for Canon encoder speed-up for the MV cost estimation (JCTVC-H0178) [S.-C. Lim, H. Y. Kim, J. Lee, J. S. Choi (ETRI)] [late]

JCTVC-H0213 Rate control based on unified RQ model for HEVC [H. Choi, J. Nam, J. Yoo, D. Sim (KWU), I.V. Bajić (SFU)]

This contribution presented a rate control scheme based on a "unified RQ" model for HEVC. The proposed rate control works at various levels such as the GOP, frame, and unit levels. The unit can be one LCU or a group of LCUs. To solve a "chicken and egg" dilemma between actual generated bit rate and QP value in rate control problem, this contribution proposed a quadratic pixel-based "unified rate-quantization" (URQ) model for HEVC rate control. The proposed URQ model is defined to show the relationship between a target rate and QP value for a pixel. It is asserted that because the proposed RQ model is designed for a pixel, it can be used for any sizes of a rate control level consisting of multiple

pixels. In addition, a MAD factor was employed to predict the texture complexity of a rate control level with a linear model. The target number of bits for the current frame was calculated according to a given frame rate, available channel bandwidth, occupancy of virtual buffer, target buffer level, and initial buffer status. For the unit level, target bits are calculated with the number of pixels of a unit, occupancy of virtual buffer, and target bits for the current frame. For evaluation of the proposed algorithm, HM5.0 which uses hierarchical QP setting, was tested.

The number of lines of code was asserted to be less than 1000, with 99% of this put into a single file.

Both a #define and config file parameter control mechanism were provided.

An apparent error was pointed out in regard to the use of QP versus quantization step size.

Delta QP is used at the LCU level.

Some adjustment is included (without operation of real rate control) for non-reference frames, to avoid wasting too many bits on non-reference frames.

Decision (SW): Adopted (with discretion to fix the QP issue), subject to prioritization with other software integration work (and assuming that the code is reasonably clean).

5.22 Withdrawn and missing contributions

JCTVC-H0060 CE11:SubTest 2 Context Simplification of Coefficient Entropy Coding [Wenpeng ding, Xiaoyin Che, Yunhui Shi, Baocai Yin (BJUT)]

Withdrawn.

JCTVC-H0144 Withdrawn

Withdrawn.

JCTVC-H0256 Improvement on LCU-based ALF/SAO [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)]

Withdrawn.

JCTVC-H0291 Information for video editing at CRA pictures - withdrawn [C. Kim, Y. Park, J. H. Kim, J. H. Park (Samsung)]

Withdrawn.

JCTVC-H0304 6H7Q luma interpolation filter [H. Zhu]

Still missing at the end of meeting – considered as withdrawn.

JCTVC-H0333 Two additions dequantization [N. Shlyakhov, J. H. Park (Samsung)]

Withdrawn.

JCTVC-H0363 Cross-check of context simplification on coeff_abs_level_greater1_flag - withdrawn (JCTVC-H0062) [J. Xu (Microsoft)]

Still missing at the end of meeting – considered as withdrawn.

JCTVC-H0470 AHG4: Cross-check of LG and Sharp proposal H0556 on harmonized method for signalling entry points of tiles and WPP substreams by Panasonic [S. M. T. Naing, V. Wahadaniah, C. S. Lim (Panasonic)]

Withdrawn.

JCTVC-H0529 Withdrawn

Withdrawn.

JCTVC-H0564 cross-check (??) [late]

Still missing at the end of the meeting – considered as withdrawn.

JCTVC-H0572 AHG10: Crosscheck [?? (??)]

Still missing at the end of the meeting – considered as withdrawn.

JCTVC-H0636 Withdrawn

Withdrawn.

JCTVC-H0647 Withdrawn

Withdrawn.

JCTVC-H0670 Downsampling filter for anchor generation for scalable extensions of HEVC [Jie Dong, Yong He, Yan Ye (InterDigital)] [late]

Outside the current scope of work (misregistered).

JCTVC-H0675 Non-CE4: Cross verification of low complexity dQP coding (JCTVC-H0189) [M. Coban (Qualcomm)]

Still missing at the end of the meeting – considered as withdrawn. At some point, this also seemed to get mixed up somehow in the database with JCTVC-H0738.

JCTVC-H0693 Withdrawn

Withdrawn.

6 Plenary Discussions and BoG Reports

6.1 Project development

No particular discussions noted.

6.2 BoGs

JCTVC-H0709 BoG Report on MV Coding [B. Bross]

See section 5.12.

JCTVC-H0710 BoG Report on Quantization Matrices [T. Suzuki, K. Sato]

See section 4.4.1.

JCTVC-H0712 BoG Report on Intra mode coding cleanup and simplification [K. Chono]

See section 5.17.

JCTVC-H0713 BoG report on subjective viewing test for CE10 deblocking filter proposals [A. Norkin, K. Andersson, M. Narroschke, X. Guo, G. van der Auwera]

See section 4.10.1.

JCTVC-H0715 BoG report on Decoded picture buffering and reference picture signalling [J. Boyce]

See section 5.13.10.

JCTVC-H0719 BoG report on significance map [G. Martin-Cocher]

See section 5.16.1.

JCTVC-H0720 BoG report on interlace indicators [K. Chono, C. Fogg, D. Flynn, S. Sekiguchi]

See section 5.6.5.

JCTVC-H0724 BoG report on coefficient level coding [V. Sze]

See section 5.16.3.

JCTVC-H0725 BoG output: Common conditions for reference picture marking and list construction proposals [Ye-Kui Wang, Miska M. Hannuksela, T. K. Tan, R. Sjöberg, Y. Ye] [late]

See section 5.13.10.

JCTVC-H0726 BoG report on reduction of SAO BO offset buffer [T. Yamakage]

See section 4.8.1.

JCTVC-H0727 BoG report: tiles and wavefront parallel processing [M. Horowitz]

See section 5.13.5.

JCTVC-H0728 BoG report on High throughput binarization for CABAC [A. Duenas]

See section 5.15.2.

JCTVC-H0729 BoG report on motion compensation operation and interpolation filters [T.Chujoh]

See section 5.11.

JCTVC-H0730 BoG Report on Quantization Matrices Subjective Viewing [K. Sato, T. Suzuki, X. Zhang, R. Joshi, J. Zheng, M. Zhou]

See section 4.4.1.

JCTVC-H0732 BoG report on Adaptive Loop Filtering [T. Yamakage]

See section 5.8.1.

JCTVC-H0738 BoG report on profiles & levels [K. McCann, T. K. Tan (BoG coordinators)]

See section 5.4.

7 Project planning

7.1 WD drafting and software

The following agreement was 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 decision of the committee without including a full integration of the available inadequate text.

7.2 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 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 CEs).

Suggestions for future meetings included the following generally-supported principles:

- No review of normative contributions without WD text
- HM text strongly encouraged for non-normative contributions
- Early upload deadline to enable substantial study prior to the meeting
- Using a clock timer to ensure efficient proposal presentations (5 min) and discussions

The document upload deadline for the next (April/May 2012) meeting was planned to be likely to be 18 Apr. After the meeting, this was later adjusted to 16 Apr., due to rescheduling of the meeting dates.

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. Also, core experiment responsibility descriptions should name individuals, not companies. AHG reports and CE descriptions/summaries are considered to be the contributions of individuals, not companies.

7.3 General issues for CEs

Because a draft design and HEVC test model (referred to as the HM) have now been established, group coordinated experiments are now referred to as "core experiments" rather than "tool experiments".

A preliminary CE description is ordinarily to be approved at the meeting at which the CE plan is established. At a minimum, the plan to have a CE on a subject area needs to be agreed at the meeting. In cases where it is not feasible to review a CE description during the meeting due to time constraints, some description needs to be provided shortly after the meeting and finalized by email discussions.

It is possible to define sub-experiments within particular CEs, for example designated as CEX.a, CEX.b, etc., for a CEX, 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 HM 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 experiments were described in the output document JCTVC-H1100.

Modifications include:

- Added SAO & RDOQ to LC and renamed to "Main".
- We have one other configuration, called HE10, and are dropping the current HE.
- Picture-based optimization for the RA configs (SAO & ALF). LCU-based optimization for AI & LD (SAO & ALF).
- New Class E test sequences.

Software HM6.0 availability (suitable for CTC coding efficiency experiments) was planned for three weeks after the end of the meeting.

Any adopted proposals where software is not delivered by the scheduled date will be rejected.

A deadline of three weeks after the meeting was established for organizations to express their interest in participating in a CE to the CE coordinators and for finalization of the CE descriptions by the CE coordinator with the assistance and consensus of the CE participants.

Any change in the scope of what technology will be tested in a CE, beyond what is recorded in the meeting notes, requires discussion on the general JCT-VC reflector.

As a general rule, all CEs are expected to include software available to all participants of the CE, with software to be provided within two (calendar) weeks after the release of the HM 5.0 software basis. Exceptions must be justified, discussed on the general JCT-VC reflector, and recorded in the abstract of the summary report.

Final CEs shall clearly describe specific tests to be performed, not describe vague activities. Activities of a less specific nature are delegated to Ad Hoc Groups rather than designated as CEs.

If combinations of proposals are intended to be tested in a CE, the precise description shall be available with the final CE description, otherwise it cannot be claimed to be part of the CE.

Experiment descriptions should be written in a way such that it is understood as a JCT-VC output document (written from an objective "third party perspective", not a company proponent perspective – e.g. referring to methods as "improved", "optimized" 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 should not contain 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 referenced documents that are also available in the JCT-VC document archive.

Those who proposed technology in the respective context (by this or the previous meeting) can propose a CE or CE sub-experiment. Harmonizations of multiple such proposals and minor refinements of proposed technology may also be considered. Other subjects would not be designated as CEs.

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.

It is strongly recommended to plan resources carefully and not waste time on technology that may have little or no apparent benefit – it is also within the responsibility of the CE coordinator to take care of this.

A summary report written by the coordinator (with the assistance of the participants) is expected to be provided to the subsequent meeting. The review of the status of the work on the CE at the meeting is expected to rely heavily on the summary report, so it is important for that report to be well-prepared, thorough, and objective.

CE plan documents were unable to be reviewed and given tentative approval during this meeting.

The CE description for each planned CE is described in an associated output document JCTVC-H11xx for CExx, where "xx" is the CE number (xx = 01, 02, etc.). Updated CE plans are recorded as revisions of these documents.

It must be understood that the JCT-VC is not obliged to consider the test methodology or outcome of a CE as being adequate. Good results from a CE do not impose an obligation on the group to accept the result (e.g., if the expert judgment of the group is that further data is needed or that the test methodology was flawed).

Some agreements relating to CE activities were established as follows:

- Only qualified JCT-VC members can participate in a CE.
- Participation in a CE is possible without a commitment of submitting an input document to the next meeting.
- All software, results, documents produced in the CE should be announced and made available to all CE participants in a timely manner.

7.4 Alternative procedure for handling complicated feature adoptions

The following alternative procedure had been approved at a previous meeting as a method to be applied for more complicated feature adoptions:

1. Run CE + provide software + text, then, if successful,
2. Adopt into HM, including refinements of software and text (both normative & non-normative); then, if successful,
3. Adopt into WD and common conditions.

Of course, we have the freedom (e.g. for simple things) to skip step 2.

7.5 Common Conditions for HEVC Coding Experiments

Preferred Common Conditions for experiment testing that are intended to be appropriate for both CEs and other experiments were selected by the group and described in output document JCTVC-H1100.

7.6 Software development

The software coordinator had already started integrating bug fixes on top of the HM software, and had strongly recommended for proponents of adopted proposals to re-implement them in the latest HM and test in this environment before integrating them into the final software to be released. All tools were planned to again be thoroughly tested after integration in HM 6.x.

HM 6.0 should be available within 3 weeks after the meeting, and will be used for CEs. HM 6.1 is planned to be available 3 weeks later.

8 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 will be the main JCT-VC reflector (jct-vc@lists.rwth-aachen.de).

Title and Email Reflector	Chairs	Mtg
JCT-VC project management (AHG1) (jct-vc@lists.rwth-aachen.de) • Coordinate overall JCT-VC interim efforts. • Report on project status to JCT-VC reflector. • Provide report to next meeting on project coordination status.	G. J. Sullivan, J.-R. Ohm (co-chairs)	N
HEVC Draft and Test Model editing (AHG2) (jct-vc@lists.rwth-aachen.de) • Produce and finalize JCTVC-H1002 HEVC Test Model 6 (HM 6) Encoder Description. • Produce and finalize JCTVC-H1003 HEVC text specification Draft 6. • Gather and address comments for refinement of these documents. • Coordinate with the Software development and HM software technical evaluation AhG to address issues relating to mismatches between software and text.	B. Bross, K. McCann (co-chairs), W.-J. Han, I. K. Kim, J.-R. Ohm, K. Sugimoto, G. J. Sullivan, T. Wiegand (vice-chairs)	N
Software development and HM software technical evaluation (AHG3) (jct-vc@lists.rwth-aachen.de) • Coordinate development of the HM software and its distribution to JCT-VC members • Produce documentation of software usage for distribution with the software • Prepare and deliver HM 6.0 software version and the reference configuration encodings according to JCTVC-H1100 based on common conditions suitable for use in most core experiments (expected within 3 weeks after the meeting). • Prepare and deliver HM 6.1 software (and additional "dot" version software releases as appropriate) and appropriate software branches that include additional items not integrated into the 6.0 version (expected within three weeks after the 6.0 software release). • Perform analysis and reconfirmation checks of the behaviour of technical changes adopted into the draft design, and report the results of such analysis. • Suggest configuration files for additional testing of tools. • Coordinate with HEVC Draft and Test Model editing AhG to identify any mismatches between software and text.	F. Bossen (chair), D. Flynn, K. Sühring (vice-chairs)	N

High-level parallelism (AHG4) (jct-vc@lists.rwth-aachen.de) • Study high-level parallelism techniques. • Identify and work to resolve issues relating to the draft text description of existing high-level parallelism related tools (i.e., tiles, wavefronts, and entropy slices), and the associated HM implementation. • Introduce slice-tile constraint functionality into the HM (i.e., addition of a slice mode to encode slices using an integer number of tiles). • Identify and discuss additional issues relating to high-level parallelism.	M. Horowitz (chair), M. Coban, F. Henry, K. Kazui, A. Segall, W. Wan, S. Wenger, M. Zhou (vice-chairs)	N
Unified Coefficient Coding (AHG5) (jct-vc@lists.rwth-aachen.de) • Study and investigate unified context selection and coefficient scanning for all TU sizes (including SQT/NSQT) . • Work on solutions that would unify coefficient coding for all TU sizes while considering throughput/complexity requirements. • Report the results of these studies, discussions and experiments to the JCT-VC, also in relation with CE3. • Recommend a unified solution if available.	V. Sze (chair), C. Auyeung, G. Martin-Cocher, T. Nguyen, J. Sole (vice-chairs)	N
In-loop filtering (AHG6) (jct-vc@lists.rwth-aachen.de) • Study simplification and harmonization of in-loop filtering technologies. • Clean up and stabilize the HM software, the draft text and the HM encoder description on non-deblocking in-loop filtering. • Study the interaction between in-loop filtering and IPCM codeblocks (including consideration of the starting basis design recorded at the San Jose meeting in response to JCTVC-H0448). • Study complexity and latency implications of in-loop filtering.	T. Yamakage (chair), K. Chono, Y. J. Chiu, I. S. Chong, M. Narroschke, A. Norkin (vice chairs)	N
Memory bandwidth restrictions in motion compensation (AHG7) (jct-vc@lists.rwth-aachen.de) • Study memory bandwidth in motion compensation. • Study restrictions to reduce the average and worst case of memory bandwidth. • Study level specific restrictions, for example restrict	T. Suzuki (chair)	N

usage of small PUs, restrict usage of 2D interpolation, restrict subpel accuracy etc, to reduce memory bandwidth in motion compensation. • Evaluate the impact of such restrictions on coding efficiency.		
Profile and level definitions (AHG8) (jct-vc@lists.rwth-aachen.de) • Review the set of levels defined in the CD to confirm that they span the target range of 8-bit 4:2:0 video applications with a reasonable degree of granularity. • Review the Main Profile defined in the CD to confirm that it meets the requirements for complexity / compression efficiency trade-off for the target range of 8-bit 4:2:0 video applications. • Evaluate the performance, functionality and complexity of coding tools that are identified as potential candidates for either inclusion or exclusion in the Main Profile. • Study the extensibility of the current concept of profile/level definition towards possible architectures for future profiles that could provide additional trade-off points between complexity and functionality, while facilitating interoperability.	M. Horowitz, K. McCann (co-chairs), T. Suzuki, T. K. Tan, W. Wan, Y.-K. Wang, T. Yamakage (vice-chairs)	N
Video test material selection (AHG9) (jct-vc@lists.rwth-aachen.de) • Identify, collect, and make available a variety of video sequence test material. • Study the coding performance and characteristics of test materials. • Identify and recommend appropriate test materials and corresponding test conditions for use in HEVC development.	T. Suzuki (chair)	N
Loss robustness (AHG10) (jct-vc@lists.rwth-aachen.de) • Create and/or maintain tools to test loss robustness including error patterns and a loss simulator. • Identify techniques and conditions for testing the loss robustness of the design. • Study the degree of loss robustness of the HM design and identify deficiencies. • Identify and study the interdependencies in the HM design in relation to loss robustness, and the potential consequences of these interdependencies. • Investigate solutions to improve loss robustness. • Investigate the trade-off between coding efficiency and	S. Wenger (chair), M. Coban, Y. W. Huang, P. Onno, Y.-K. Wang (vice-chairs)	N

loss robustness. • Discuss related Core Experiments, and identify potential synergies or incompatibilities related to the tools being tested in the CEs.		
High-level syntax (AHG11) (jct-vc@lists.rwth-aachen.de) • Study NAL unit header, sequence parameter set, picture parameter set, adaptation parameter set, and slice header syntax designs. • Study the partial update issue associated with adaptation parameter set. • Study and identify needs for SEI messages and VUI. • Study the hypothetical reference decoder (HRD) behaviour, discuss and provide a draft text of sub-picture based HRD operations. • Work towards simplification and general minor cleanup of the high-level syntax. • Assist in software development and text drafting for the high-level syntax in the HEVC design.	Y. K. Wang (chair), J. Boyce, Y. Chen, M. Hannuksela, K. Kazui, T. Schierl, R. Sjöberg, T. K. Tan W. Wan, P. Wu (vice-chairs)	N
Hooks for scalable coding (AHG12) (jct-vc@lists.rwth-aachen.de) • Investigate hooks that would be needed for support of bitstream scalability in HEVC syntax.	J. Boyce (chair), J. Kang, J. Samuelsson, W. Wan, Y.-K. Wang (vice-chairs)	N
Lossless coding (AHG13) (jct-vc@lists.rwth-aachen.de) • Study and investigate techniques which enable lossless coding. • Examine common test cases for lossless coding modes.	W. Gao (chair), K. Chono, J. Xu, M. Zhou, P. Topiwala (vice-chairs)	N
Chroma format support (AHG14) (jct-vc@lists.rwth-aachen.de) • Study aspects of the technical design and software that need modification to support non-4:2:0 chroma formats. • Assist and advise in the work of removing implicit assumptions of 4:2:0 formatting from the WD and software (where feasible, without introducing technical design changes).	D. Flynn (chair), D. Hoang, K. McCann, E. Francois, K. Sugimoto, P. Topiwala (vice-chairs)	N
Reference picture buffering and list construction (AHG15) (jct-vc@lists.rwth-aachen.de) • Finalize the test specification document for reference picture buffering and list construction proposals for the 9th JCT-VC meeting in a timely manner (JCTVC-H0725).	R. Sjöberg (chair), Y. Chen, Hendry, T. K. Tan, W. Wan, Y.-K. Wang (vice chairs)	N

• Provide source code that enables HM encoding of all test cases described in JCTVC-H0725 and produce anchor data. • Identify and work to resolve issues relating to the draft text description of reference picture handling and list construction, and the associated HM software functionality. • Study possible improvements related to reference picture buffering and list construction. • Study the loss resilience properties of reference picture handling and its support in the HM software (in coordination with the loss resilience AHG).		
Subjective impact of quantization (AHG16) (jct-vc@lists.rwth-aachen.de) • Investigate tools for intensity dependent quantization and related impact on bit-rate. • Study the impact of varying QPs on affected tools and rate control. • Study the subjective impact of quantization matrices in relation to CE4. • Investigate solutions for adapting the deblocking filter under varying QPs.	M. Mrak (chair), C. Auyeung, A. Norkin, K. Sato, J. Zheng (vice-chairs)	N

9 Output documents

The following documents were agreed to be produced or endorsed as outputs of the meeting. Names recorded below indicate those responsible for document production.

JCTVC-H1000 Meeting Report of 8th JCT-VC Meeting [G. J. Sullivan, J.-R. Ohm]

JCTVC-H1001 HEVC software guidelines [K. Suehring, D. Flynn, F. Bossen, (software coordinators)]

JCTVC-H1002 High Efficiency Video Coding (HEVC) Test Model 6 (HM 6) Encoder Description [K. McCann (primary), B. Bross, W.-J. Han, I. K. Kim, K. Sugimoto, G. J. Sullivan] (WG 11 N 12555)

JCTVC-H1003 High Efficiency Video Coding (HEVC) text specification draft 6 [B. Bross (primary), W.-J. Han, G. J. Sullivan, J.-R. Ohm, T. Wiegand] (WG 11 N 12556)

JCTVC-H1004 Report on preliminary subjective testing of HEVC compression capability [V. Baroncini, J.-R. Ohm, G. J. Sullivan] (WG 11 N 12475)

NOTE – The above-listed output report JCTVC-H1004 was requested by the WG 11 parent body to be generated by JCT-VC management for review as a separate part of the reported meeting results.

JCTVC-H1100 Common HM test conditions and software reference configurations [F. Bossen]

JCTVC-H1101 Core Experiment 1: Sample adaptive offset filtering [Y. Huang (primary), E. Alshina, I. S. Chong, W. Wan, M. Zhou]

JCTVC-H1102 Core Experiment 2: Adaptive loop filtering [T. Yamakage (primary), M. Budagavi, I. S. Chong, M. Narroschke, Y.-W. Huang]

JCTVC-H1103 Core Experiment 3: Coefficient scanning and coding [V. Sze (primary), J. Chen, T. Nguyen, K. Panusopone, J. Sole]

JCTVC-H1104 Core Experiment 4: Quantization matrices [K. Sato (primary), R. Joshi, S. Liu, M. Zhou]

10 Future meeting plans, expressions of thanks, and closing of the meeting

Future meeting plans were established according to the following guidelines:

- Meeting under ITU-T SG 16 auspices when it meets (starting meetings on the Monday or Tuesday of the first week and closing it on the Tuesday or Wednesday of the second week of the SG 16 meeting), and
- Otherwise meeting under ISO/IEC JTC 1/SC 29/WG 11 auspices when it meets (starting meetings on the Wednesday or Thursday prior to such meetings and closing it on the last day of the WG 11 meeting).

Some specific future meeting plans were established as follows:

- 27 April – 7 May 2012 under ITU-T auspices in Geneva, CH.

  NOTE – The planned dates as listed above for the 9th meeting are the result of a change of plans that was established and announced after the 8th meeting had ended.
- 11–20 July 2012 under WG 11 auspices in Stockholm, SE.
- 10–19 October 2012 under WG 11 auspices in Shanghai, CN.
- 14–23 January 2013 under ITU-T auspices in Geneva, CH.

The US NB of WG 11 and Julie Higgins, Diane Pearson, and Betsy Bartlett of Meeting Planit were thanked for their excellent hosting of the 8th meeting of the JCT-VC. Huawei and Sony were thanked for providing the viewing equipment used at the meeting, and David Flynn for providing appropriate video player software. The JCT-VC thanked Vittorio Baroncini, Giancarlo Gaudino, FUB, and ISCOM for conducting formal subjective tests on the compression performance of the current draft HEVC standard in comparison to AVC. Christian Feldmann, Bin Li, Mathias Wien and Jizheng Xu were thanked for preparing the bitstreams and performing preliminary investigations.

The JCT-VC meeting was closed at approximately 1250 hours on Friday 10 Feb 2012.

Annex A to JCT-VC report:
List of documents

JCT-VC number	MPEG number	Created	First upload	Last upload	Title	Source
JCTVC-H0001	m24001	2012-02-10 17:17:01	2012-04-20 20:21:13	2012-04-20 20:21:13	JCT-VC AHG Report: Project Management (AHG1)	G. J. Sullivan, J.-R. Ohm
JCTVC-H0002	m23853	2012-02-01 02:16:31	2012-02-01 02:28:21	2012-02-01 19:02:19	JCT-VC AHG report: HEVC Draft and Test Model editing (AHG 2)	B. Bross, K. McCann (co-chairs), W.-J. Han, I.-K. Kim, J.-R. Ohm, S. Sekiguchi, G. J. Sullivan, T. Wiegand (vice-chairs)
JCTVC-H0003	m23851	2012-01-31 20:09:18	2012-04-18 20:13:44	2012-04-18 20:13:44	JCT-VC AHG report: Software development and HM software technical evaluation (AHG 3)	F. Bossen, D. Flynn, K. Suehring
JCTVC-H0004	m23733	2012-01-30 16:57:58	2012-01-30 17:01:51	2012-01-30 17:01:51	JCT-VC AHG report: Picture Partitioning and LCU scan order (AHG4)	R. Sjöberg (chair), Y. Chen, F. Henry, M. Horowitz, K. Kazui, A. Segall, W. Wan (vice chairs)
JCTVC-H0005	m23846	2012-01-31 17:05:53	2012-01-31 17:09:23	2012-01-31 17:09:23	JCT-VC AHG Report: Spatial Transforms (AHG 5)	P. Topiwala, M. Budagavi, R. Cohen, R. Joshi
JCTVC-H0006	m23845	2012-01-31 16:13:47	2012-02-01 02:29:54	2012-02-04 17:38:18	JCT-VC AHG report: In-loop and post-processing filtering (AHG 6)	T. Yamakage, K. Chono, Y. J. Chiu, I. S. Chong, M. Narroschke, A. Norkin
JCTVC-H0007	m23496	2012-01-24 12:41:23	2012-02-01 07:50:40	2012-02-01 07:50:40	JCTVC AHG Report: Memory bandwidth restrictions in motion compensation (AHG7)	T. Suzuki
JCTVC-H0008	m23849	2012-01-31 19:07:51	2012-01-31 19:21:53	2012-01-31 19:21:53	JCT-VC AHG report: Profile and level definitions (AHG 8)	M. Horowitz (eBrisk), K. McCann (Samsung/Zetacast), T. Suzuki (Sony), T.K. Tan (NTT DOCOMO), W. Wan (Broadcom), Y.-K. Wang (Qualcomm)
JCTVC-H0009	m23855	2012-02-01 02:24:22	2012-02-01 02:29:44	2012-02-01 02:29:44	JCT-VC AHG report: Entropy Coding Architecture (AHG 9)	K. McCann (chair), J. Lainema, D. Marpe, A. Segall, K. Sugimoto, V. Sze, W. Wan, X. Wang
JCTVC-H0010	m23286	2012-01-20 21:50:22	2012-02-01 14:10:00	2012-02-03 19:22:06	JCTVC AHG Report: Parallel merge/skip (AHG10)	M. Zhou, H. Y. Kim, P. Onno, X. Wen
JCTVC-H0011	m23497	2012-01-24 12:42:31	2012-02-01 07:51:09	2012-02-01 22:03:29	JCTVC AHG Report: Video test material selection (AHG11)	T. Suzuki

JCTVC-H0012	m23879	2012-02-01 09:19:20	2012-02-01 09:20:01	2012-02-01 09:20:01	JCT-VC AHG Report: Objective quality metric and alternative methods for measuring coding efficiency (AHG12)	G. Sullivan, K. Minoo
JCTVC-H0013	m22926	2012-01-19 03:09:58	2012-01-30 02:29:07	2012-02-02 23:43:48	JCTVC AHG Report: Interlace indication (AHG13)	K. Chono, C. Fogg, K. Sato, S. Sekiguchi, W. Wan,
JCTVC-H0014	m23820	2012-01-31 01:59:58	2012-01-31 02:01:02	2012-01-31 02:01:02	JCT-VC AHG Report: Loss robustness (AHG14)	S. Wenger (AHG chair)
JCTVC-H0015	m23614	2012-01-30 00:56:10	2012-01-31 03:29:15	2012-01-31 03:29:15	JCT-VC AHG report: High-level syntax (AHG 15)	Y. -K. Wang (chair), J. Boyce, Y. Chen, M. M. Hannuksela, K. Kazui, T. Schierl, R. Sjöberg, T. K. Tan, W. Wan, P. Wu (vice chairs),
JCTVC-H0016	m23595	2012-01-28 18:15:52	2012-02-01 02:19:00	2012-02-01 02:19:00	JCTVC AHG Report: Unification of NSQT and SDIP (AHG16)	X. Zheng, J. Xu, X. Wang, A. Tabatabai, J. Lim
JCTVC-H0017	m23347	2012-01-21 00:22:19	2012-02-01 18:19:33	2012-02-01 18:50:00	JCTVC AHG Report: Hooks for scalable coding	J. Boyce, J. Kang, J. Samuelsson, W. Wan, Y.-K. Wang,
JCTVC-H0018	m23083	2012-01-20 11:05:14	2012-01-30 19:30:25	2012-02-02 00:14:30	JCT-VC AHG report: Resolution adaption (AHG 18)	T. Davies (Chair), P. Topiwala, P. Wu (Vice-chairs)
JCTVC-H0019	m23864	2012-02-01 05:28:23	2012-02-01 05:38:26	2012-02-01 05:38:33	JCT-VC AHG report: Lossless Coding (AHG19)	Wen Gao (chair), Keiichi Chono, Jizheng Xu, Minhua Zhou, Pankaj Topiwala (vice chairs)
JCTVC-H0020	m23894	2012-02-01 20:15:35	2012-02-01 20:17:15	2012-02-01 20:37:23	JCT-VC AHG report: Chroma format support (AHG20)	D. Flynn, P. Topiwala, D. Hoang, K. McCann
JCTVC-H0021	m23735	2012-01-30 17:09:20	2012-01-30 17:12:20	2012-02-03 04:19:33	JCT-VC AHG report: Reference picture buffering and list construction (AHG21)	R. Sjöberg (chair), Y. Chen, Hendry, T. K. Tan, W. Wan, Y. -K. Wang (vice chairs)
JCTVC-H0022	m23863	2012-02-01 05:08:55	2012-02-01 05:18:36	2012-02-11 00:30:12	JCT-VC AHG report: HM subjective quality investigation (AHG22)	G. J. Sullivan, J.-R. Ohm (AHG chairs), F. Bossen, T. Wiegand (vice chairs)
JCTVC-H0031	m23453	2012-01-21 21:34:14	2012-01-31 18:27:24	2012-01-31 18:27:24	CE1: Summary report of core experiment on entropy coding	R. Joshi, A. Alshina, H. Sasai, H. Kirchhoffer, J. Lainema (CE Coordinators)
JCTVC-H0032	m23871	2012-02-01 07:17:08	2012-02-01 07:25:42	2012-02-01 07:25:42	CE2: Summary report of Core Experiment on Chroma RQT depth	K. Sugimoto, X. Guo, X. Wang (CE Coordinators)
JCTVC-H0033	m23065	2012-01-20 10:03:52	2012-01-31 00:31:10	2012-01-31 00:31:10	CE3: Summary of Core Experiment on Chroma Interpolation Filter	T.Chujoh, E.Alshina (CE coordinators)
JCTVC-H0034	m23522	2012-01-26 06:14:34	2012-02-01 18:17:16	2012-02-01 18:17:16	CE4: Summary report of Core Experiment on Quantization	K Sato (Sony), M Budagavi (TI), M Coban (Qualcomm), H Aoki (NEC), X Li (MediaTek)
JCTVC-H0035	m23478	2012-01-23	2012-01-30	2012-02-01	CE5: Summary Report of Core Experiment on Transform Skipping	M. Mrak, J. Sole, J. Xu, A. Saxena

		17:03:00	00:35:27	08:20:18		(CE coordinators)
JCTVC-H0036	m23512	2012-01-26 01:34:11	2012-01-31 01:06:18	2012-02-01 18:09:41	CE6: Summary Report of Core Experiments on Intra Coding Improvements	Ali Tabatabai, Keiichi Chono, Edouard Francois (CE Coordinators)
JCTVC-H0037	m23474	2012-01-23 14:53:50	2012-01-30 19:35:55	2012-02-03 01:42:32	CE7: Summary Report of Core Experiment on Additional Transforms	R. Cohen, C. Yeo, R. Joshi, F. Fernandes (CE coordinators)
JCTVC-H0038	m23834	2012-01-31 09:28:21	2012-02-01 02:20:16	2012-02-04 16:51:46	CE8: Summary report of Core Experiment on non-deblocking loop filtering	T. Yamakage, I. S. Chong, M. Narroschke, Y.-W. Huang
JCTVC-H0039	m23525	2012-01-26 07:33:12	2012-01-30 12:17:19	2012-01-30 12:17:19	CE9: Summary report of Core Experiment on MV Coding and Skip/Merge Operations	I.-K Kim, J. Jung, S. Oudin (CE coordinators)
JCTVC-H0040	m23353	2012-01-21 00:38:17	2012-02-01 18:19:18	2012-02-04 03:21:13	CE10: Summary report of Core Experiment on deblocking filtering	A. Norkin, X. Guo, B. Jeon, M. Narroschke (CE coordinators)
JCTVC-H0041	m23477	2012-01-23 16:55:05	2012-02-01 06:09:48	2012-02-03 02:34:25	CE11: Summary report of Core Experiment on coefficient scanning and coding	V. Sze, T. Nguyen, K. Panusopone, Y. Piao, J. Sole (CE coordinators)
JCTVC-H0051	m22916	2012-01-13 10:58:59	2012-01-18 02:54:14	2012-02-06 16:17:03	Burst transmission of I_PCM blocks	K. Chono, H. Aoki (NEC)
JCTVC-H0052	m22919	2012-01-18 10:16:46	2012-01-20 03:15:16	2012-02-04 08:36:50	Coding with Group of LCUs (GOC)	L. Liang, M. Li, J. Lin, N. Wang, W. Zuo (ZTE)
JCTVC-H0053	m22922	2012-01-18 11:56:25	2012-01-20 13:55:47	2012-01-20 13:55:47	CE4 Subtest 1: Rate control friendly spatial QP prediction based on intra prediction (test 1.3)	H. Aoki, K. Chono (NEC), M. Kobayashi, M. Shima (Canon), M. Coban, M. Karczewicz (Qualcomm), K. Sato (Sony)
JCTVC-H0054	m22923	2012-01-18 11:58:20	2012-01-20 13:51:52	2012-01-21 03:33:04	CE4 Subtest 1: HM 4 QP prediction with reset to preceding QP in scan order at LCU boundary (test 1.2)	H. Aoki, K. Chono (NEC)
JCTVC-H0055	m22924	2012-01-19 03:03:51	2012-02-09 19:20:45	2012-02-09 19:20:45	AHG19: Cross-verification of a method of frame-based lossless coding mode for HEVC	K. Chono, H. Aoki (NEC)
JCTVC-H0056	m22925	2012-01-19 03:05:10	2012-01-20 13:55:41	2012-01-31 22:59:44	AHG13: On interlace indication	K. Chono, H. Aoki (NEC)
JCTVC-H0057	m22927	2012-01-19 07:47:24	2012-01-20 14:10:31	2012-01-20 14:10:31	CE6 subset 5.2.2 and 6.2.2: Intra coding improvements	Y. Lin, L. Liu, J. Zheng (HiSilicon), H. Yang, H. Yu (Huawei),
JCTVC-H0058	m22928	2012-01-19 07:51:20	2012-01-20 14:11:16	2012-01-20 14:11:16	Cross-verification of CE6 subset 6.2.1: On intra prediction mode coding (JCTVC-H0075)	Y. Lin, L. Liu (HiSilicon)
JCTVC-H0059	m22929	2012-01-19 07:52:12	2012-01-20 14:11:58	2012-01-20 14:11:58	Cross-verification of JVC's proposal on Intra mode reduction (JCTVC-H0081)	Y. Lin (HiSilicon)
JCTVC-H0060	m22930	2012-01-19 09:33:49	2012-01-19 11:44:15	2012-01-19 11:44:15	Withdraw	
JCTVC-H0061	m22931	2012-01-19 09:39:11	2012-01-19 11:44:50	2012-02-02 18:32:12	Non Transform Mode for Inter Coding	Weijia Zhu, Wenpeng Ding, Yunhui Shi, Baocai Yin

JCTVC-H0062	m22932	2012-01-19 09:50:42	2012-01-19 11:45:05	2012-02-02 18:33:39	Context Simplification on coeff_abs_level_greater1_flag	Wenpeng Ding, Yunhui Shi, Baocai Yin
JCTVC-H0063	m22933	2012-01-19 12:33:34	2012-01-20 08:54:18	2012-01-20 08:54:18	Coding efficiency comparison between HM5.0 and JM16.2 based on PQI, PSNR and SSIM	Yin Zhao
JCTVC-H0064	m22936	2012-01-19 15:27:47	2012-01-19 17:22:17	2012-01-20 10:47:32	CE5.c – Mode-dependent significance scans for transform skip	M. Mrak, A. Gabriellini (BBC)
JCTVC-H0065	m22937	2012-01-19 15:35:49	2012-01-19 15:46:41	2012-02-06 21:55:59	Mixed Chroma Sampling-rate coding: combining the merits of 4:4:4 and 4:2:0 and increasing the value of past 4:2:0 investment	Tao Lin, Shuhui Wang
JCTVC-H0066	m22938	2012-01-19 20:58:39	2012-01-20 20:14:10	2012-02-01 04:40:50	CE8.a.2: ALF with LCU-based syntax	A. Fuldseth, G. Bjøntegaard (Cisco)
JCTVC-H0067	m22939	2012-01-19 21:00:22	2012-01-20 20:14:53	2012-02-08 19:50:08	Non-CE8.a.2: SAO with LCU-based syntax	A. Fuldseth, G. Bøntegaard (Cisco)
JCTVC-H0068	m22940	2012-01-19 23:28:43	2012-01-19 23:34:47	2012-02-09 23:45:09	CE8.b: ALF with single filter type	M. Budagavi (TI)
JCTVC-H0069	m22941	2012-01-20 00:54:13	2012-01-20 16:52:51	2012-02-09 01:03:25	APS partial update through Referencing	Stephan Wenger, Jill Boyce, Ming Li, Ping Wu, David Flynn,
JCTVC-H0070	m22942	2012-01-20 00:57:45	2012-01-21 02:03:37	2012-02-01 20:19:05	APS partial update through conditional replacement	Stephan Wenger, Jill Boyce
JCTVC-H0071	m22943	2012-01-20 01:00:49	2012-01-20 19:57:51	2012-01-20 19:57:51	On the need for an Adaptation Parameter Set	Stephan Wenger, Jill Boyce, Won Kap Jang
JCTVC-H0072	m22944	2012-01-20 01:29:27	2012-01-21 02:02:33	2012-01-23 03:16:03	NAL Unit loss software	Stephan Wenger
JCTVC-H0073	m22945	2012-01-20 01:49:24	2012-01-20 02:34:47	2012-02-06 21:59:00	4:4:4 screen content coding using Macroblock-Adaptive Mixed Chroma-Sampling-Rate	Shuhui Wang, Tao Lin
JCTVC-H0074	m22946	2012-01-20 02:11:10	2012-01-20 12:47:21	2012-01-20 12:47:21	CE9: Cross-verification of BP03 (JCTVC-H0111)	S. Fukushima, M. Ueda (JVC Kenwood)
JCTVC-H0075	m22947	2012-01-20 02:11:31	2012-01-20 10:27:59	2012-01-20 10:27:59	CE6: Subtest 6c (6.2.1) – Intra mode coding simplification	C. Yeo, Y. H. Tan, H. L. Tan, Z. G. Li (I2R)
JCTVC-H0076	m22948	2012-01-20 02:13:14	2012-01-20 08:59:43	2012-01-27 09:39:01	CE1: Cross-check of Subtest B2 – Test 3 (H0266)	C. Yeo, Y. H. Tan, Z. G. Li (I2R), L. Guo, M. Karczewicz (Qualcomm)
JCTVC-H0077	m22949	2012-01-20 02:13:31	2012-01-20 12:48:20	2012-01-20 12:48:20	Non-CE9: Merge candidates pruning without reference indices	S. Fukushima, K. Arakage (JVC Kenwood)
JCTVC-H0078	m22950	2012-01-20 02:16:18	2012-01-20 12:48:55	2012-01-20 12:48:55	Non-CE9: Simplification of AMVP spatial candidate derivation	S. Fukushima, H. Nakamura, H. Takehara (JVC Kenwood)
JCTVC-H0079	m22951	2012-01-20 02:17:26	2012-01-20 12:49:24	2012-02-02 23:27:31	Non-CE6.c: Unified neighboring positions for intra mode coding	S. Fukushima, H. Nakamura (JVC Kenwood)

JCTVC-H0080	m22952	2012-01-20 02:18:11	2012-01-20 10:20:20	2012-01-20 10:20:20	CE7: Cross-check of Tool 2, Boundary-dependent transform for inter	Y. Sugito, A. Ichigaya (NHK)
JCTVC-H0081	m22953	2012-01-20 02:18:27	2012-01-20 12:49:51	2012-02-02 23:28:12	Non-CE6.c: Fixed length binarization of remaining intra prediction mode	T. Kumakura, S. Fukushima, M. Ueda (JVC Kenwood)
JCTVC-H0082	m22954	2012-01-20 02:26:12	2012-01-20 20:50:43	2012-01-22 23:07:48	AHG10: Configurable and CU-group level parallel merge/skip	M. Zhou (TI)
JCTVC-H0083	m22955	2012-01-20 02:26:29	2012-01-20 20:51:41	2012-02-04 20:14:22	AHG19: Method of frame-based lossless coding mode for HEVC	M. Zhou (TI)
JCTVC-H0084	m22956	2012-01-20 02:26:42	2012-01-20 20:53:01	2012-01-20 20:53:01	CE10 Subtest 1: Test results on unification of luma and chroma filtering	M. Zhou (TI)
JCTVC-H0085	m22957	2012-01-20 02:27:02	2012-01-20 13:43:24	2012-01-20 13:43:24	Non-CE6.c: Cross-verification of unified neighboring positions for intra mode coding (JCTVC-H0079 from JVC)	M. Zhou(TI)
JCTVC-H0086	m22958	2012-01-20 02:27:18	2012-01-21 05:06:58	2012-01-21 05:06:58	Non-CE9: Cross-verification of modification of derivation process for MVP candidate in AMVP/Merge (JCTVC-H0216 from Panasonic)	M.Zhou (TI)
JCTVC-H0087	m22959	2012-01-20 02:27:56	2012-01-20 14:06:22	2012-01-20 14:06:22	Non-CE9: Cross-verification of removing PU dependency in TMVP reference index derivation (JCTVC-H0092 from LGE and Qualcomm)	M. Zhou (TI)
JCTVC-H0088	m22960	2012-01-20 02:32:19	2012-01-30 06:13:16	2012-01-30 06:13:16	Non-CE8.a.2: Cross-check of SAO with LCU-based syntax (JCTVC-H0067)	T. Nishi, K. Uchibayashi (Panasonic)
JCTVC-H0089	m22961	2012-01-20 02:44:43	2012-01-21 01:54:49	2012-01-21 01:54:49	AHG7: Feasibility study results on virtual motion compensation memory bandwidth verifier (VMBV)	H. Kim, M. Zhou (TI)
JCTVC-H0090	m22962	2012-01-20 02:47:26	2012-01-20 10:09:10	2012-02-01 20:02:39	AHG10: Unified design on parallel merge/skip	Y. Jeon, B. Jeon (LG), M. Zhou (TI), X. Wen, O. C. Au (HKUST), H. Y. Kim (ETRI), K. Y. Kim (KHU)
JCTVC-H0091	m22963	2012-01-20 02:52:14	2012-01-20 09:55:16	2012-02-01 19:31:59	Non-CE9: Parallel Merge Candidate Derivation for Inter_NxN partition type	Y. Jeon, B. Jeon (LG), V. Seregin, X Wang, J. Chen, M. Karczewicz (Qualcomm)
JCTVC-H0092	m22964	2012-01-20 02:53:29	2012-01-20 09:56:30	2012-01-20 09:56:30	Non-CE9: Removing PU dependency in TMVP reference index derivation	Y. Jeon, B. Jeon (LG), V. Seregin, X Wang, J. Chen, M. Karczewicz (Qualcomm)
JCTVC-H0093	m22965	2012-01-20 02:57:15	2012-01-20 09:59:13	2012-01-23 05:00:29	Non-CE9: Crosscheck of Panasonic's proposal on TMVP refIdx derivation in merge/skip (JCTVC-H0214)	Y. Jeon, B. Jeon (LG)
JCTVC-H0094	m22966	2012-01-20 03:06:03	2012-01-20 10:42:25	2012-02-05 18:47:37	Non-CE8: Modification of directional classification for block-based adaptation on ALF	M. Matsumura, S. Takamura, A. Shimizu, H. Jozawa (NTT),
JCTVC-H0095	m22967	2012-01-20 03:17:44	2012-01-20 06:22:24	2012-02-09 22:40:16	CE11.1 Simplified significant_coeff_flag context derivation at high freaquency area	T. Ikai (Sharp)
JCTVC-H0096	m22968	2012-01-20 03:17:47	2012-01-20 06:23:05	2012-02-02 02:39:43	AHG7: Controllable memory bandwidth reduction with bi-pred to uni-pred conversion	T. Ikai (Sharp)

JCTVC-H0097	m22969	2012-01-20 03:17:50	2012-01-21 08:59:03	2012-01-30 08:33:20	Subjective quality assessment of ALF on still images	Y. Yasugi, T. Ikai (Sharp)
JCTVC-H0098	m22970	2012-01-20 03:17:52	2012-01-20 09:26:56	2012-02-03 19:52:50	Non-CE6: Modified definitions of intra mode and most probable mode	T. Yamamoto (Sharp)
JCTVC-H0099	m22971	2012-01-20 03:17:55	2012-01-20 09:28:53	2012-02-02 06:51:23	On CABAC context for partition mode	T. Yamamoto (Sharp)
JCTVC-H0100	m22972	2012-01-20 03:17:57	2012-01-20 05:38:06	2012-02-01 07:06:16	Non-CE11.1: Context reduction of significance map coding	T. Tsukuba, T. Ikai (Sharp), V. Seregin, J. Sole, M. Karczewicz (Qualcomm)
JCTVC-H0101	m22973	2012-01-20 03:17:59	2012-01-20 06:26:45	2012-01-23 06:12:18	CE11: Crosscheck of MediaTek's significant_coeff_flag modification (JCTVC-H0282)	T. Ikai (Sharp)
JCTVC-H0102	m22974	2012-01-20 03:18:01	2012-01-30 02:05:55	2012-01-30 02:05:55	CE8.a.1: Crosscheck of MQT's One-stage SAO and ALF with LCU-based syntax (JCTVC-H0272)	E. Alshina (Samsung), T. Ikai (Sharp)
JCTVC-H0103	m22975	2012-01-20 03:18:03	2012-01-23 13:47:26	2012-01-30 02:06:38	CE8.a.3: Crosscheck of MQS's SAO with LCU-based syntax (JCTVC-H0273)	T. Ikai (Sharp)
JCTVC-H0104	m22976	2012-01-20 03:18:07	2012-01-23 07:35:29	2012-01-25 08:30:37	AHG7: Crosscheck of Toshiba's memory bandwidth reduction proposal (JCTVC-H0181)	T. Ikai (Sharp)
JCTVC-H0105	m22977	2012-01-20 03:18:08	2012-01-25 04:03:52	2012-01-30 08:49:11	AHG7: Crosscheck of Sony's memory bandwidth reduction proposal (JCTVC-H0221)	T. Ikai (Sharp)
JCTVC-H0106	m22978	2012-01-20 03:18:11	2012-01-27 02:08:57	2012-01-27 02:08:57	AHG16:Crosscheck of Unification of SDIP and NSQT (JCTVC-H0347 case1)	T. Yamamoto (Sharp)
JCTVC-H0107	m22979	2012-01-20 03:18:13	2012-01-27 02:12:05	2012-02-06 12:32:50	Cross check on Logical intra mode numbering (JCTVC-H0407)	T. Yamamoto (Sharp)
JCTVC-H0108	m22980	2012-01-20 03:25:54	2012-01-20 10:15:11	2012-01-30 13:33:19	CE10 Subtest3: Simplified BS calculation process in deblocking filter	S. Park, B. Jeon (LG)
JCTVC-H0109	m22981	2012-01-20 03:46:51	2012-01-20 13:52:07	2012-02-04 18:20:20	Non-CE6: Modification/simplification of intra angular prediction	S. Matsuo, M. Takagi, S. Takamura, A. Shimizu, H. Jozawa (NTT)
JCTVC-H0110	m22982	2012-01-20 03:47:10	2012-01-27 02:22:13	2012-01-27 02:22:13	Non-CE11: Cross-verification of MediaTek's modified method for two-level coding of significance maps (JCTVC-H0287)	S. Fukushima, T. Kumakura (JVC Kenwood)
JCTVC-H0111	m22983	2012-01-20 03:48:51	2012-01-20 07:11:25	2012-02-02 01:39:02	CE9: Modification of bi-prediction	Y. Suzuki (NTT DOCOMO)
JCTVC-H0112	m22984	2012-01-20 03:52:29	2012-01-20 11:26:34	2012-02-01 13:36:59	CE1, subtest C4: Multi-parameter probability estimation for CABAC	E. Alshina, A. Alshin, J. H. Park (Samsung)
JCTVC-H0113	m22985	2012-01-20 03:56:04	2012-01-20 11:29:41	2012-02-01 13:37:48	Non-CE1: Accurate initialization and conditional probability for CABAC performance improvement	E. Alshina, A. Alshin, J. H. Park (Samsung)
JCTVC-H0114	m22986	2012-01-20 04:01:53	2012-01-20 11:33:06	2012-02-01 22:23:54	Non-CE8: Sample adaptive offset with constrained ranges of edge offset	E. Alshina, A. Alshin, J. H. Park (Samsung), I. S. Chong, M.

						Karczewicz (Qualcomm), C.-M. Fu, C.-I. Chen, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-H0115	m22987	2012-01-20 04:06:46	2012-01-20 11:37:29	2012-02-01 16:39:12	Sample adaptive offset in Low Complexity test	E. Alshina, A. Alshin, J. H. Park (Samsung)
JCTVC-H0116	m22988	2012-01-20 04:17:08	2012-01-20 18:29:38	2012-02-04 22:53:05	[AHG8] Objective and subjective evaluation of HM5.0.	TK Tan, A Fujibayashi, J Takiue (NTT DOCOMO),
JCTVC-H0117	m22989	2012-01-20 04:49:07	2012-01-20 11:27:45	2012-01-20 11:27:45	CE6.a: Chroma intra prediction based on residual luma samples	K. Kawamura, T. Yoshino, H. Kato, S. Naito (KDDI)
JCTVC-H0118	m22990	2012-01-20 04:50:00	2012-01-20 11:28:50	2012-01-20 11:28:50	CE6.a: Cross-check results of intra chroma prediction	K. Kawamura, S. Naito (KDDI)
JCTVC-H0119	m22991	2012-01-20 04:50:46	2012-01-20 05:23:49	2012-01-25 01:23:53	Non-CE4 Subtest2 : Extension of Adaptation Parameter Sets syntax for scaling list matrix	J. Tanaka, Y. Morigami, T. Suzuki (Sony)
JCTVC-H0120	m22992	2012-01-20 05:10:30	2012-01-21 05:56:07	2012-02-02 01:17:51	Non-CE6: Improvement of Intra DC prediction for cases without neighbouring samples	Alberto Duenas, Francisco Javier Roncero, Oscar Patino, Adam Malamy (Cavium)
JCTVC-H0121	m22993	2012-01-20 05:18:03	2012-01-20 23:55:20	2012-01-20 23:55:20	Cross Check for Huawei's CABAC simplification (JCTVC-H0327)	Y. Shibahara, T. Nishi (Panasonic)
JCTVC-H0122	m22994	2012-01-20 05:18:45	2012-01-25 09:13:54	2012-01-25 09:13:54	CE2: Cross-check report for CE2 Subtest 4.4 (JCTVC-H0308)	Y. Shibahara, T. Nishi (Panasonic)
JCTVC-H0123	m22995	2012-01-20 05:18:54	2012-01-20 23:51:02	2012-02-10 00:28:05	On merge transform_tree and transform_coeff	Y. Shibahara, T. Nishi (Panasonic)
JCTVC-H0124	m22996	2012-01-20 05:18:56	2012-01-20 11:33:15	2012-01-20 11:33:15	CE7: Cross check report of Tool1, Mode dependent secondary transform	A. Ichigaya, Y. Sugito (NHK)
JCTVC-H0125	m22997	2012-01-20 05:20:07	2012-01-21 08:29:10	2012-02-01 21:21:07	CE 7 : On secondary transforms for intra prediction residual	A. Saxena, Y. Shibahara, F. Fernandes, T. Nishi
JCTVC-H0126	m22998	2012-01-20 05:20:21	2012-01-21 08:54:37	2012-02-02 20:40:52	CE 7: On secondary transforms for inter prediction residual	A. Saxena, Y. Shibahara, F. Fernandes, T. Nishi
JCTVC-H0127	m22999	2012-01-20 05:20:24	2012-01-24 17:48:14	2012-01-24 17:48:14	CE 7: Cross-Check for JCTVC-H0309 on boundary dependent transforms for inter-predicted residue	A. Saxena, F. Fernandes
JCTVC-H0128	m23000	2012-01-20 05:20:32	2012-01-24 18:25:44	2012-01-24 18:25:44	Cross-Check of H0123 on merge transform tree and transform coefficient	A. Saxena, E. Alshina, F. Fernandes
JCTVC-H0129	m23001	2012-01-20 05:44:16	2012-01-20 13:30:31	2012-01-20 13:30:31	CE6.a: Cross-check results of intra chroma prediction	S. Matsuo, M. Matsumura, S. Takamura, H. Jozawa (NTT)
JCTVC-H0130	m23002	2012-01-20 06:16:07	2012-01-20 07:35:56	2012-02-07 00:46:51	CE11 Subtest 2: Level luma context reduction	Y. Piao, J. Min, J. H. Park (Samsung)
JCTVC-H0131	m23003	2012-01-20	2012-01-20	2012-01-30	Non-CE11: Simplified multi-level significance map coding	J. Min, Y. Piao, J. H. Park (Samsung)

		06:20:08	16:22:47	07:56:46		
JCTVC-H0132	m23004	2012-01-20 06:21:12	2012-01-21 06:08:49	2012-02-03 04:45:26	On Adaptation Paremeter Signalling	Y. Ye, E. S. Ryu (InterDigital)
JCTVC-H0133	m23005	2012-01-20 06:22:24	2012-01-20 12:50:17	2012-01-23 08:35:19	Non-CE9: Merge candidates pruning without TMVP	H. Takehara, K. Arakage, S. Fukushima (JVC Kenwood)
JCTVC-H0134	m23006	2012-01-20 06:25:08	2012-01-27 05:41:59	2012-01-27 05:41:59	Cross-check of CE11 subtest2: On context simplification for coefficients entropy coding(JCTVC-H060)	Y. Piao, J. H. Park (Samsung)
JCTVC-H0135	m23007	2012-01-20 06:52:57	2012-01-20 07:04:10	2012-01-20 07:21:09	CE1: Cross check of Multi-parameter probability up-date for CABAC by Samsung: Sub-test C2 (H0112)	C. Rosewarne, M. Maeda (Canon)
JCTVC-H0136	m23008	2012-01-20 06:54:31	2012-01-20 08:06:09	2012-02-04 04:41:29	Non-CE8: Report on visual artifacts by ALF virtual boundary processing and proposal on the filtering process modification	O. Nakagami, M. Ikeda, T. Suzuki (Sony)
JCTVC-H0137	m23009	2012-01-20 07:12:40	2012-01-21 06:16:34	2012-02-07 02:48:36	AHG21: Reference picture lists combination syntax	Y Ye, Y He (InterDigital)
JCTVC-H0138	m23010	2012-01-20 07:13:33	2012-01-21 06:19:13	2012-02-07 02:51:05	AHG21: Unification of reference picture list modification processes	Y He, Y Ye (InterDigital)
JCTVC-H0139	m23011	2012-01-20 07:17:56	2012-01-22 09:55:48	2012-01-24 01:01:10	Non-CE9: Cross-verification of Merge candidates pruning without TMVP (JCTVC-H0133 from JVC Kenwood)	Y. Suzuki (NTT DOCOMO)
JCTVC-H0140	m23012	2012-01-20 07:22:58	2012-01-20 07:30:21	2012-02-02 01:16:18	CE1: Modified probability update and table removal for multi-parameter CABAC update	C. Rosewarne, M. Maeda (Canon)
JCTVC-H0141	m23013	2012-01-20 07:23:38	2012-01-21 07:06:45	2012-02-03 04:40:59	Non-CE5: Complexity reduction for transform skipping mode	J. Dong, Y. Ye(InterDigital)
JCTVC-H0142	m23014	2012-01-20 07:26:59	2012-01-30 22:48:54	2012-01-30 22:48:54	CE5.d: Cross-verification for coefficients coding for transform skipping	E.S. Ryu, J. Dong (InterDigital)
JCTVC-H0143	m23015	2012-01-20 07:27:30	2012-01-20 07:33:25	2012-01-20 08:09:27	CE9: Cross verification of Nokia's proposal JCTVC-G593	S. Lu, K. Sato (Sony)
JCTVC-H0144	m23940	2012-02-04 03:26:42			WIthdrawn	
JCTVC-H0145	m23017	2012-01-20 07:33:28	2012-01-20 07:43:08	2012-02-03 06:00:59	Non-CE11: Harmonisation of 8x8 TU residual scan	C. Rosewarne, M. Maeda (Canon)
JCTVC-H0146	m23018	2012-01-20 07:36:27	2012-01-20 16:35:37	2012-02-03 04:17:24	CE10.3: Simplified delta calculation in the deblocking filter	M. Narroschke, A. Kotra, T. Wedi (Panasonic)
JCTVC-H0147	m23019	2012-01-20 07:39:53	2012-01-20 15:20:03	2012-02-05 04:35:28	CE10.1: Symmetric rounding in the deblocking filter	M. Narroschke, A. Kotra, T. Wedi (Panasonic)
JCTVC-H0148	m23020	2012-01-20 07:43:08	2012-01-20 15:48:01	2012-02-03 04:22:54	CE10.4: Deblocking filter using adaptive weighting factors	A.-K. Seifert, T. Wedi, M. Narroschke, (Panasonic)
JCTVC-H0149	m23021	2012-01-20	2012-01-20	2012-01-20	CE10.2: Cross check results for the deblocking filter line buffer reduction of	A. Kotra, S. Esenlik, M. Narroschke

		07:52:06	16:28:44	16:28:44	Sony and MediaTek	(Panasonic)
JCTVC-H0150	m23022	2012-01-20 07:54:28	2012-01-20 08:40:46	2012-01-26 07:10:13	CE4 Subtest 2.1: Crosscheck report of Enhancements of AVC quantization matrix in HEVC (JCTVC-H0230)	M. Shima (Canon)
JCTVC-H0151	m23023	2012-01-20 07:55:04	2012-01-20 08:41:47	2012-01-26 07:12:23	CE4 Subtest 2.2: Crosscheck report of up-sampling large size quantization matrices based on JCTVC-G152 (JCTVC-H0384)	M. Shima (Canon)
JCTVC-H0152	m23024	2012-01-20 07:55:16	2012-01-20 08:42:29	2012-01-26 07:14:15	CE4 Subtest 2.4: Crosscheck report of Layered quantization matrices compression (JCTVC-H0314)	M. Shima (Canon)
JCTVC-H0153	m23025	2012-01-20 07:55:29	2012-01-20 08:43:22	2012-02-01 06:47:52	CE4 Subtest 2.5: Crosscheck report of Coding of quantization matrices based on modified prediction and mapping to unsigned values (JCTVC-H0451)	M. Shima (Canon)
JCTVC-H0154	m23026	2012-01-20 07:56:52	2012-01-26 06:07:44	2012-01-26 06:07:44	Side information signaling improvement for TU	B. Lee, M. Kim
JCTVC-H0155	m23027	2012-01-20 08:07:35	2012-01-20 15:55:48	2012-02-03 08:48:36	CE10.3: Simplification of First Delta Calculation in Deblocking by SKT/SKKU	J. Yang, J. Kim, K. Won, B. Jeon (SKKU), J. Lim (SKT)
JCTVC-H0156	m23028	2012-01-20 08:10:43	2012-01-20 15:56:39	2012-02-03 08:57:46	CE10.3: Simplification of Second Delta Calculation in Deblocking by SKT/SKKU	J. Yang, J. Kim, K. Won, B. Jeon (SKKU), J. Lim (SKT)
JCTVC-H0157	m23029	2012-01-20 08:32:42	2012-01-24 04:37:53	2012-01-30 04:00:51	CE10.3: Cross verification of SKT/SKKU's Simplification of Second Delta Calculation in Deblocking (JCTVC-H0156)	S. Lee, N. Eum (ETRI)
JCTVC-H0158	m23030	2012-01-20 08:35:00	2012-01-20 08:55:56	2012-01-20 08:55:56	Non-CE8: Cross-check of modified directional classification for block-based adaptation on ALF (JCTVC-H0094)	T. Yoshino, K. Kawamura, S. Naito(KDDI)
JCTVC-H0159	m23031	2012-01-20 08:37:34	2012-01-20 08:56:31	2012-01-30 03:21:35	Non-CE6: Cross-check of modified/simplified intra angular prediction (JCTVC-H0109)	T. Yoshino, K. Kawamura, S. Naito(KDDI)
JCTVC-H0160	m23032	2012-01-20 08:49:39	2012-01-20 09:26:29	2012-02-03 01:26:28	CE11:Context reduction for coefficient level	K. Terada, H. Sasai, T. Nishi (Panasonic)
JCTVC-H0161	m23033	2012-01-20 09:06:19	2012-01-20 09:14:20	2012-01-25 01:15:31	CE1: verification of C3 sub-test from HHI (JCTVC-H0266) by Samsung and Qualcomm	E. Alshina, A. Alshin, J. H. Park (Samsung), R. Joshi, J. Sole (Qualcomm)
JCTVC-H0162	m23034	2012-01-20 09:13:27	2012-01-23 09:56:15	2012-01-23 09:56:15	CE11: Cross-check report for TI's proposal (Subtest 3.1.4 fixed context)	H. Sasai, K. Terada, T. Nishi (Panasonic)
JCTVC-H0163	m23035	2012-01-20 09:13:43	2012-01-26 13:58:40	2012-02-01 22:14:48	Non-CE8: Cross check report of JCTVC-H0136	A. Ichigaya, S. Iwamura
JCTVC-H0164	m23036	2012-01-20 09:14:12	2012-01-20 09:51:13	2012-01-20 09:51:13	Non CE9: Removing non-scaled bi-predictive merging candidates	Y. H. Tan, C. Yeo, H. L. Tan, Z. Li (I2R)
JCTVC-H0165	m23037	2012-01-20 09:16:27	2012-01-20 09:19:06	2012-01-25 01:12:29	CE1: verification of C2 sub-test from Canon (JCTVC-H0140) by Samsung	E. Alshina, A. Alshin, J. H. Park (Samsung)
JCTVC-H0166	m23038	2012-01-20 09:17:04	2012-01-20 09:54:22	2012-02-03 02:06:11	Non CE6: Unification of the number of intra prediction modes	H. L. Tan, C. Yeo, Y. H. Tan, Z. Li (I2R)

JCTVC-H0167	m23039	2012-01-20 09:20:43	2012-01-26 01:59:09	2012-01-27 00:26:13	CE1: Cross-check report for Sharp's proposal (Subtest B4)	H. Sasai, T. Nishi (Panasonic)
JCTVC-H0168	m23040	2012-01-20 09:25:11	2012-01-20 14:25:43	2012-02-04 20:00:53	AHG8: Proposal of HEVC profile/level definitions	T. Suzuki (Sony), H. Sasai, T. Nishi (Panasonic)
JCTVC-H0169	m23050	2012-01-20 09:30:32	2012-01-20 09:44:56	2012-01-20 09:44:56	CE5.b: Transform skipping choices based on block parameters	G. Van Wallendael, S. Van Leuven, J. De Cock, R. Van de Walle (Ghent Univ.)
JCTVC-H0170	m23051	2012-01-20 09:32:12	2012-01-28 06:15:39	2012-01-28 06:15:39	CE8.a.2: Cross-check of Cisco's proposal "ALF with LCU-based syntax (JCTVC-H066)	T.Yamakage (Toshiba)
JCTVC-H0171	m23041	2012-01-20 09:28:04	2012-01-20 17:35:15	2012-01-26 12:09:20	CE6a: Results on experiments related to section a on Intra Chroma Prediction	C.Gisquet, E. François (Canon), Yi-Jen Chiu, Yu Han (Intel), Xingyu Zhang, Oscar C. AU (HKUST), Kei Kawamura, Tomonobu Yoshino (KDDI)
JCTVC-H0172	m23042	2012-01-20 09:28:23	2012-01-20 17:47:07	2012-01-20 17:47:07	CE6a: Cross verification of results related to section CE6.A	E. François, C.Gisquet (Canon)
JCTVC-H0173	m23043	2012-01-20 09:28:32	2012-01-30 17:05:50	2012-01-30 17:05:50	CE8: Cross verification of Mediatek results regarding section e.1	G. Laroche, T. Poirier, P. Onno (Canon)
JCTVC-H0174	m23044	2012-01-20 09:28:49	2012-01-20 18:39:13	2012-02-06 19:05:21	CE8: Results related to section e.2	G. Laroche, T. Poirier, P. Onno (Canon)
JCTVC-H0175	m23045	2012-01-20 09:29:01	2012-01-20 17:26:11	2012-02-05 05:10:19	Non-CE6c: Adaptations of intra mode coding	E. François, S. Pautet, C.Gisquet (Canon)
JCTVC-H0176	m23046	2012-01-20 09:29:11	2012-01-20 17:20:16	2012-02-03 20:09:06	Non-CE6a: Border adaptive decimation for LM mode	C.Gisquet, E. François (Canon)
JCTVC-H0177	m23047	2012-01-20 09:29:21	2012-01-20 17:40:11	2012-02-03 21:02:44	Non-CE6a: Use of chroma phase in LM mode	E. François, S. Pautet, C.Gisquet (Canon)
JCTVC-H0178	m23048	2012-01-20 09:29:31	2012-01-20 17:41:29	2012-02-02 20:45:53	Encoder speed-up for the MV cost estimation	G. Laroche, T. Poirier, P. Onno (Canon)
JCTVC-H0179	m23049	2012-01-20 09:29:46	2012-01-20 17:46:47	2012-02-01 04:00:04	AHG4: Storage reduction for dependent Tiles	E. François (Canon), S. Pautet
JCTVC-H0180	m23052	2012-01-20 09:32:16	2012-01-20 10:18:06	2012-01-30 11:19:44	Non-CE3: Phase adjustment of interpolation filter	T.Chujoh, T.Yamakage (Toshiba)
JCTVC-H0181	m23054	2012-01-20 09:32:34	2012-01-21 04:06:49	2012-02-05 18:36:57	AHG07: A restriction of motion vector for small PU size	T.Chujoh, T.Yamakage (Toshiba)
JCTVC-H0182	m23055	2012-01-20 09:32:46	2012-01-21 03:37:56	2012-02-01 02:51:45	CE3: Cross-check report for Motorola Mobility's chroma interpolation filter (JCTVC-H0494)	T.Chujoh (Toshiba)
JCTVC-H0183	m23056	2012-01-20	2012-01-28	2012-01-28	Non-CE8: Cross-check report for sample adaptive offset with constrained	T.Chujoh (Toshiba)

		09:32:54	02:18:54	02:18:54	ranges of edge offset (JCTVC-H0114)	
JCTVC-H0184	m23057	2012-01-20 09:37:41	2012-01-20 13:53:39	2012-01-23 04:34:21	CE4 Subtest 3: Cross-verification report for test 3.1.a (JCTVC-H0506)	H. Aoki, K. Chono (NEC)
JCTVC-H0185	m23058	2012-01-20 09:43:57	2012-01-29 14:10:20	2012-01-29 14:10:20	Cross-check of Adaptive Resolution Coding (ARC)	G. Van Wallendael, S. Van Leuven, J. De Cock, R. Van de Walle (Ghent Univ.)
JCTVC-H0186	m23059	2012-01-20 09:49:37	2012-01-21 02:49:49	2012-01-21 02:49:49	CE4: Result of subtest 1.1&1.2	K Sato (Sony)
JCTVC-H0187	m23060	2012-01-20 09:50:41	2012-01-21 03:18:37	2012-01-21 03:18:37	CE6: Crosscheck of G119	K Sato (Sony)
JCTVC-H0188	m23061	2012-01-20 09:52:24	2012-01-21 04:06:47	2012-01-21 04:06:47	On the syntax of ChromaQpOffset	K Sato (Sony)
JCTVC-H0189	m23062	2012-01-20 09:53:42	2012-01-21 06:45:54	2012-01-25 08:25:46	Non-CE4: low-complexity dQP coding	K Sato (Sony)
JCTVC-H0190	m23063	2012-01-20 09:55:23	2012-01-21 10:53:31	2012-02-04 03:45:24	Non-CE10: Difference-QP-based Deblocking	K Sato (Sony)
JCTVC-H0191	m23064	2012-01-20 09:55:56	2012-01-26 05:32:30	2012-01-26 05:32:30	CE4 Subtest 3: Cross-verification report for test 3.1.b (JCTVC-H0508)	H. Aoki, K. Chono (NEC)
JCTVC-H0192	m23066	2012-01-20 10:08:11	2012-01-25 09:44:57	2012-01-25 09:44:57	CE6: Cross-check report for Subtest CE6b and CE6c on modifications to Intra-frame coding	H. L. Tan, C. Yeo, Y. H. Tan (I2R)
JCTVC-H0193	m23067	2012-01-20 10:09:08	2012-01-25 09:45:31	2012-01-25 09:45:31	Non-CE6: Cross-check report for JCTVC-H0175 on Intra mode coding	H. L. Tan, C. Yeo, Y. H. Tan (I2R)
JCTVC-H0194	m23068	2012-01-20 10:09:36	2012-01-21 05:13:18	2012-01-23 04:51:11	Non-CE4: Cross-verification report for modified spatial QP prediction based on intra prediction direction (method 1 of JCTVC-H0204)	H. Aoki, K. Chono (NEC)
JCTVC-H0195	m23069	2012-01-20 10:10:04	2012-01-25 09:46:11	2012-01-25 09:46:11	Non-CE6: Cross-check report for JCTVC-H0326 on Chroma Intra coding	H. L. Tan, C. Yeo, Y. H. Tan (I2R)
JCTVC-H0196	m23070	2012-01-20 10:22:18	2012-01-20 10:38:21	2012-02-02 01:33:10	AHG21: Comments on signaling of short-term reference pictures	Hendry, S. Jeong, S. Park, B. Jeon (LG)
JCTVC-H0197	m23071	2012-01-20 10:23:31	2012-01-20 15:55:48	2012-01-20 15:55:48	CE4: Results of subtest 1.4	H. Nakamura, M. Nishitani, S. Fukushima (JVC Kenwood)
JCTVC-H0198	m23072	2012-01-20 10:24:17	2012-01-20 10:28:37	2012-01-20 10:28:37	Comments on Slice-independent Loop Filtering	M. LI, P. WU(ZTE)
JCTVC-H0199	m23073	2012-01-20 10:24:46	2012-01-20 16:04:41	2012-02-03 06:31:16	Non-CE9: Derivation process of reference indices for temporal merging candidates	H. Nakamura, S. Fukushima (JVC Kenwood)
JCTVC-H0200	m23074	2012-01-20 10:25:14	2012-01-20 10:38:54	2012-02-02 05:59:53	AHG21: Comments on Signaling of Long-term Reference Pictures	Hendry, S. Jeong, S. Park, B. Jeon (LG)

JCTVC-H0201	m23075	2012-01-20 10:25:30	2012-01-20 13:58:14	2012-02-05 00:34:33	Non-CE8: Method of removing boundary artifacts for SAO	T.Matsunobu, H.Sasai, T.Nishi(Panasonic)
JCTVC-H0202	m23076	2012-01-20 10:26:46	2012-01-21 07:46:17	2012-02-03 06:28:44	PU structure for intra NxN	H. Nakamura, S. Fukushima (JVC Kenwood)
JCTVC-H0203	m23077	2012-01-20 10:28:10	2012-01-20 10:39:22	2012-02-03 01:21:35	AHG4: Further latency reduction of CABAC initialization for dependent Tiles	Hendry, S. Jeong, S. Park, B. Jeon (LG)
JCTVC-H0204	m23078	2012-01-20 10:29:24	2012-01-20 16:24:59	2012-02-07 06:29:12	Non-CE4: Compatible QP prediction with RC and AQ	H. Nakamura, M. Nishitani, S. Fukushima (JVC Kenwood)
JCTVC-H0205	m23079	2012-01-20 10:29:36	2012-01-20 15:48:43	2012-01-20 15:48:43	CE4: Cross-check of subtest1.3 by JVC Kenwood (JCTVC-H0053)	H. Nakamura, M. Nishitani, S. Fukushima (JVC Kenwood)
JCTVC-H0206	m23080	2012-01-20 10:42:41	2012-01-27 11:39:07	2012-01-27 11:39:07	Crosscheck of JCTVC-H0176	K Sato (Sony)
JCTVC-H0207	m23081	2012-01-20 10:43:01	2012-01-20 10:47:03	2012-01-30 08:32:02	Non-CE3: Crosscheck of JCTVC-Hxxx : an AIF for low complexity configuration	J. Park, Hendry, B. Jeon (LG)
JCTVC-H0208	m23082	2012-01-20 11:04:41	2012-01-21 00:49:22	2012-02-02 04:36:32	CE5.a: Quantization for transform skipping	M. Naccari, A. Gabriellini, M. Mrak (BBC)
JCTVC-H0209	m23084	2012-01-20 11:11:04	2012-01-31 08:59:57	2012-01-31 08:59:57	CE10.3: Cross-verification Results of Qualcomm's Simplification of Deblocking (JCTVC-Hxxx) by SKT/SKKU	J. Yang, J. Kim, K. Won, B. Jeon (SKKU), J. Lim (SKT)
JCTVC-H0210	m23085	2012-01-20 11:11:07	2012-01-20 11:17:21	2012-01-20 11:17:21	CE1: Crosscheck of Test A Modified LPS range and state transition tables for BAC (G324, Qualcomm) by Cisco	T. Davies
JCTVC-H0211	m23086	2012-01-20 11:13:59	2012-01-21 00:47:57	2012-02-01 06:51:04	CE5.g: Integration of tools CE5.a to CE5.e	M. Mrak, A. Gabriellini (BBC), G. Van Wallendael (Ghent university), R. Joshi (Qualcomm)
JCTVC-H0212	m23087	2012-01-20 11:19:18	2012-01-20 11:35:39	2012-01-30 16:26:30	CE1: Subtest D1 - cross-verification of Nokia's Single entropy coder for HEVC with a high throughput binarization mode (JCTVC-G569) by Cisco	D. Sychov, T. Davies,
JCTVC-H0213	m23088	2012-01-20 11:20:17	2012-01-20 22:55:31	2012-02-04 17:50:00	Rate control based on unified RQ model for HEVC	H. Choi, J. Nam, J. Yoo, D. Sim (KWU), I.V. Bajić (SFU)
JCTVC-H0214	m23089	2012-01-20 11:24:07	2012-01-20 14:06:05	2012-02-02 03:07:19	Non-CE9: Modification of derivation process for the reference index for temporal merging candidate	T. Sugio, T. Nishi (Panasonic)
JCTVC-H0215	m23090	2012-01-20 11:24:28	2012-01-21 05:27:12	2012-02-02 17:04:09	Market needs and practicality of sub-picture based CPB operation	K. Kazui, S.Shimada, J.Koyama, A.Nakagawa (Fujitsu), A.Duenas (CAVIUM)
JCTVC-H0216	m23091	2012-01-20 11:24:34	2012-01-20 14:06:58	2012-02-02 03:16:55	Non-CE9: Modification of derivation process for MVP candidate in AMVP/Merge	T. Sugio, T. Nishi (Panasonic)
JCTVC-H0217	m23092	2012-01-20 11:24:45	2012-01-20 14:08:01	2012-01-20 14:08:01	CE9: Cross-check report of BP05 by Panasonic	T. Sugio, T. Nishi (Panasonic)
JCTVC-H0218	m23093	2012-01-20	2012-01-23	2012-01-23	Non-CE9: Cross-check report of JVC KENWOOD's modified derivation	T. Sugio, T. Nishi (Panasonic)

		11:25:51	01:12:02	01:12:02	process of the reference index for temporal merging candidate (JCTVC-H0199) by Panasonic	
JCTVC-H0219	m23094	2012-01-20 11:26:03	2012-01-23 09:28:05	2012-01-23 09:28:05	Non-CE9: Cross-check report of parallel merge candidate derivation for Inter_NxN partition type (JCTVC-H0091) by Panasonic	T. Sugio, T. Nishi (Panasonic)
JCTVC-H0220	m23095	2012-01-20 11:26:12	2012-01-30 01:51:27	2012-01-30 01:51:27	AHG10: Cross-check report of TI's configurable and CU-group level parallel merge/skip (JCTVC-H0082) by Panasonic	T. Sugio, T. Nishi (Panasonic)
JCTVC-H0221	m23096	2012-01-20 11:28:10	2012-01-20 12:58:06	2012-01-20 12:58:06	AHG7: Modification of merge candidate derivation to reduce MC memory bandwidth	K. Kondo, T. Suzuki (Sony)
JCTVC-H0222	m23097	2012-01-20 11:29:44	2012-01-21 05:39:36	2012-02-02 17:07:34	Introduction of AVC's derivation process of chroma motion vector for interlace format support	K.Kazui, J.Koyama, S.Shimada, A.Nakagawa (Fujitsu)
JCTVC-H0223	m23098	2012-01-20 11:33:10	2012-01-21 01:06:22	2012-01-21 01:06:22	CE8.e.3: Modified SAO edge offsets	Kenneth Andersson (Ericsson), Per Wennersten (Ericsson), Rickard Sjöberg (Ericsson), Semih Esenlik (Panasonic), Matthias Narroschke(Panasonic), Thomas Wedi(Panasonic)
JCTVC-H0224	m23099	2012-01-20 11:38:57	2012-01-20 15:02:12	2012-02-03 02:16:09	CE11: Sign Data Hiding	Gordon Clare, Felix Henry, Joel Jung, Stephane Pateux
JCTVC-H0225	m23100	2012-01-20 11:40:12	2012-01-21 01:08:28	2012-01-27 14:34:33	CE8.e.5: Combination of CE8.e.2 and CE8.e.3	Kenneth Andersson (Ericsson), Per Wennersten (Ericsson), Rickard Sjöberg (Ericsson), Guillaume Laroche (Canon), Patrice Onno (Canon), Tangi Poirier (Canon), Semih Esenlik (Panasonic), Matthias Narroschke (Panasonic), Thomas Wedi (Panasonic)
JCTVC-H0226	m23101	2012-01-20 11:41:05	2012-01-21 06:02:55	2012-02-09 22:03:53	On derivation of luma QP predictor for Wavefront Parallel Processing	S. Shimada, K. Kazui, J. Koyama, A.Nakagawa (Fujitsu)
JCTVC-H0227	m23102	2012-01-20 11:42:24	2012-01-20 15:02:42	2012-02-02 20:37:44	Non-CE11: Sign Data Hiding without RDOQ	Gordon Clare, Felix Henry, Joel Jung, Stephane Pateux
JCTVC-H0228	m23103	2012-01-20 11:47:01	2012-01-20 23:23:03	2012-01-27 15:47:51	Non-CE11: Proposed Cleanup for Transform Coefficient Coding	T. Nguyen, D. Marpe, T. Wiegand (Fraunhofer HHI)
JCTVC-H0229	m23104	2012-01-20 11:48:38	2012-01-21 01:12:25	2012-01-21 01:12:25	CE8.e.2: Cross check of CE8.e.2 (JCTVC-H0174)	Kenneth Andersson(Ericsson)
JCTVC-H0230	m23105	2012-01-20 11:58:44	2012-01-20 16:48:15	2012-02-10 10:38:50	CE4 subtest 2.1: Enhancements of HEVC quantization matrix	Y. Morigami, J. Tanaka, T. Suzuki (Sony), V. Sze, M. Zhou (TI)
JCTVC-H0231	m23106	2012-01-20 12:02:59	2012-01-20 14:31:30	2012-01-25 07:39:15	CE4: Cross check of CE4 Subset2.4 on JCTVC-H0314	Y. Morigami, J. Tanaka, T. Suzuki (Sony)

JCTVC-H0232	m23107	2012-01-20 12:23:38	2012-01-20 14:54:19	2012-01-25 13:41:49	CE1.D1: Nokia report on high throughput binarization	J. Lainema, K. Ugur, A. Hallapuro (Nokia)
JCTVC-H0233	m23108	2012-01-20 12:23:55	2012-01-20 14:55:25	2012-01-25 13:42:21	Non-CE1: CABAC bypass for coefficient data	J. Lainema, K. Ugur, A. Hallapuro (Nokia)
JCTVC-H0234	m23109	2012-01-20 12:36:57	2012-01-21 01:40:14	2012-02-02 05:11:36	AHG18: Design considerations for Adaptive Resolution Coding (ARC)	T. Davies
JCTVC-H0235	m23110	2012-01-20 12:38:54	2012-01-20 13:06:36	2012-01-20 13:06:36	CE2 4.2: report on fixed TU depth for chroma	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi), A. Ichigaya, S. Sakaida (NHK)
JCTVC-H0236	m23111	2012-01-20 12:39:17	2012-01-25 12:07:43	2012-01-25 12:07:43	CE2 4.3: cross-verification of signaling max chroma TU depth	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-H0237	m23112	2012-01-20 12:48:03	2012-01-20 17:33:44	2012-02-09 09:42:46	Non-CE4 Subtest 2: Improvement on quantization matrix signaling	S.-C. Lim, H. Y. Kim, J. Lee, J. S. Choi (ETRI)
JCTVC-H0238	m23113	2012-01-20 12:48:12	2012-01-20 15:50:35	2012-01-30 14:27:56	Non-CE6: Simplification of intra vertical/horizontal prediction	J. Lee, S.-C. Lim, H. Y. Kim, J. S. Choi (ETRI)
JCTVC-H0239	m23114	2012-01-20 12:48:18	2012-01-20 17:47:46	2012-02-02 04:56:21	Non-CE9: Simplification on AMVP list construction	S.-C. Lim, H. Y. Kim, J. Lee, J. S. Choi (ETRI)
JCTVC-H0240	m23115	2012-01-20 12:48:23	2012-01-20 19:17:10	2012-02-02 12:43:08	Non-CE9: Throughput improvement for merge/skip mode	H. Y. Kim (ETRI), K. Y. Kim, S. M. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee, S. Cho, J. S. Choi (ETRI)
JCTVC-H0241	m23116	2012-01-20 12:48:28	2012-01-27 06:48:21	2012-01-27 06:48:21	Cross-check report for Canon's encoder speed-up for the MV cost estimation (JCTVC-H0178)	S.-C. Lim, H. Y. Kim, J. Lee (ETRI)
JCTVC-H0242	m23117	2012-01-20 12:50:48	2012-01-20 16:16:13	2012-02-07 05:12:00	DC mode as a default intra mode	I.-K Kim, T. Lee, J. H. Kim, J. H. Park (Samsung)
JCTVC-H0243	m23118	2012-01-20 12:51:31	2012-01-20 16:16:53	2012-02-02 03:51:50	Simplification of spatial motion vector scaling process	I.-K Kim, J. H. Park (Samsung)
JCTVC-H0244	m23119	2012-01-20 12:53:55	2012-01-20 18:48:09	2012-02-04 02:09:20	Non-CE6: Intra-mode bypass parallelism (IMBP)	C. Rosewarne, M. Maeda (Canon)
JCTVC-H0245	m23120	2012-01-20 12:56:06	2012-02-01 08:25:52	2012-02-01 08:25:52	CE11: cross-verification of Motorola's proposal (H0511)	X. Zheng (HiSilicon)
JCTVC-H0246	m23121	2012-01-20 12:58:06	2012-01-30 18:09:07	2012-01-30 18:09:07	CE5: Cross-verification of Ghent University's proposal on transform skipping (H0246)	X. Zheng (HiSilicon)
JCTVC-H0247	m23122	2012-01-20 12:59:03	2012-01-29 16:44:39	2012-02-02 12:44:54	AHG10: Unified design on parallel merge/skip with reduced candidates	H. Y. Kim (ETRI), K. Y. Kim (KHU), Y. Jeon, B. Jeon (LG), M. Zhou (TI), X. Wen, O. C. Au (HKUST)
JCTVC-H0248	m23123	2012-01-20 13:06:49	2012-01-21 08:11:26	2012-01-31 02:17:58	Clean-up of redundant CABAC memorization process	Y. Chiu, W. Zhang, L. Xu, Y. Han (Intel)

JCTVC-H0249	m23124	2012-01-20 13:07:58	2012-01-31 04:35:05	2012-01-31 04:35:05	Non-CE11: Coefficient sub-sampling for large transform	Y. Chiu, W. Zhang, L. Xu, Y. Han (Intel)
JCTVC-H0250	m23125	2012-01-20 13:10:13	2012-01-20 13:58:33	2012-01-28 13:27:53	Non-CE9: Removal of non-scaled merge candidate	O. Bici, J. Lainema, K. Ugur (Nokia)
JCTVC-H0251	m23126	2012-01-20 13:11:21	2012-01-20 13:58:54	2012-02-10 03:42:58	Context reduction for merge index coding	O. Bici, J. Lainema, K. Ugur (Nokia)
JCTVC-H0252	m23127	2012-01-20 13:11:53	2012-01-20 13:59:11	2012-02-02 21:39:15	CE9: Results of SP experiments on simplification of merge process	O. Bici, J. Lainema, K. Ugur (Nokia)
JCTVC-H0253	m23128	2012-01-20 13:13:09	2012-01-20 13:30:46	2012-02-03 04:27:20	Improvement on parallelism for context derivation process of significant_coeff_flag	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-H0254	m23129	2012-01-20 13:14:11	2012-01-30 18:11:02	2012-01-30 18:11:02	CE4: Cross-verification of JVC KENWOOD's proposal (H0197)	X. Zheng (HiSilicon)
JCTVC-H0255	m23130	2012-01-20 13:14:17	2012-01-20 13:31:11	2012-02-03 16:02:47	On partial updating of APS parameters	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-H0256	m23131	2012-01-20 13:14:38	2012-01-20 14:09:01	2012-01-20 14:09:01	Withdrawn	
JCTVC-H0257	m23132	2012-01-20 13:14:39	2012-01-21 05:53:17	2012-02-02 17:11:27	Cyclic POC	J. Koyama, K. Kazui, S. Shimada, A. Nakagawa (Fujitsu)
JCTVC-H0258	m23133	2012-01-20 13:15:44	2012-02-01 08:22:41	2012-02-01 08:22:41	CE2: Cross-verification of CE2 subtest4-TEST0(H0308)	X. Zheng (HiSilicon)
JCTVC-H0259	m23134	2012-01-20 13:38:54	2012-02-04 17:41:30	2012-02-05 18:04:51	Efficient signaling of transform skipping mode	J. Kim, M. Kim,
JCTVC-H0260	m23135	2012-01-20 13:47:42	2012-01-20 14:42:11	2012-01-30 14:10:46	CE4:Subset 3.2 Implicit signalling of QP offset based on TU size	C. Kim, Y.Park, K.Choi, J.H.Kim, J.H. Park (Samsung)
JCTVC-H0261	m23136	2012-01-20 14:02:18	2012-01-20 14:19:23	2012-01-27 07:58:55	CE10 Subtest3: Cross-verification for Panasonic's proposal JCTVC-H0146	M. Ikeda, T. Suzuki (Sony)
JCTVC-H0262	m23137	2012-01-20 14:03:35	2012-01-20 14:20:04	2012-01-20 14:20:04	CE10 Subtest1: Cross-verification for Panasonic's proposal JCTVC-H0147	M. Ikeda, T. Suzuki (Sony)
JCTVC-H0263	m23138	2012-01-20 14:05:19	2012-01-20 14:20:40	2012-01-26 12:46:15	CE10 Subtest1: Cross-verification for TI's proposal JCTVC-H0084	M. Ikeda, T. Suzuki (Sony)
JCTVC-H0264	m23139	2012-01-20 14:06:36	2012-01-20 14:21:28	2012-01-20 14:21:28	CE10 Subtest2: Cross-verification for Ericsson's proposal	M. Ikeda, T. Suzuki (Sony)
JCTVC-H0265	m23140	2012-01-20 14:12:39	2012-01-20 17:09:15	2012-02-03 02:08:14	Non-CE1: Dimension reduced rangeTabLPS table for the interval subdivision of the arithmetic coding engine	J. Stegemann, H. Kirchhoffer, D. Marpe, T. Wiegand (Fraunhofer HHI)
JCTVC-H0266	m23141	2012-01-20 14:13:16	2012-01-21 10:24:22	2012-01-26 11:25:35	CE1: Report of test results related to subtests B2 (8-bit-init) and C3 (Alt. PMU)	H. Kirchhoffer, B. Bross, P. Helle, D. Marpe, T. Nguyen, M. Siekmann, J. Stegemann, T. Wiegand (Fraunhofer

						HHI)
JCTVC-H0267	m23142	2012-01-20 14:15:01	2012-01-21 11:32:54	2012-01-30 14:11:38	AHG7:Constraint the number of motion vector for memory bandwidth reduction	C.S.Park, T. Kosuge, J.H. Kim, K.H. Lee, J.H.Park, C. Kim (Samsung)
JCTVC-H0268	m23143	2012-01-20 14:17:14	2012-01-20 18:16:56	2012-01-20 18:16:56	CE6: Cross-check for Subtest CE6b of Rectangular (2NxN and Nx2N) Intra Prediction	S. Oudin (Fraunhofer HHI)
JCTVC-H0269	m23144	2012-01-20 14:27:28	2012-01-21 05:56:05	2012-01-30 14:12:59	AHG15 : Independent control of Max CU and LCU size for small LCU	J.B.Choi, J.H. Kim, K.H. Lee, J.H. Park, C. Kim (Samsung)
JCTVC-H0270	m23145	2012-01-20 14:28:11	2012-01-20 15:15:47	2012-01-31 08:07:59	AHG4: Avoiding lower left LCUs at dependent tile column boundaries	C.-W. Hsu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-H0271	m23146	2012-01-20 14:30:48	2012-01-20 15:20:38	2012-01-31 08:07:17	AHG9: CABAC with constrained outstanding bits	T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-H0272	m23147	2012-01-20 14:33:29	2012-01-20 15:25:39	2012-02-04 21:24:09	CE8.a.1: One-stage SAO and ALF with LCU-based syntax	C.-Y. Chen, C.-Y. Tsai, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek), I. S. Chong, M. Karczewicz (Qualcomm), T. Yamakage, T. Itoh, T. Watanabe, T. Chujoh (Toshiba)
JCTVC-H0273	m23148	2012-01-20 14:36:34	2012-01-20 15:30:48	2012-01-31 08:05:58	CE8.a.3: SAO with LCU-based syntax	C.-M. Fu, C.-Y. Chen, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), I. S. Chong, M. Karczewicz (Qualcomm), E. Alshina, A. Alshin (Samsung)
JCTVC-H0274	m23149	2012-01-20 14:39:04	2012-01-20 15:43:38	2012-02-04 21:30:30	CE8.a.4: One-stage/Two-stage SAO and ALF with LCU-based syntax	C.-Y. Chen, C.-Y. Tsai, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek), I. S. Chong, M. Karczewicz (Qualcomm), T. Yamakage, T. Itoh, T. Watanabe, T. Chujoh (Toshiba)
JCTVC-H0275	m23150	2012-01-20 14:39:37	2012-01-20 14:45:42	2012-02-05 19:03:37	Non-CE10: Introduction of strong filter clipping in deblocking filter	M. Ikeda, T. Suzuki (Sony)
JCTVC-H0276	m23151	2012-01-20 14:42:20	2012-01-20 15:47:42	2012-02-01 20:54:36	CE8.e.1: Offset coding in SAO	C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek), I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-H0277	m23152	2012-01-20 14:45:31	2012-01-20 15:52:41	2012-01-31 08:00:59	Non-CE8: Additional simulation results of SAO and ALF	T.-D. Chuang, Y.-W. Chen, J.-L. Lin, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-H0278	m23153	2012-01-20 14:47:54	2012-01-20 15:55:45	2012-01-31 07:58:21	Non-CE9: CU-based parallel merge mode	J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-H0279	m23154	2012-01-20 14:49:53	2012-01-20 15:57:57	2012-01-31 07:57:47	Non-CE9: CU-based paralllel inter mode	J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-H0280	m23155	2012-01-20 14:51:38	2012-01-20 16:02:22	2012-02-02 20:14:55	CE10.2.1: Reducing one pixel line buffer by modified deblocking filter for horizontal LCU boundaries	C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek), M. Ikeda,

						T. Suzuki (Sony)
JCTVC-H0281	m23156	2012-01-20 14:53:48	2012-01-20 16:05:24	2012-01-31 07:56:26	Non-CE10: Removing QP line buffer	Y.-W. Chen, J.-L. Lin, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-H0282	m23157	2012-01-20 14:55:35	2012-01-20 17:11:06	2012-01-31 07:55:44	CE11.1.2: Unified method for coding 4x4 & 8x8 significance maps	S.-T. Hsiang, T.-D. Chuang, S. Lei (MediaTek)
JCTVC-H0283	m23158	2012-01-20 14:57:28	2012-01-20 16:07:46	2012-01-31 07:54:45	CE11.4.2: Modified NSQT coefficient scan	C.-W. Hsu, T.-D. Chuang, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-H0284	m23159	2012-01-20 14:59:15	2012-01-20 16:10:50	2012-02-07 03:25:33	Non-CE11: Unification of transform coefficient coding	C.-W. Hsu, T.-D. Chuang, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-H0285	m23160	2012-01-20 15:01:26	2012-01-20 16:13:33	2012-01-31 07:53:18	Non-CE11: Block-based significance map context selection	T.-D. Chuang, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-H0286	m23161	2012-01-20 15:03:38	2012-01-20 16:16:15	2012-01-31 07:52:28	Non-CE11: Parallel significance map context assignment	T.-D. Chuang, C.-W. Hsu, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-H0287	m23162	2012-01-20 15:07:05	2012-01-20 17:11:46	2012-02-02 21:40:33	Non-CE11: Modified method for two-level coding of significance maps	S.-T. Hsiang, T.-D. Chuang, S. Lei (MediaTek)
JCTVC-H0288	m23163	2012-01-20 15:18:57	2012-01-20 16:21:35	2012-01-30 10:43:21	Syntax on picture size signaling	Y. Park, C. Kim, J. H. Kim, J. H. Park (Samsung)
JCTVC-H0289	m23164	2012-01-20 15:22:24	2012-01-20 15:29:06	2012-02-01 18:06:57	Non-CE4: Spatial QP prediction based on motion vector predictors (AMVP)	P. Andrivon, P. Bordes (Technicolor)
JCTVC-H0290	m23165	2012-01-20 15:27:16	2012-01-20 15:31:25	2012-02-03 01:31:01	Non-CE11:Simplification of context selection for significant_coeff_flag	K. Terada, H. Sasai, T. Nishi (Panasonic)
JCTVC-H0291	m23933	2012-02-03 18:12:54			Withdrawn	
JCTVC-H0292	m23167	2012-01-20 15:32:01	2012-01-20 16:22:47	2012-01-30 10:44:07	Syntax on List Combination	Y. Park, T. Lee, J. H. Kim, J. H. Park (Samsung)
JCTVC-H0293	m23168	2012-01-20 15:35:01	2012-01-20 16:28:12	2012-02-06 02:36:50	Syntax on parallel processing information signaling	S. S. Jeong, Y. Park, C. Kim, J. H. Kim, J. H. Park (Samsung),
JCTVC-H0294	m23169	2012-01-20 15:35:27	2012-01-20 16:03:22	2012-02-16 04:29:45	YUV4:4:4 test sequences for screen content coding	Jiaomeng Cao, Kailun Zhou, Shuhui Wang, Tao Lin
JCTVC-H0295	m23170	2012-01-20 15:36:09	2012-01-21 07:57:25	2012-01-21 07:57:25	CE6.a: Cross-channel prediction refinement to improve intra chroma prediction	Y.J. chiu, Y. Han, L. Xu, W. Zhang, H. Jiang(Intel)
JCTVC-H0296	m23171	2012-01-20 15:37:35	2012-01-21 04:15:59	2012-01-21 04:15:59	CE6.a: Cross-check report for CE6a on intra chroma prediction	Y.J. Chiu, Y. Han, L. Xu, W. Zhang(Intel)
JCTVC-H0297	m23172	2012-01-20 15:38:51	2012-01-21 04:16:49	2012-01-21 04:16:49	CE6.b: Cross verification of MediaTek's rectangular (2NxN and Nx2N) intra prediction (JCTVC-H0437)	Y.J. Chiu, Y. Han, L. Xu, W. Zhang(Intel)

JCTVC-H0298	m23173	2012-01-20 15:39:48	2012-01-21 04:19:07	2012-02-01 19:27:05	CE10 Subtest1: Cross verification of MediaTek's chroma deblocking filter (JCTVC-H0310)	Y.J. Chiu, L. Xu, Y. Han, W. Zhang(Intel)
JCTVC-H0299	m23174	2012-01-20 15:40:52	2012-01-21 04:20:04	2012-02-01 19:27:44	CE10 Subtest1: Cross verification of MediaTek's simplified chroma deblocking (JCTVC-H0311)	Y.J. Chiu, L. Xu, Y. Han, W. Zhang(Intel)
JCTVC-H0300	m23175	2012-01-20 15:41:43	2012-01-22 05:45:01	2012-01-22 05:45:01	AHG16: Crosscheck of SDIP and NSQT unification (JCTVC-H0347)	Y.J. Chiu, L. Xu, W. Zhang, Y. Han(Intel)
JCTVC-H0301	m23176	2012-01-20 15:42:32	2012-01-22 05:58:27	2012-01-29 10:03:32	Non-CE6.a: Crosscheck of Huawei's removal of large multiplier for LM mode calculation (JCTVC-H0491)	Y.J. Chiu, L. Xu, Y. Han, W. Zhang(Intel)
JCTVC-H0302	m23177	2012-01-20 15:43:29	2012-01-23 18:12:28	2012-01-23 18:12:28	AHG16: Crosscheck of MediaTek's harmonization of 2NxN/Nx2N Intra PU with SDIP and NSQT (JCTVC-H0455)	Y.J. Chiu, L. Xu, W. Zhang, Y. Han(Intel)
JCTVC-H0303	m23178	2012-01-20 15:43:57	2012-01-21 05:29:28	2012-01-21 05:29:28	CE4: Cross-check report of subtest 2.1 for Sony/TI on Enhancements of AVC quantization matrix in HEVC	J. Zheng(HiSilicon)
JCTVC-H0304	m23179	2012-01-20 15:45:49			Sum-128 luma/chroma interpolation filter	Hongbo Zhu
JCTVC-H0305	m23180	2012-01-20 15:47:51	2012-02-05 19:33:38	2012-02-05 19:33:38	The core spatial transform with fast algorithm	Hongbo Zhu
JCTVC-H0306	m23181	2012-01-20 15:47:51	2012-01-21 05:29:44	2012-01-21 05:29:44	CE4: Cross-check report of subtest 2.2 for MediaTek on quantization matrices representation Method and syntax	J. Zheng(HiSilicon)
JCTVC-H0307	m23182	2012-01-20 15:52:12	2012-01-21 05:29:56	2012-01-21 05:29:56	CE4: Cross-check report of subtest 2.5 for Qualcomm on Quantization matrix compression and signaling	J. Zheng(HiSilicon)
JCTVC-H0308	m23183	2012-01-20 15:52:30	2012-01-20 17:02:02	2012-02-02 01:27:22	CE2: Subset 4.4: Test Results on Harmonization of JCTVC-G283, JCTVC-G442 and JCTVC-G980	X. Zhao, J. An, X. Guo, S. Lei (MediaTek), L. Guo, X. Wang, M. Karczewicz (Qualcomm), A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi), A. Ichigaya, S. Sakaida (NHK), S. Ma, W. Gao (PKU),
JCTVC-H0309	m23184	2012-01-20 15:53:35	2012-01-20 17:03:26	2012-01-30 01:41:45	CE7: Boundary-Dependent Transform for Inter-Predicted Residue	J. An, X. Zhao, X. Guo, S. Lei (MediaTek)
JCTVC-H0310	m23185	2012-01-20 15:54:08	2012-01-20 17:05:05	2012-02-02 17:21:58	CE10 Subtest1: Chroma Deblocking Filter	Q. Huang, J. An, X. Guo, S. Lei (MediaTek)
JCTVC-H0311	m23186	2012-01-20 15:54:21	2012-01-20 17:19:59	2012-02-02 17:25:42	CE10 Subtest1: Simplified Chroma Deblocking Filter in JCTVC-H0310	Q. Huang, J. An, X. Guo, S. Lei (MediaTek)
JCTVC-H0312	m23187	2012-01-20 15:55:27	2012-01-20 17:20:52	2012-02-09 21:41:26	Non-CE4: Clipping of Transformed Coefficients before De-Quantization	X. Li, X. Guo, S. Lei (MediaTek)
JCTVC-H0313	m23188	2012-01-20 15:55:51	2012-01-20 17:21:43	2012-02-03 02:44:19	AHG15: On Signaling of Several Syntax Elements in SPS	X. Li, J. An, X. Guo, S. Lei (MediaTek)
JCTVC-H0314	m23189	2012-01-20	2012-01-21	2012-02-07	CE4: Subtest 2.4 Layered quantization matrices representation and	Y. Wang(Tsinghua), J.

		15:56:04	05:30:08	02:14:00	compression	Zheng(HiSilicon), Y. He(Tsinghua)
JCTVC-H0315	m23190	2012-01-20 15:57:13	2012-01-20 17:26:04	2012-01-20 17:26:04	Non-CE2: Separate RQT structure for Y, U and V components	J. An, X. Zhao, X. Guo, S. Lei (MediaTek)
JCTVC-H0316	m23191	2012-01-20 15:57:23	2012-01-20 19:22:52	2012-02-02 02:57:41	Non-CE9: Simplification of AMVP	L. Zhao, X. Guo, S. Lei (MediaTek), S. Ma, W. Gao (PKU), D. Zhao (HIT)
JCTVC-H0317	m23192	2012-01-20 15:57:38	2012-01-31 02:20:40	2012-02-02 01:28:11	CE2 Subtest 4.1: Test Report on Chroma RQT Depth	X. Zhao, J. An, X. Guo, S. Lei (MediaTek)
JCTVC-H0318	m23193	2012-01-20 15:58:20	2012-01-25 07:39:56	2012-01-25 07:39:56	CE4.4: Crosscheck for Samsung's Higher Granularity of Quantization Parameter Scaling	X. Li, X. Guo (MediaTek)
JCTVC-H0319	m23194	2012-01-20 15:58:36	2012-01-31 02:31:34	2012-01-31 02:31:34	CE2 Subtest 4.2: Crosscheck for Mitsubishi/NHK's Fixed TU Depth for Chroma in JCTVC-H0235	X. Zhao, X. Guo (MediaTek)
JCTVC-H0320	m23195	2012-01-20 16:03:14	2012-01-26 12:15:14	2012-01-30 13:52:24	CE5: Cross-check report of CE5.g combined tool	T. Davies (Cisco)
JCTVC-H0321	m23196	2012-01-20 16:04:31	2012-01-20 16:07:39	2012-01-27 17:46:24	AHG18: Resolution Adaptation Coding (ARC) using single resolution in DPB	P. Bordes, P. Andrivon (Technicolor)
JCTVC-H0322	m23197	2012-01-20 16:05:23	2012-01-21 01:23:37	2012-01-30 15:04:27	Cross-check of I2R's proposal on intra luma mode coding (JCTVC-H0166)	H. Yang (Huawei)
JCTVC-H0323	m23198	2012-01-20 16:07:16	2012-01-21 01:25:24	2012-01-21 01:25:24	CE6.a: Cross-check of three combined cases of the four intra chroma prediction tools by Huawei	H. Yang (Huawei)
JCTVC-H0324	m23199	2012-01-20 16:07:33	2012-01-20 16:17:43	2012-01-30 19:39:47	CE7: Cross verification of JCTVC-H0309, Boundary Dependent Transform for Inter Predicted Residue	R. Cohen (MERL)
JCTVC-H0325	m23200	2012-01-20 16:08:21	2012-01-21 01:25:39	2012-01-30 15:06:24	Cross-check of BJUT's proposal on the modified transform skip mode (JCTVC-H0061)	H. Yang (Huawei)
JCTVC-H0326	m23201	2012-01-20 16:09:53	2012-01-21 01:22:58	2012-02-08 18:49:40	Non-CE6: Simplification of intra chroma mode coding	H. Li, B. Li, L. Li, J. Zhang (USTC), H. Yang, H. Yu (Huawei)
JCTVC-H0327	m23202	2012-01-20 16:11:17	2012-01-21 01:24:09	2012-02-02 00:58:39	Simplification of MVP index coding and AMP mode coding	H. Li, B. Li (USTC), H. Yang, H. Yu (Huawei)
JCTVC-H0328	m23203	2012-01-20 16:18:21	2012-01-29 15:19:09	2012-01-29 15:19:09	AHG4: Crosscheck for Samsung's simplification on WPP in JCTVC-H0349	C.-Y. Tsai, Y.-W. Huang (MediaTek)
JCTVC-H0329	m23204	2012-01-20 16:19:12	2012-01-30 11:48:04	2012-01-30 11:48:04	AHG4: Crosscheck for LG's further latency reduction of CABAC initialization for dependent tiles in JCTVC-H0203	C.-W. Hsu, Y.-W. Huang (MediaTek)
JCTVC-H0330	m23205	2012-01-20 16:20:00	2012-01-29 16:24:41	2012-01-29 16:24:41	CE5.a: Crosscheck for BBC's quantization for transform skipping in JCTVC-H0208	S.-T. Hsiang, T.-D. Chuang (MediaTek)
JCTVC-H0331	m23206	2012-01-20 16:22:56	2012-01-29 01:04:18	2012-01-29 01:04:18	CE8.c.1: Crosscheck for TI's necessity of sign bits for SAO offsets in JCTVC-H0434	E. Alshina, A. Alshin (Samsung), C.-M. Fu, Y.-W. Huang (MediaTek)
JCTVC-H0332	m23207	2012-01-20	2012-01-29	2012-01-29	CE8.d.1: Crosscheck for TI's reduced number of band offsets in SAO in	C.-M. Fu, Y.-W. Huang (MediaTek)

		16:23:55	01:06:09	01:06:09	JCTVC-H0436	
JCTVC-H0333	m23208	2012-01-20 16:24:11	2012-01-20 16:25:39	2012-01-20 16:25:39	Withdrawn	
JCTVC-H0334	m23209	2012-01-20 16:24:49	2012-01-29 01:09:17	2012-01-29 01:09:17	CE8.d.2: Crosscheck for Panasonic's SAO line buffer reduction in JCTVC-H0375	C.-M. Fu, Y.-W. Huang (MediaTek)
JCTVC-H0335	m23210	2012-01-20 16:25:49	2012-01-29 15:17:16	2012-01-29 15:17:16	CE8.e.4: Crosscheck for Motorola Mobility's selection and coding of SAO parameters in JCTVC-H0557	C.-M. Fu, Y.-W. Huang (MediaTek)
JCTVC-H0336	m23211	2012-01-20 16:27:00	2012-01-20 16:31:59	2012-02-02 06:47:32	CE4 Subtest 4.1: Higher granularity of quantization parameter scaling	T. Lee, J. Park (Samsung), K. Keiichi (NEC)
JCTVC-H0337	m23212	2012-01-20 16:27:19	2012-01-29 01:10:51	2012-01-29 01:10:51	CE8.e.5: Crosscheck for combination of CE8.e.2 and CE8.e.3 in JCTVC-H0225	C.-M. Fu, Y.-W. Huang (MediaTek)
JCTVC-H0338	m23213	2012-01-20 16:28:21	2012-01-30 11:48:57	2012-01-30 11:48:57	Non-CE8: Crosscheck for TI and Sharp's new chroma band offset design in SAO in JCTVC-H0438	C.-M. Fu, Y.-W. Huang (MediaTek)
JCTVC-H0339	m23214	2012-01-20 16:29:34	2012-01-29 01:12:24	2012-01-29 01:12:24	Non-CE6: Crosscheck for LG's signalling of chroma intra prediction mode in JCTVC-H0475	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-H0340	m23215	2012-01-20 16:30:30	2012-01-29 01:13:59	2012-01-29 01:13:59	Non-CE9: Crosscheck for JVC Kenwood's simplification of AMVP spatial candidate derivation in JCTVC-H0078	J.-L. Lin, Y.-W. Huang (MediaTek)
JCTVC-H0341	m23216	2012-01-20 16:31:39	2012-01-29 01:15:28	2012-01-29 01:15:28	Non-CE9: Crosscheck for Qualcomm's moving fifth spatial MV candidate after TMVP for merge mode in JCTVC-H0429	Y.-W. Chen, Y.-W. Huang (MediaTek)
JCTVC-H0342	m23217	2012-01-20 16:32:27	2012-01-20 17:23:19	2012-02-03 18:57:14	Non CE6: Unify the intra mode number for all PU size	C. Lai, L. Liu, J. Zheng (HiSilicon)
JCTVC-H0343	m23218	2012-01-20 16:33:44	2012-01-20 16:35:58	2012-01-30 11:43:41	Redundancy removal of syntax	T. Lee, J. Park (Samsung)
JCTVC-H0344	m23219	2012-01-20 16:33:53	2012-01-20 18:40:01	2012-01-23 15:48:11	CE9: Cross-check report for tests BP01 and BP04 (JCTVC-H0111)	P. Helle (Fraunhofer HHI)
JCTVC-H0345	m23220	2012-01-20 16:34:16	2012-01-20 23:11:55	2012-01-31 09:49:45	Constrained Tile for parallel decoding	H. Sasai, K. Uchibayashi, T. Nishi (Panasonic)
JCTVC-H0346	m23221	2012-01-20 16:38:10	2012-01-20 17:08:30	2012-01-20 17:08:30	CE6.b crosscheck for MediaTek's proposal	Y. Lin, C. Lai, L. Liu, J. Zheng (HiSilicon)
JCTVC-H0347	m23222	2012-01-20 16:40:38	2012-01-21 04:27:37	2012-02-01 21:46:03	AHG16: SDIP unified with NSQT	X. Cao, Y. He(Tsinghua), X. Peng(USTC), C. Lai, X.Zheng, L. Liu, J. Zheng(HiSilicon), J. Xu(Microsoft), H. Yang, J. Song, H. Yu(Huawei), J. Lim, B. Jeon(LGE), J. Sole, L.Guo, X. Wang, M. Karczewicz(Qualcomm), J. Xu, E. Maani, A. Tabatabai(Sony), X. Zhang, S. Liu, S. Lei(MediaTek), ,

JCTVC-H0348	m23223	2012-01-20 16:41:21	2012-01-20 17:28:23	2012-02-01 07:43:25	Simplification on tiles and slices	T. Lee, B. Choi, J. Park (Samsung)
JCTVC-H0349	m23224	2012-01-20 16:43:44	2012-01-20 17:29:01	2012-01-30 11:46:23	Simplification on WPP	T. Lee, J. Choi, J. Park (Samsung)
JCTVC-H0350	m23225	2012-01-20 16:53:19	2012-01-27 08:59:06	2012-01-27 08:59:06	CE10 Subtest4: Cross-verification for Panasonic's proposal JCTVC-H0148	S. Lu, M. Ikeda, T. Suzuki (Sony)
JCTVC-H0351	m23226	2012-01-20 16:53:54	2012-01-30 17:28:28	2012-01-30 17:28:28	AHG18: Cross-check of JCTVC-H0321 by Cisco	T. Davies
JCTVC-H0352	m23227	2012-01-20 16:56:42	2012-01-21 01:03:44	2012-01-23 17:07:53	CE11: Test results for Subtest 3.1.4.	V. Sze (TI)
JCTVC-H0353	m23228	2012-01-20 16:57:28	2012-01-21 00:01:13	2012-02-05 01:12:29	AHG8: Comments on HEVC version 1 Profile and Level definition	M. Zhou, V. Sze, H. Tamama (TI)
JCTVC-H0354	m23229	2012-01-20 16:58:06	2012-01-23 16:52:59	2012-01-24 00:47:09	CE11: Cross-check results for subtest 3.1.1 (H0095)	V. Sze (TI)
JCTVC-H0355	m23230	2012-01-20 16:58:11	2012-01-23 16:53:20	2012-01-24 00:47:18	CE11: Cross-check results for subtest 3.2.2 (H0160)	V. Sze (TI)
JCTVC-H0356	m23231	2012-01-20 16:58:14	2012-01-23 16:53:41	2012-01-24 00:47:28	CE11: Cross-check results for subtest 3.4.2 (H0283)	V. Sze (TI)
JCTVC-H0357	m23232	2012-01-20 16:58:18	2012-02-02 19:00:48	2012-02-02 19:00:48	Non-CE11: Cross-check of proposal H0290 on significant_coeff_flag context selection	V. Sze (TI)
JCTVC-H0358	m23233	2012-01-20 16:58:28	2012-02-09 19:34:21	2012-02-09 19:34:21	Non-CE11: Cross-check of proposal H0404 on coefficient level context selection	V. Sze (TI)
JCTVC-H0359	m23234	2012-01-20 16:58:31	2012-02-09 19:35:35	2012-02-09 19:35:35	Non-CE11: Cross-check of proposal H0432 on significant_coeff_flag context selection	V. Sze (TI)
JCTVC-H0360	m23235	2012-01-20 17:04:04	2012-01-21 03:18:34	2012-01-21 09:12:11	Comparison of Compression Performance of HEVC Working Draft 5 with AVC High Profile	B. Li (USTC), G. J. Sullivan, J. Xu (Microsoft)
JCTVC-H0361	m23236	2012-01-20 17:04:25	2012-01-20 18:49:10	2012-02-01 19:14:39	CE5.f: Residual Scalar Quantization for HEVC	C. Lan (Xidian Univ.), J. Xu, F. Wu (Microsoft)
JCTVC-H0362	m23237	2012-01-20 17:04:37	2012-01-20 18:49:30	2012-01-20 18:49:30	Motion prediction at entropy slice boundary	B. Li (USTC), J. Xu (Microsoft), H. Li (USTC)
JCTVC-H0363	m23238	2012-01-20 17:04:46			withdrawn	
JCTVC-H0364	m23239	2012-01-20 17:04:55	2012-01-20 18:49:52	2012-01-20 18:49:52	Non CE6: Cross-check of 35 intra prediction modes for intra 4x4 PU (JCTVC-H0342)	J. Xu (Microsoft)
JCTVC-H0365	m23240	2012-01-20 17:05:03	2012-01-20 18:50:13	2012-01-20 18:50:13	Non-CE9: Cross-verification of merge candidates pruning without reference indices (JCTVC-H0077)	B. Li (USTC), J. Xu (Microsoft)

JCTVC-H0366	m23241	2012-01-20 17:05:12	2012-01-20 18:55:23	2012-01-20 18:55:23	Non-CE4: Cross-check of clipping of transformed coefficients before de-quantization (JCTVC-H0312)	B. Li (USTC), J. Xu (Microsoft)
JCTVC-H0367	m23242	2012-01-20 17:05:20	2012-01-20 18:54:31	2012-01-20 18:54:31	Cross-check of context reduction for merge index coding (JCTVC-H0251)	J. Xu (Microsoft)
JCTVC-H0368	m23243	2012-01-20 17:05:29	2012-01-20 18:54:46	2012-01-20 18:54:46	Non-CE9: Cross-check of removal of non-scaled merge candidate (JCTVC-H0250)	J. Xu (Microsoft)
JCTVC-H0369	m23244	2012-01-20 17:05:37	2012-01-23 03:36:45	2012-01-29 17:29:03	AHG10: Cross-check of configurable and CU-group level parallel merge/skip (JCTVC-H0082)	J. Xu (Microsoft)
JCTVC-H0370	m23245	2012-01-20 17:13:50	2012-01-20 17:46:31	2012-02-03 18:19:09	Crosscheck of LGE/Sharp proposal for byte-aligned substreams and harmonized entry points (JTCVC-H0556)	Felix Henry, Gordon Clare
JCTVC-H0371	m23246	2012-01-20 17:21:02	2012-01-20 18:27:51	2012-02-01 21:33:57	CE8 subtest A: Cross-check report for JCTVC-H0274	S. Esenlik (Panasonic)
JCTVC-H0372	m23247	2012-01-20 17:28:06	2012-01-20 18:26:55	2012-02-05 22:24:32	Non-CE8: Line memory reduction fix at independent slice and tile boundaries	S. Esenlik, M. Narroschke, T. Wedi (Panasonic)
JCTVC-H0373	m23248	2012-01-20 17:31:35	2012-01-29 18:48:56	2012-01-29 18:51:18	CE5.f: Cross-check of Microsoft's JCTVC-H0361 Residual Scalar Quantization for HEVC	X. Wen, O. Au, J. Dai, F. Zou, X. Zhang, L. Fang (HKUST)
JCTVC-H0374	m23249	2012-01-20 17:35:12	2012-01-29 20:12:17	2012-01-29 20:12:17	Cross-check of Hisilicon's JCTVC-H0465 Simplification of mode dependent intra smoothing	X. Wen, O. Au, J. Li, D. Wei, S. Lin, X.Zhang, R. Zou (HKUST)
JCTVC-H0375	m23250	2012-01-20 17:47:28	2012-01-20 18:25:56	2012-01-20 18:25:56	CE8.d.2: SAO Line Buffer Reduction	S. Esenlik, M. Narroschke, T. Wedi (Panasonic)
JCTVC-H0376	m23251	2012-01-20 17:55:00	2012-01-20 18:24:24	2012-02-06 00:43:14	Non-CE8: Low-delay support for APS	S. Esenlik, M. Narroschke, V. Drugeon, T. Wedi (Panasonic)
JCTVC-H0377	m23252	2012-01-20 18:11:08	2012-01-27 15:50:07	2012-01-27 16:04:59	CE11: Cross-check of Mediatek's proposal H0282 by BBC	M. Mrak, D. Flynn (BBC)
JCTVC-H0378	m23253	2012-01-20 18:12:37	2012-01-27 17:57:47	2012-01-27 17:57:47	Non-CE1: Cross check of Nokia's proposal: CABAC bypass for coefficient data	M. Siekmann (Fraunhofer HHI)
JCTVC-H0379	m23254	2012-01-20 19:15:48	2012-01-21 05:19:50	2012-02-01 15:38:38	Context reduction of 8x8 significance map coding by hybrid scan with mask	C. Auyeung, J. Xu, A. Tabatabai (Sony)
JCTVC-H0380	m23255	2012-01-20 19:22:54	2012-01-20 19:27:20	2012-02-05 19:16:54	AHG15: SPS and PPS syntax modifications	V. Drugeon, T. Wedi, M. Narroschke, V. Wahadaniah (Panasonic)
JCTVC-H0381	m23256	2012-01-20 19:33:10	2012-01-20 19:35:24	2012-02-03 19:04:23	AHG15: Partial APS update	V. Drugeon, S. Esenlik, M. Narroschke, T. Wedi, V. Wahadaniah (Panasonic)
JCTVC-H0382	m23257	2012-01-20 19:33:31	2012-01-20 23:54:25	2012-02-07 18:33:09	Inclusion of adaptive loop filtering in the HEVC standard	T. Yamakage (Toshiba), I. S. Chong (Qualcomm), Y.-W. Huang (MediaTek)
JCTVC-H0383	m23258	2012-01-20	2012-01-21	2012-02-01	Complexity reduction of significance map coding	C. Auyeung (Sony)

		19:35:24	05:20:36	15:39:53		
JCTVC-H0384	m23259	2012-01-20 19:42:30	2012-01-20 19:51:01	2012-01-31 20:35:43	CE4 Subset2.2: Results for up-sampling large size quantization matrices based on JCTVC-G152	S. Liu, X. Zhang, T.-D. Chuang, S. Lei (MediaTek)
JCTVC-H0385	m23260	2012-01-20 19:42:32	2012-01-21 02:12:17	2012-01-21 03:23:03	CE8.b.1: Crosscheck of Modification of ALF BA classification (JCTVC-H0413) by Qualcomm	I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-H0386	m23261	2012-01-20 19:43:35	2012-01-21 01:06:45	2012-01-25 19:47:58	Information for scalable extension high layer syntax	J. Boyce, S. Wenger, W. Jang, D. Hong (Vidyo), Y.-K. Wang, Y. Chen (Qualcomm)
JCTVC-H0387	m23262	2012-01-20 19:43:42	2012-01-21 00:18:32	2012-01-31 20:36:41	Non-CE4: Handling large size quantization matrices	S. Liu, X. Zhang, S. Lei (MediaTek)
JCTVC-H0388	m23263	2012-01-20 19:43:47	2012-01-21 01:07:14	2012-02-10 00:42:20	High level syntax hooks for future extensions	J. Boyce, S. Wenger, W. Jang, D. Hong (Vidyo), Y.-K. Wang, Y. Chen (Qualcomm)
JCTVC-H0389	m23264	2012-01-20 19:44:01	2012-01-31 19:16:40	2012-02-09 19:41:40	New Class E videoconferencing source content	W. Jang, J. Boyce, D. Hong, A. Abbas (Vidyo)
JCTVC-H0390	m23265	2012-01-20 19:44:32	2012-01-21 02:13:40	2012-01-21 03:25:20	CE8.e.3: Crosscheck of Modified SAO edge offsets (JCTVC-H0223) by Qualcomm	I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-H0391	m23266	2012-01-20 19:49:50	2012-01-20 21:04:13	2012-01-21 11:39:19	AHG15: Slice-Level Control of In-Loop Filter	R. Srinivasan, C. Ghone (TI)
JCTVC-H0392	m23267	2012-01-20 19:58:30	2012-01-20 21:08:43	2012-01-20 21:08:43	AHG15: Enable picture-level CU/TU size signaling in HEVC	N. Srinivasamurthy, K. Prasad, Y. Dutt, M. Zhou (TI)
JCTVC-H0393	m23268	2012-01-20 20:10:27	2012-01-20 20:23:19	2012-01-20 20:23:19	CE7: Cross verification of JCTVC-H0126, on secondary transforms for inter prediction residual	R. Cohen (MERL)
JCTVC-H0394	m23269	2012-01-20 20:17:11	2012-01-21 14:09:55	2012-02-02 20:16:25	Coding in 444: Preferred Conversions in Color and Sampling	W. Dai, M. Krishnan, P. Topiwala (FastVDO),
JCTVC-H0395	m23270	2012-01-20 20:22:04	2012-01-20 21:16:28	2012-01-20 21:16:28	CE1: Cross-check report for Subtest B3	P. Helle, H. Kirchhoffer
JCTVC-H0396	m23271	2012-01-20 20:22:54	2012-01-20 20:26:39	2012-01-28 01:01:49	CE10 Subtest 3: Deblocking Filter Simplifications	G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-H0397	m23272	2012-01-20 20:34:29	2012-01-21 04:23:17	2012-02-02 00:29:34	Context reduction of split_transform_flag in CABAC	J. Xu, A. Tabatabai(Sony)
JCTVC-H0398	m23273	2012-01-20 20:34:35	2012-01-21 01:07:47	2012-02-07 01:29:59	CE10 Subtest 4: Transform Dependent Deblocking Filter Parameter Adjustment	G. Van der Auwera, R. Joshi, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-H0399	m23274	2012-01-20 20:36:16	2012-01-21 04:24:51	2012-02-09 17:52:50	Harmonization of coefficient coding	J. Xu, A. Tabatabai (Sony)
JCTVC-H0400	m23275	2012-01-20 20:36:48	2012-01-21 04:27:10	2012-02-02 21:21:19	Chroma QP extension	J. Xu (Sony), A. Tourapis (Magnum), E. Maani, K. Sato (Sony),

JCTVC-H0401	m23276	2012-01-20 20:37:20	2012-01-21 07:03:32	2012-02-02 00:32:30	Differentiated weighting parameter sets for weighted prediction	J. Xu (Sony), A. Tourapis (Magnum), E. Maani, A. Tabatabai (Sony)
JCTVC-H0402	m23277	2012-01-20 20:37:43	2012-01-21 04:12:09	2012-01-24 04:02:54	CE11 subset 4: Cross-check report of JCTVC-H0443	J. Xu, A. Tabatabai (Sony)
JCTVC-H0403	m23278	2012-01-20 20:38:04	2012-01-21 04:10:51	2012-01-29 00:10:41	CE6.b: Cross-check report for Rectangular (2NxN and Nx2N) PU for Intra Prediction	J. Xu, A. Tabatabai (Sony)
JCTVC-H0404	m23279	2012-01-20 21:19:20	2012-01-20 21:30:15	2012-01-31 02:17:11	Context Set Selection for Coefficient Level Coding	N.Nguyen, T.Ji, D.He, G.Martin-Cocher (RIM)
JCTVC-H0405	m23280	2012-01-20 21:25:55	2012-01-21 04:17:31	2012-01-30 20:20:02	Bypass coding in chroma Intra modes	E. Maani, A. Tabatabai (Sony)
JCTVC-H0406	m23281	2012-01-20 21:26:24	2012-01-21 04:23:01	2012-02-05 23:46:56	Flexible Band Offset Mode in SAO	E. Maani, O. Nakagami (Sony)
JCTVC-H0407	m23282	2012-01-20 21:27:28	2012-01-21 04:31:00	2012-02-05 05:13:35	Intra mode coding using logical mode numbering	E. Maani, A. Tabatabai (Sony)
JCTVC-H0408	m23283	2012-01-20 21:28:05	2012-02-01 02:11:57	2012-02-01 02:11:57	CE8.a.4 Cross-check	A. Fuldseth (Cisco)
JCTVC-H0409	m23284	2012-01-20 21:28:34	2012-01-21 04:36:54	2012-02-06 03:21:43	Harmonization of number of ALF classes between RA and BA modes	E. Maani, A. Tabatabai (Sony)
JCTVC-H0410	m23285	2012-01-20 21:44:35	2012-01-20 21:56:04	2012-01-30 09:17:33	Simple NAL Unit Header for HEVC	J. W. Kang, H. Lee, J. S. Choi, T. C. Thang
JCTVC-H0411	m23287	2012-01-20 22:05:24	2012-01-20 22:11:34	2012-01-29 23:57:34	Significant Coefficient Flag Context Models for Modular Processing	N.Nguyen, T.Ji, D.He, G.Martin-Cocher (RIM)
JCTVC-H0412	m23288	2012-01-20 22:23:56	2012-01-21 11:22:05	2012-02-05 17:42:51	AHG21: Reference picture list restrictions	R. Sjöberg, J. Samuelsson (Ericsson)
JCTVC-H0413	m23289	2012-01-20 22:32:01	2012-01-20 23:20:59	2012-01-20 23:20:59	CE8.b.1: ALF BA feature computation at upper-left 4 pixels in a 4×4 block	P. Lai, F. C. A. Fernandes (Samsung), E. Maani, A. Tabatabai, M. Ikeda (Sony)
JCTVC-H0414	m23290	2012-01-20 22:32:28	2012-01-21 02:47:23	2012-01-31 20:13:00	Cross-check of "AHG4: Further latency reduction of CABAC initialization for dependent Tiles" (JCTVC-H203)	M. Horowitz, S. Xu (eBrisk)
JCTVC-H0415	m23291	2012-01-20 22:32:51	2012-01-21 09:22:01	2012-01-29 23:54:10	Non-CE8: ALF BA feature computation only accessing 3x3 area	P. Lai, F. C. A. Fernandes (Samsung), E. Maani, A. Tabatabai, M. Ikeda (Sony)
JCTVC-H0416	m23292	2012-01-20 22:33:27	2012-01-24 08:53:28	2012-01-31 22:37:48	CE8.b.2 Crosscheck of JCTVC-G0068 ALF with single filter type	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-H0417	m23293	2012-01-20 22:33:59	2012-01-21 07:15:26	2012-01-29 01:01:21	Non-CE8: Supplementary analysis of ALF with single shape	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-H0418	m23294	2012-01-20	2012-01-21	2012-01-31	Non-CE8: Unification of k-index mapping for ALF luma filter coefficients of	P. Lai, F. C. A. Fernandes (Samsung)

		22:34:31	07:36:08	22:42:37	the two shapes	
JCTVC-H0419	m23295	2012-01-20 22:35:18	2012-02-01 07:47:43	2012-02-02 18:34:49	Non-CE8: Techniques in LCU-based ALF in CE8.a.2 and CE8.a.4	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-H0420	m23296	2012-01-20 22:36:11	2012-01-21 08:35:16	2012-02-01 18:53:27	Non-CE8: Information on codebook size for LCU-based ALF	Zhan Ma, P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-H0421	m23297	2012-01-20 22:36:48	2012-01-23 04:46:05	2012-02-02 15:19:22	AHG7: Cross-verification of controllable memory bandwidth reduction with bi-pred to uni-pred conversion (JCTVC-H0096 from Sharp)	M. Zhou (TI)
JCTVC-H0422	m23298	2012-01-20 22:36:49	2012-01-31 04:20:56	2012-01-31 04:20:56	CE8.a.4 Crosscheck of JCTVC-H0274 Table 7, 8, and 9: ALF with LCU-based syntax (SAO the same as HM5.0, two-stage SAO-ALF)	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-H0423	m23299	2012-01-20 22:38:04	2012-01-20 23:00:36	2012-02-09 21:46:12	Indication of the temporal structure of coded video sequences	M. M. Hannuksela, S. M. Gopalakrishna (Nokia)
JCTVC-H0424	m23300	2012-01-20 22:41:20	2012-01-21 01:09:12	2012-02-07 01:35:16	Non-CE10 Subtest 4: On Deblocking Parameter Signalling	G. Van der Auwera, Y.-K. Wang, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-H0425	m23301	2012-01-20 22:41:34	2012-01-20 22:59:51	2012-02-02 21:39:42	POC granularity for reference picture sets and slice header	M. M. Hannuksela, S. M. Gopalakrishna (Nokia)
JCTVC-H0426	m23302	2012-01-20 22:42:43	2012-01-20 22:59:18	2012-02-03 19:15:06	AHG21: Removal of reference picture list modification	M. M. Hannuksela, S. M. Gopalakrishna (Nokia)
JCTVC-H0427	m23303	2012-01-20 22:47:16	2012-01-21 09:48:09	2012-02-05 20:44:08	Non-CE11: Support modification for parallel calculation of significant map contexts	V. Seregin, J. Sole, M. Karczewicz (Qualcomm)
JCTVC-H0428	m23304	2012-01-20 22:47:31	2012-01-21 09:49:04	2012-02-04 05:12:14	Non-CE6: Postpone MPM sorting	V. Seregin, W.-J. Chien, M. Karczewicz (Qualcomm)
JCTVC-H0429	m23305	2012-01-20 22:47:42	2012-01-21 09:50:00	2012-01-31 02:53:57	Non-CE9: Moving fifth spatial MV candidate after TMVP for merge mode	V. Seregin, X. Wang, J. Chen, M. Karczewicz (Qualcomm)
JCTVC-H0430	m23306	2012-01-20 22:47:47	2012-01-21 10:01:34	2012-02-01 08:08:17	Non-CE9: Single TMVP for merge mode	V. Seregin, X. Wang, J. Chen, M. Karczewicz (Qualcomm)
JCTVC-H0431	m23307	2012-01-20 22:47:52	2012-01-21 09:52:39	2012-02-02 20:42:21	Non-CE9: Splitting contexts for MVD coding	V. Seregin, J. Chen, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-H0432	m23308	2012-01-20 22:49:44	2012-01-20 22:59:55	2012-01-31 01:21:42	Sub-Block Based Significance Map Region Classification	T.Ji, N.Nguyen, D.He, G.Martin-Cocher (RIM)
JCTVC-H0433	m23309	2012-01-20 22:50:54	2012-01-21 05:13:35	2012-02-01 05:07:29	AHG21: Reference Picture Set Signaling Method	Sachin Deshpande, Kiran Misra, Andrew Segall
JCTVC-H0434	m23310	2012-01-20 22:51:22	2012-01-21 02:02:12	2012-02-06 04:12:35	CE8 Subset c: Necessity of Sign Bits for SAO Offsets	W.-S. Kim, D.-K. Kwon (TI)
JCTVC-H0435	m23311	2012-01-20 22:52:24	2012-01-21 01:26:58	2012-01-30 23:34:30	Non-CE6: Intra mode coding with fixed length binarization	X. Zhang, S. Liu, M. Guo, X. Guo, S. Lei (MediaTek)
JCTVC-H0436	m23312	2012-01-20	2012-01-21	2012-01-21	CE8 Subset d.1: Reduced Number of Band Offsets in SAO	W.-S. Kim, D.-K. Kwon (TI)

		22:52:30	02:02:47	02:02:47		
JCTVC-H0437	m23313	2012-01-20 22:54:59	2012-01-21 01:28:42	2012-02-02 03:23:46	CE6.b: Rectangular (2NxN and Nx2N) PU for Intra Prediction	X. Zhang, S. Liu, S. Lei (MediaTek)
JCTVC-H0438	m23314	2012-01-20 22:55:42	2012-01-21 02:03:16	2012-01-24 23:03:00	Non-CE8: New Chroma Band Offset (BO) Design in SAO	W.-S. Kim, D.-K. Kwon (TI), Y. Yasugi, T. Ikai (Sharp)
JCTVC-H0439	m23315	2012-01-20 22:57:07	2012-01-23 16:32:42	2012-01-23 16:32:42	Cross-verification of Non-CE8: Method of removing boundary artifacts for SAO (JCTVC-H0201)	D.-K. Kwon, W.-S. Kim (TI)
JCTVC-H0440	m23316	2012-01-20 22:58:39	2012-01-24 19:47:36	2012-01-24 19:47:36	CE6.c: Cross-check of JCTVC-H0075: Intra mode coding simplification	X. Zhang, S. Liu (MediaTek)
JCTVC-H0441	m23317	2012-01-20 23:01:56	2012-01-20 23:38:29	2012-02-04 21:22:45	Motion Compensation Restrictions to Alleviate Memory Bandwidth Concerns for High Resolution Video	T. Hellman, W. Wan (Broadcom)
JCTVC-H0442	m23318	2012-01-20 23:03:44	2012-01-20 23:38:59	2012-02-02 03:55:32	Limiting Collocated Temporal Reference to One Per Picture	T. Hellman, W. Wan (Broadcom)
JCTVC-H0443	m23319	2012-01-20 23:12:49	2012-01-21 02:40:52	2012-02-02 21:42:10	CE11: Harmonization of residual coding and NSQT	J. Kim, B. Jeon (LGE), J. Sole, M. Karczewicz (Qualcomm)
JCTVC-H0444	m23320	2012-01-20 23:12:55	2012-01-21 12:20:04	2012-01-31 07:11:13	CE1: Modified LPS range and state transition tables for BAC	J. Sole, L. Guo, M. Karczewicz (Qualcomm)
JCTVC-H0445	m23321	2012-01-20 23:12:59	2012-01-21 11:26:30	2012-02-02 03:35:33	Non-CE11: Low complexity parallel significance map coding	J.Sole, V. Seregin, M. Karczewicz (Qualcomm), T. Ikai, T. Tsukuba (Sharp)
JCTVC-H0446	m23322	2012-01-20 23:13:03	2012-01-26 02:01:50	2012-01-26 02:01:50	CE11: Cross-check of Samsung's context number reduction for level coding in CABAC (JCTVC-H0130)	J. Sole (Qualcomm)
JCTVC-H0447	m23323	2012-01-20 23:13:08	2012-01-21 08:42:52	2012-01-21 08:42:52	Reduced Resolution Update Mode for enhanced compression	Alexis Tourapis, Lowell Winger
JCTVC-H0448	m23324	2012-01-20 23:16:30	2012-01-21 01:08:23	2012-01-27 23:09:01	AHG6: Deblocking of IPCM Blocks Containing Reconstructed Samples	G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-H0449	m23325	2012-01-20 23:17:18	2012-01-20 23:27:23	2012-02-03 09:41:16	AHG21: A constraint to simplify and improve the robustness of POC computation	G. J. Sullivan (Microsoft)
JCTVC-H0450	m23326	2012-01-20 23:21:35	2012-01-21 00:25:09	2012-02-10 20:12:38	Limiting the Bin to Bit Expansion Ratio	Y. Yu, T. Hellman, W. Wan (Broadcom)
JCTVC-H0451	m23327	2012-01-20 23:28:53	2012-01-21 08:39:21	2012-02-01 21:34:21	CE4: Subtest 2.5: Coding of quantization matrices based on modified prediction and mapping to unsigned values	R. Joshi, J. Sole, M. Karczewicz (Qualcomm)
JCTVC-H0452	m23328	2012-01-20 23:30:25	2012-01-21 08:40:09	2012-02-02 04:38:36	CE5: Subtest d: Modifications to last significant coefficient position coding for transform skip mode	R. Joshi, J. Sole, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-H0453	m23329	2012-01-20 23:33:11	2012-01-21 08:42:25	2012-01-21 08:42:25	Non-CE4 subtest 2: Signaling a subset of quantizer matrix coefficients for 32x32 quantization matrices	R. Joshi, M. Karczewicz (Qualcomm)

JCTVC-H0454	m23330	2012-01-20 23:33:51	2012-01-29 07:51:44	2012-01-29 07:51:44	CE5.c: A crosscheck report for mode-dependent significance scans for transform skip (JCTVC-H0064)	R. Joshi (Qualcomm)
JCTVC-H0455	m23331	2012-01-20 23:38:03	2012-01-21 06:22:23	2012-02-03 21:54:22	AHG16: Harmonization of 2NxN/Nx2N Intra PU with SDIP and NSQT	X. Zhang, S. Liu, C.-W. Hsu, T.-D. Chuang, S. Lei (MediaTek)
JCTVC-H0456	m23332	2012-01-20 23:39:39	2012-01-21 00:12:47	2012-01-21 00:12:47	Non CE 7: Experimental Results for the ROT	Zhan Ma, Felix Fernandes, Elena Alshina, Alexander Alshin
JCTVC-H0457	m23333	2012-01-20 23:40:15	2012-01-21 00:18:47	2012-02-02 20:55:47	Removal of Monochrome Chroma Format Support	T. Hellman, W. Wan (Broadcom)
JCTVC-H0458	m23334	2012-01-20 23:40:16	2012-01-21 00:31:05	2012-01-27 18:37:33	Non-CE1: High Throughput Coding Scheme with Rice Binarization	T. Nguyen, D. Marpe, M. Siekmann, T. Wiegand (Fraunhofer HHI)
JCTVC-H0459	m23335	2012-01-20 23:42:10	2012-01-21 00:29:18	2012-02-01 21:04:47	CE10.3: Cross Check of SKT/SKKU Proposal JCTVC-H0155	G. Van der Auwera (Qualcomm)
JCTVC-H0460	m23336	2012-01-20 23:45:04	2012-01-21 05:21:51	2012-02-02 02:26:35	High-level Syntaxes for the Scaling List Matrices Parameters and Parametric coding	Munsi Haque, Ehsan Maani, Ali Tabatabai
JCTVC-H0461	m23337	2012-01-20 23:51:22	2012-01-21 05:21:14	2012-02-10 03:22:17	On HVS only Default Scaling List Matrices	M. Haque, A. Tabatabai, J. Xu, C. Auyeung, Y. Morigami, T. Suzuki
JCTVC-H0462	m23338	2012-01-21 00:07:57	2012-01-21 01:10:47	2012-01-21 01:10:47	Spatial Motion Vector Predictor Mismatch and Possible Unintended Behavior	B. Heng, P. Chen, W. Wan (Broadcom),
JCTVC-H0463	m23339	2012-01-21 00:09:34	2012-01-21 04:47:24	2012-02-04 19:39:15	Comments on specifying tile support in HEVC Profiles and Levels	W. Wan, T. Hellman (Broadcom)
JCTVC-H0464	m23340	2012-01-21 00:09:50	2012-01-21 02:29:44	2012-02-03 23:58:18	Non-CE6a: Using averaged down-sampling reference pixels in LM parameter generation	L. Liu, J. Zheng, P. Zhang (HiSilicon), G. Li, N. Ling, L. Song (SCU)
JCTVC-H0465	m23341	2012-01-21 00:12:22	2012-01-21 03:15:37	2012-02-03 19:02:43	Simplification of mode dependent intra smoothing	G. Li, N. Ling, L. Song (SCU), L. Liu, C. Lai, J. Zheng, P. Zhang (HiSilicon),
JCTVC-H0466	m23342	2012-01-21 00:17:30	2012-01-21 15:02:55	2012-01-30 04:42:37	AHG21: Unified reference list for single-directional prediction	V. Wahadaniah, C. S. Lim (Panasonic)
JCTVC-H0467	m23343	2012-01-21 00:17:52	2012-01-22 02:06:18	2012-01-27 11:10:46	AHG21: Signalling periodic reference picture lists	V. Wahadaniah, S. M. T. Naing, C. S. Lim (Panasonic)
JCTVC-H0468	m23344	2012-01-21 00:18:27	2012-01-22 04:13:33	2012-01-27 11:11:29	AHG21: Flexible signalling of long term reference pictures	V. Wahadaniah, C. S. Lim (Panasonic)
JCTVC-H0469	m23345	2012-01-21 00:18:51	2012-01-30 23:03:02	2012-02-04 04:31:21	Cross-check of NEC's proposal H0051 on burst transmission of I_PCM blocks by Panasonic	S. M. T. Naing, V. Wahadaniah, C. S. Lim (Panasonic)
JCTVC-H0470	m23346	2012-01-21 00:19:14			Withdrawn	
JCTVC-H0471	m23348	2012-01-21	2012-01-21	2012-02-02	Proposal to Improve Ultra Low Delay Coding with Minimal Decoder Impact	Osnat Bar-Nir

		00:22:36	01:55:46	16:56:41		
JCTVC-H0472	m23349	2012-01-21 00:27:03	2012-01-21 00:50:03	2012-02-07 19:59:33	CE10.2: Level restrictions on tiles for line buffer reduction	Andrey Norkin, Rickard Sjöberg
JCTVC-H0473	m23350	2012-01-21 00:28:40	2012-01-21 00:48:59	2012-02-04 22:18:11	CE10.3: Deblocking filter simplifications: Bs computation and strong filtering decision	Andrey Norkin
JCTVC-H0474	m23351	2012-01-21 00:34:32	2012-01-28 01:33:07	2012-01-28 01:33:07	CE10.4: Cross check of Ericsson's proposal JCTVC-H0574	G. Van der Auwera (Qualcomm)
JCTVC-H0475	m23352	2012-01-21 00:37:30	2012-01-21 00:40:10	2012-02-04 20:04:05	Signalling chroma intra prediction mode	J. Kim, B. Jeon
JCTVC-H0476	m23354	2012-01-21 00:42:50	2012-01-21 00:44:31	2012-01-30 08:18:32	Non-CE11: Adjusted significant coefficient map context for Non-Square blocks	J. Kim, B. Jeon
JCTVC-H0477	m23355	2012-01-21 00:46:44	2012-01-21 00:52:29	2012-02-03 17:19:02	On Just Noticeable Distortion Quantization in the HEVC Codec	Matteo Naccari, Marta Mrak
JCTVC-H0478	m23356	2012-01-21 01:18:36	2012-01-21 01:20:36	2012-01-21 01:20:36	CE6.c: Cross check of Huawei/HiSilicon’s proposal JCTVC-H0057	J Kim, C Kim, B Jeon
JCTVC-H0479	m23357	2012-01-21 01:35:02	2012-02-01 21:41:25	2012-02-02 02:04:47	Cross-check of CE5.g: Integration of tools CE5.a to CE5.e	J. Wang, X. Yu, D. He
JCTVC-H0480	m23358	2012-01-21 01:36:02	2012-01-31 05:07:17	2012-01-31 05:07:17	Cross-check of CE11 Subtest3: Orange Labs’ Sign Data Hiding	J. Wang, X. Yu, D. He
JCTVC-H0481	m23359	2012-01-21 01:37:59	2012-01-21 01:56:11	2012-02-10 00:37:38	Multiple Sign Bits Hiding	X. Yu, J. Wang, D. He, G. Martin-Cocher, S. Campbell
JCTVC-H0482	m23360	2012-01-21 01:44:23	2012-01-21 09:05:01	2012-01-31 09:21:42	AHG21: Improvement to Intra RPS Prediction	J. Zhao, S. Deshpande, A. Segall (sharp)
JCTVC-H0483	m23361	2012-01-21 01:47:47	2012-01-21 07:51:33	2012-02-07 02:25:29	Harmonization of ALF Luma and Chroma Center Coefficient Prediction	J. Zhao, A. Segall (sharp)
JCTVC-H0484	m23362	2012-01-21 01:49:02	2012-01-31 15:56:03	2012-01-31 15:56:03	CE11: Crosscheck of JCTVC-G301 on context simplification for coefficients entropy coding	C. Auyeung (Sony)
JCTVC-H0485	m23363	2012-01-21 01:58:46	2012-01-21 02:01:12	2012-02-11 01:38:52	Picture size signaling and cropping operation	K. Suehring, B. Bross (Fraunhofer HHI)
JCTVC-H0486	m23367	2012-01-21 02:16:06	2012-01-22 00:16:35	2012-01-22 00:16:35	Suggested figures for the HEVC specification	Chad Fogg
JCTVC-H0487	m23368	2012-01-21 02:27:53	2012-01-21 10:25:27	2012-02-02 02:02:42	Importance of very high bit rate and ultra-low latency applications	Alberto Duenas, Francisco Javier Roncero (Cavium)
JCTVC-H0488	m23369	2012-01-21 02:32:43	2012-01-30 22:00:47	2012-01-30 22:00:47	Cross-check of Samsung's H0131: Simplified multi-level significance map coding	N.Nguyen, T.Ji, D.He, G.Martin-Cocher (RIM)
JCTVC-H0489	m23370	2012-01-21	2012-01-21	2012-02-05	Complexity analysis of high throughput CABAC Entropy codecs	Alberto Duenas, Prashant Arora,

		02:34:44	10:24:29	05:39:18		Oscar Patino, Francisco Javier Roncero (Cavium)
JCTVC-H0490	m23371	2012-01-21 02:36:25	2012-01-21 08:32:03	2012-02-03 19:27:31	Non-CE6a: Reduce the look-up table entries for LM mode calculation	L. Liu (HiSilicon), G. Li (SCU)
JCTVC-H0491	m23372	2012-01-21 02:43:32	2012-01-21 08:42:42	2012-02-03 19:12:43	Non-CE6a: Remove the large multiplier for LM mode calculation	L. Liu, Y. Lin (HiSilicon), G. Li (SCU)
JCTVC-H0492	m23373	2012-01-21 02:44:27	2012-01-21 09:38:54	2012-01-23 17:28:34	Clean-up of NSQT implementation	Y. Yuan (Tsinghua), X. Zheng (HiSilicon), H. Yu (Huawei), Y. He (Tsinghua)
JCTVC-H0493	m23374	2012-01-21 02:47:34	2012-01-31 00:04:38	2012-01-31 00:04:38	Cross-verification of JCTVC-H0435: Intra mode coding with fixed length binarization	E. S. Ryu, Y. Ye (InterDigital)
JCTVC-H0494	m23375	2012-01-21 02:58:40	2012-01-21 19:13:10	2012-01-21 19:13:10	CE3: Chroma interpolation filter with half pixel phase offset	J. Lou, K. Minoo, L. Wang, A. Luthra (Motorola Mobility)
JCTVC-H0495	m23376	2012-01-21 03:01:16	2012-01-21 19:14:14	2012-02-03 05:45:02	Quantization matrices for 4x4 and 8x8 TUs matching HEVC integer transforms	J. Lou, J. Kim, L. Wang (Motorola Mobility)
JCTVC-H0496	m23377	2012-01-21 03:01:54	2012-01-21 09:10:14	2012-02-10 00:18:25	On bitstreams starting with CRA pictures	Y. -K. Wang, Y. Chen, Marta Karczewicz, J. Chen (Qualcomm)
JCTVC-H0497	m23378	2012-01-21 03:03:01	2012-01-21 19:21:40	2012-01-29 06:14:24	Improving coeff_abs_level_minus3 coding performance under high bitrate	J. Lou, X. Fang, L. Wang (Motorola Mobility)
JCTVC-H0498	m23379	2012-01-21 03:03:27	2012-01-21 19:37:19	2012-02-05 10:20:23	Simplified coeff_abs_level_minus3 coding	J. Lou, L. Wang (Motorola Mobility)
JCTVC-H0499	m23380	2012-01-21 03:04:42	2012-01-29 08:33:37	2012-02-04 05:13:36	Simplified CABAC for Lossless compression	S.H. Kim, A. Segall (sharp)
JCTVC-H0500	m23381	2012-01-21 03:06:29	2012-01-21 09:10:39	2012-01-21 09:10:39	Bit depth of output pictures	Y. Chen, Y. -K. Wang, X. Wang, I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-H0501	m23382	2012-01-21 03:07:45	2012-01-21 09:11:02	2012-01-31 23:24:28	Efficient POC signaling for temporal scalability	Y. Chen, Y. -K. Wang, Adarsh K. Ramasubramonian (Qualcomm)
JCTVC-H0502	m23383	2012-01-21 03:08:30	2012-01-21 09:11:26	2012-01-21 09:11:26	Signaling of long-term reference pictures in the PPS	Y. -K. Wang, Y. Chen (Qualcomm)
JCTVC-H0503	m23384	2012-01-21 03:09:45	2012-01-30 20:27:54	2012-01-30 20:27:54	Cross-check of RIM's multiple sign bits hiding (JCTVC-H0481)	J. Sole
JCTVC-H0504	m23385	2012-01-21 03:12:40	2012-01-21 09:11:48	2012-01-21 09:11:48	Comments on Reference Picture Lists Combination Syntax	Hendry, Y. J. Jeon, S. W. Park, S. O. Jeong, B. M. Jeon (LG), Y. Chen, Y. -K. Wang, W. -J. Chien (Qualcomm)
JCTVC-H0505	m23386	2012-01-21 03:15:05	2012-01-21 09:12:14	2012-02-01 07:55:23	On APS partial update	Y. -K. Wang, Y. Chen, G. Van der Auwera (Qualcomm)
JCTVC-H0506	m23387	2012-01-21	2012-01-22	2012-01-23	CE4 subtest 3.1.a: QP adaptation at sub_CU level	J. H. Kim, X. Fang, K. Panusopone,

		03:18:29	06:18:06	08:39:44		L. Wang, A. Luthra (Motorola Mobility)
JCTVC-H0507	m23388	2012-01-21 03:19:22	2012-01-21 09:12:37	2012-01-21 09:12:37	Referencing different APS's in the same picture	S. Wenger (Vidyo), Y. -K. Wang, I. S. Chong (Qualcomm)
JCTVC-H0508	m23389	2012-01-21 03:19:45	2012-01-22 06:22:02	2012-02-02 05:42:04	CE4 subtest 3.1.b: Additional constraint for QP adaptation at sub_CU level	J. H. Kim, X. Fang, K. Panusopone, L. Wang, A. Luthra (Motorola Mobility)
JCTVC-H0509	m23390	2012-01-21 03:22:44	2012-01-22 06:32:24	2012-02-03 02:56:16	CE11 subtest 3.1.3: Simplification of significant map coding for CABAC	V. Kung, K. Panusopone, L. Wang (Motorola Mobility)
JCTVC-H0510	m23391	2012-01-21 03:23:21	2012-01-21 04:40:26	2012-02-05 23:50:08	Non-CE1:High Throughput Binarization (HTB) method with modified level coding	S.H. Kim, K. Misra, L. Kerofsky, A. Segall (Sharp)
JCTVC-H0511	m23392	2012-01-21 03:23:28	2012-01-22 06:35:21	2012-02-03 04:06:31	CE11 subtest 3.4.4: Entropy coding for non square blocks	V. Kung, K. Panusopone, L. Wang (Motorola Mobility)
JCTVC-H0512	m23393	2012-01-21 03:23:57	2012-01-21 09:13:11	2012-01-21 09:13:11	APS fragmentation	Y. Chen, Y. -K. Wang, R. Joshi, M. Karczewicz (Qualcomm)
JCTVC-H0513	m23394	2012-01-21 03:25:18	2012-01-21 09:48:28	2012-01-31 03:30:07	On parallel processing schemes	Y. -K. Wang, M. Coban (Qualcomm)
JCTVC-H0514	m23395	2012-01-21 03:27:00	2012-01-22 06:28:23	2012-02-10 00:38:40	Chroma Context reduction for Last Coefficient Position Coding in HEVC	X. Fang, K. Panusopone, L. Wang (Motorola Mobility)
JCTVC-H0515	m23396	2012-01-21 03:27:26	2012-01-21 09:13:42	2012-01-31 01:51:39	On entropy slices	M. Coban, Y. -K. Wang, J. Chon, M. Karczewicz (Qualcomm)
JCTVC-H0516	m23397	2012-01-21 03:27:52	2012-01-22 06:25:34	2012-02-03 01:50:26	On MPM determination and Planar mode signaling	Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)
JCTVC-H0517	m23398	2012-01-21 03:28:21	2012-01-22 01:44:28	2012-01-22 01:44:28	On wavefront parallel processing	Y. -K. Wang, M. Coban (Qualcomm)
JCTVC-H0518	m23399	2012-01-21 03:28:24	2012-02-01 08:23:13	2012-02-01 08:23:13	CE4: cross check report for subtest 3.2 (JCTVC-H0260)	K. Panusopone
JCTVC-H0519	m23400	2012-01-21 03:28:48	2012-02-02 10:18:35	2012-02-02 10:18:35	CE11: cross check report for subtest 3.1.4 (JCTVC-H0352)	K. Panusopone, W.-Y. Kung
JCTVC-H0520	m23401	2012-01-21 03:31:51	2012-01-21 10:14:22	2012-01-31 03:30:58	Tile groups	Y. -K. Wang, A. K. Ramasubramonian, Y. Chen, M. Coban, M. Karczewicz (Qualcomm)
JCTVC-H0521	m23402	2012-01-21 03:35:35	2012-01-21 10:30:04	2012-01-31 03:31:31	Flexible tile dependency and loop filter control	Y. -K. Wang, J. Chon, Y. Chen, I. S. Chong, M. Coban, M. Karczewicz (Qualcomm)
JCTVC-H0522	m23403	2012-01-21 03:40:29	2012-01-21 08:27:46	2012-02-03 20:04:32	Weighted predictive coding for Quantization matrices	J. Zheng(HiSilicon), J. Chen(UCLA)

JCTVC-H0523	m23404	2012-01-21 03:42:50	2012-01-21 09:03:22	2012-02-01 22:08:55	On partial updating the set of quantization matrices	J. Zheng(HiSilicon), J. Chen(UCLA)
JCTVC-H0524	m23405	2012-01-21 03:45:32	2012-01-21 03:48:49	2012-01-30 08:20:06	Extending 4×4 sub-block diagonal scan to 8×8 TU	J. Kim, J Chen, C. Kim, J. Sole, W. Chien, M. Karczewicz, B. Jeon
JCTVC-H0525	m23406	2012-01-21 03:56:46	2012-01-31 02:39:36	2012-01-31 02:39:36	Non-CE4: Cross-verification report for spatial QP prediction based on motion vector predictors (JCTVC-H0289)	H. Aoki, K. Chono (NEC)
JCTVC-H0526	m23407	2012-01-21 04:11:04	2012-01-21 04:24:47	2012-02-10 00:08:44	Multi-level Significance Maps for Small Transform Units	N.Nguyen, T.Ji, D.He, G.Martin-Cocher (RIM)
JCTVC-H0527	m23408	2012-01-21 04:11:18	2012-01-30 20:30:44	2012-01-30 20:30:44	Cross-check of modified Intra mode definitions by Sharp (JCTVC-H0098)	Ehsan Maani
JCTVC-H0528	m23409	2012-01-21 04:29:47	2012-01-21 08:00:49	2012-02-10 21:48:51	AHG19: A QP-based enabling method for lossless coding in HEVC	W. Gao, M. Jiang, H. Yu (Huawei)
JCTVC-H0529	m23410	2012-01-21 04:33:16			Withdrawn (duplicate registration)	
JCTVC-H0530	m23411	2012-01-21 04:36:10	2012-01-21 08:01:42	2012-02-09 22:10:00	AHG19: A lossless coding solution for HEVC	W. Gao, M. Jiang, H. Yu (Huawei), M. Zhou (TI)
JCTVC-H0531	m23412	2012-01-21 04:38:47	2012-01-27 00:12:44	2012-02-07 00:11:36	AHG21: Comments on Signaling of Reference Pictures	Sachin Deshpande, Andrew Segall
JCTVC-H0532	m23413	2012-01-21 05:01:32	2012-01-21 05:15:14	2012-01-21 05:15:14	Quantization reconstruction offset	J. Wang, X. Yu, D. He, G. Martin-Cocher
JCTVC-H0533	m23414	2012-01-21 05:23:08	2012-01-30 04:03:16	2012-01-31 02:33:26	NON-CE1: On CABAC parsing throughput	W. Zhang, P. Wu(ZTE)
JCTVC-H0534	m23415	2012-01-21 05:28:13	2012-01-21 05:41:31	2012-02-03 02:36:50	Non-CE6: Modifications of intra mode coding	W. -J. Chien, J. Chen, V. Seregin, X. Wang, M. Karczewicz, (Qualcomm)
JCTVC-H0535	m23416	2012-01-21 05:34:55	2012-01-21 08:23:24	2012-02-09 21:37:23	CE1 B3: 8-bit Linear Initialization for CABAC	L. Guo, M. Karczewicz, J. Sole, R. Joshi(Qualcomm), C. Yeo, Y.H. Tan, Z. Li (I2R)
JCTVC-H0536	m23417	2012-01-21 05:37:51	2012-01-21 06:15:46	2012-01-31 01:57:21	CE1 D2: Adaptive initialization for CABAC with fixed probability contexts	L. Guo, M. Karczewicz, J. Sole, X. Wang(Qualcomm)
JCTVC-H0537	m23418	2012-01-21 05:39:33	2012-01-21 06:18:23	2012-02-03 06:21:49	CABAC Contexts Reduction for Last Position Coding	L. Guo, M. Karczewicz, W.-J. Chien, X. Wang(Qualcomm)
JCTVC-H0538	m23419	2012-01-21 05:42:41	2012-01-21 06:51:37	2012-01-21 06:51:37	CE2 4.3: Report on Limiting Chroma Transform Depth in RQT	L. Guo, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-H0539	m23420	2012-01-21 05:43:12	2012-01-22 04:17:28	2012-01-22 04:17:28	CE6.a: Cross-check report for intra chroma prediction	X. Zhang, O. Au (HKUST)
JCTVC-H0540	m23421	2012-01-21 05:44:30	2012-01-21 05:46:37	2012-02-10 07:31:52	CE1: Subtest B4 - On cabac_init_idc	Kiran Misra, Andrew Segall

JCTVC-H0541	m23422	2012-01-21 05:48:18	2012-01-21 05:51:37	2012-02-04 02:19:06	Non CE4: Limiting dynamic range when using a quantization weighting matrix	Louie Kerofsky, Andrew Segall (Sharp)
JCTVC-H0542	m23423	2012-01-21 05:48:19	2012-01-26 02:37:57	2012-02-04 06:00:43	Non-CE2: Cross-verification of Separate RQT for Y,U and V from MediaTek (JCTVC-H0315)	L. Guo (Qualcomm)
JCTVC-H0543	m23424	2012-01-21 05:50:09	2012-01-30 03:04:14	2012-01-30 03:06:32	CE2: Cross verification of subtest 4.1	L. Guo, M. Karczewicz (Qualcomm)
JCTVC-H0544	m23425	2012-01-21 05:56:50	2012-01-22 10:23:58	2012-02-02 19:15:04	CE6.a: New modes (LML and LMA) for chroma intra prediction	X. Zhang, O. Au, J. Dai, X. Wen, C. Pang, F. Zou (HKUST)
JCTVC-H0545	m23426	2012-01-21 06:07:30	2012-01-21 08:43:45	2012-02-08 21:10:28	Context modeling for asymmetric partitioning on partition mode	W. -J. Chien, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-H0546	m23427	2012-01-21 06:30:56	2012-01-21 06:39:01	2012-01-27 01:32:22	On weighted prediction precision	M. Coban, M. Karczewicz (Qualcomm)
JCTVC-H0547	m23428	2012-01-21 06:37:57	2012-01-22 06:36:51	2012-02-03 21:10:35	Significance map contexts reduction for small TU	V. Kung, K. Panusopone, L. Wang (Motorola Mobility)
JCTVC-H0548	m23429	2012-01-21 06:40:01	2012-01-22 06:55:46	2012-02-01 18:42:54	Signaling of collocated picture for HEVC	Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)
JCTVC-H0549	m23430	2012-01-21 06:43:07	2012-01-21 07:42:17	2012-01-21 07:42:17	Enabling Sub-LCU level parallel decoding	S. Kumar, H. -C. Chuang, S. Xiao, X. Wang, W. -J. Chien, M. Karczewicz (Qualcomm)
JCTVC-H0550	m23431	2012-01-21 07:41:40	2012-01-21 08:10:29	2012-01-22 19:27:21	Non-CE11: context assignment for parallel coefficient level coding	W. -J. Chien, J. Chen, J. Sole, M. Karczewicz, (Qualcomm)
JCTVC-H0551	m23432	2012-01-21 07:57:32	2012-01-21 09:05:35	2012-02-04 23:07:22	AHG21: Parameterized RPS Models	J. Zhao, S. Deshpande, A. Segall
JCTVC-H0552	m23433	2012-01-21 08:12:23	2012-01-21 22:56:24	2012-02-07 03:21:17	Non-CE8: Modified EO offset operation and offset quantization	K. Minoo, D. Baylon (Motorola Mobility)
JCTVC-H0553	m23434	2012-01-21 08:26:44	2012-01-21 22:57:08	2012-02-05 05:12:55	Non-CE8: Harmonization of LCU-based SAO	K. Minoo, Y. Yu, D. Baylon, L. Wang (Motorola Mobility)
JCTVC-H0554	m23435	2012-01-21 08:27:09	2012-01-21 09:22:47	2012-02-07 01:23:54	Non-CE1: throughput improvement on CABAC coefficients level coding	J. Chen, W.-J. Chien, R. Joshi, J. Sole, M. Karczewicz (Qualcomm)
JCTVC-H0555	m23436	2012-01-21 08:29:42	2012-01-21 08:37:12	2012-01-21 08:37:12	Range restriction of motion vector predictor	J. Chen, M. Coban, M. Karczewicz (Qualcomm)
JCTVC-H0556	m23437	2012-01-21 08:50:56	2012-01-21 10:11:36	2012-02-10 09:33:56	AHG4: Harmonized method for signalling entry points of tiles and WPP substreams	Hendry, Sangoh Jeong, Seung Wook Park, Byeong Moon Jeon (LG), Kiran Misra, Andrew Segall (Sharp)
JCTVC-H0557	m23438	2012-01-21 08:53:48	2012-01-21 11:31:36	2012-01-29 07:33:57	CE8.e.4 Selection and Coding of SAO Parameters	Koohyar Minoo, David Baylon
JCTVC-H0558	m23439	2012-01-21	2012-01-27	2012-01-30	AhG16: Cross-Check of H0347 on unification of SDIP and NSQT (tests 1 and	Ankur Saxena, Felix Fernandes

		09:00:49	00:14:39	21:20:34	2)	
JCTVC-H0559	m23440	2012-01-21 09:03:27	2012-01-21 09:55:51	2012-02-04 00:11:29	Non-CE 7 : Recent results for secondary transforms for intra/inter prediction residual	Ankur Saxena, Youji Shibahara, Elena Alshina, Felix Fernandes, T Nishi
JCTVC-H0560	m23441	2012-01-21 09:04:27	2012-01-26 01:03:34	2012-01-27 21:42:35	CE 5: Cross-Check of H0169 on transform skipping choices based on block size	Ankur Saxena, Felix Fernandes
JCTVC-H0561	m23442	2012-01-21 10:34:07	2012-01-21 10:36:25	2012-02-04 20:58:48	On CABAC Initialization	L. Guo, M. Karczewicz (Qualcomm)
JCTVC-H0562	m23443	2012-01-21 11:04:19	2012-01-21 13:59:13	2012-02-04 20:58:01	Informal Subjective Quality Comparison of Compression Performance of HEVC Working Draft 5 with AVC High Profile	F. Kossentini, N. Mahdi, H. Guermazi, M. Horowitz, S. Xu (eBrisk Video Inc.), B. Li (University of Science and Technology of China), G. J. Sullivan, J. Xu (Microsoft Corp)
JCTVC-H0563	m23444	2012-01-21 11:44:54	2012-01-21 11:47:43	2012-02-01 10:20:14	Non-CE6: Intra mode coding simplification	W.-J. Chien, J. Chen, M. Karczewicz, (Qualcomm)
JCTVC-H0564	m23445	2012-01-21 11:45:15			cross-check	
JCTVC-H0565	m23446	2012-01-21 12:16:09	2012-01-21 12:57:01	2012-01-21 12:57:01	AHG21: Short-term reference picture range	J. Samuelsson, R. Sjöberg (Ericsson)
JCTVC-H0566	m23447	2012-01-21 12:19:08	2012-01-21 12:52:28	2012-02-10 05:58:44	AHG15: Temporal layer access pictures	J. Samuelsson, R. Sjöberg (Ericsson)
JCTVC-H0567	m23448	2012-01-21 12:21:53	2012-01-21 13:05:20	2012-02-10 00:34:43	AHG15: Syntax controlled output process	J. Samuelsson, R. Sjöberg (Ericsson)
JCTVC-H0568	m23449	2012-01-21 12:22:45	2012-01-21 13:29:05	2012-02-10 01:09:59	AHG15: Specification of bitstream subsets	J. Samuelsson, R. Sjöberg (Ericsson)
JCTVC-H0569	m23450	2012-01-21 14:17:58	2012-01-21 14:27:26	2012-02-01 18:45:01	Non-CE3: An Adaptive Interpolation Filtering Technique for Improved Subjective Quality in the Low Complexity Configuration	F. Kossentini, N. Mahdi, H. Guermazi, M. Horowitz, S. Xu (eBrisk Video Inc.)
JCTVC-H0570	m23451	2012-01-21 15:21:10	2012-01-21 18:11:13	2012-02-08 00:22:33	AHG14/AHG15/non-CE9: Loss robustness issue in TMVP disabling	V. Wahadaniah, C. S. Lim (Panasonic), J. Xu (Microsoft), B. Li (USTC)
JCTVC-H0571	m23452	2012-01-21 21:09:37	2012-01-21 21:38:31	2012-02-01 18:42:28	A Comparison of HM-5.0 ALF with H0068's Proposed Single-Shape ALF for Some Video Sequences	Faouzi Kossentini, Hsan Guermazi (eBrisk Video Inc.), Wang Lai, Felix Fernandes(Samsung)
JCTVC-H0572	m23454	2012-01-22 00:53:11			AHG10: Crosscheck	
JCTVC-H0573	m23455	2012-01-22 11:10:20	2012-01-24 01:58:34	2012-01-24 01:58:34	Cross Check for Intel's intra chroma prediction (JCTVC-H0295)	K. Kawamura, S. Naito (KDDI)

JCTVC-H0574	m23456	2012-01-22 23:23:30	2012-01-22 23:33:42	2012-02-05 00:57:20	CE10.4: deblocking parameters signaling	A. Norkin, K. Andersson, J. Enhorn, R. Sjöberg (Ericsson)
JCTVC-H0575	m23457	2012-01-22 23:51:02	2012-01-31 02:32:49	2012-01-31 02:32:49	CE10.2: cross-verification of Sony's and Mediatec's proposal on deblocking line memory reduction	A. Norkin (Ericsson)
JCTVC-H0576	m23458	2012-01-22 23:53:08	2012-01-31 02:34:05	2012-01-31 02:34:05	CE10.3: Cross-verifiaction of proposal on deblocking Bs simplification from LG	A. Norkin (Ericsson)
JCTVC-H0577	m23459	2012-01-22 23:57:56	2012-01-31 02:35:04	2012-01-31 02:35:04	Cross-verification of Qualcomm's proposal JCTVC-H0424 on deblocking filtering	A. Norkin (Ericsson)
JCTVC-H0578	m23463	2012-01-23 04:01:39	2012-01-25 01:19:22	2012-01-25 01:19:22	AHG6: Inspection report on deblocking of IPCM Blocks containing reconstructed samples (JCTVC-H0448)	K. Chono, H. Aoki (NEC)
JCTVC-H0579	m23464	2012-01-23 04:02:25	2012-01-26 06:37:14	2012-01-26 06:37:14	Cross-verification of sample adaptive offset in low complexity test (JCTVC-H0115)	K. Chono, H. Aoki (NEC)
JCTVC-H0580	m23465	2012-01-23 06:21:08	2012-01-25 06:59:39	2012-01-25 06:59:39	AHG10: Crosscheck of TI's Configurable and CU-group level parallel merge/skip (JCTVC-H0082 combination case)	T. Ikai (Sharp)
JCTVC-H0581	m23466	2012-01-23 06:26:09	2012-01-27 02:05:21	2012-02-04 06:17:40	Crosscheck of context modeling for parition mode (JCTVC-H0545)	T. Yamamoto (Sharp)
JCTVC-H0582	m23467	2012-01-23 07:17:55	2012-01-26 01:26:59	2012-01-26 01:26:59	Non-CE9: Crosscheck of JCTVC-H0430 on single TMVP for merge mode	Y. Jeon, B. Jeon (LG)
JCTVC-H0583	m23468	2012-01-23 11:26:04	2012-01-23 13:00:20	2012-01-30 12:44:45	CE9: cross-check of experiment BP02 and BP06 (JCTVC-H0583)	J. Jung (Orange Labs)
JCTVC-H0584	m23469	2012-01-23 12:23:31	2012-01-23 13:50:41	2012-01-23 13:50:41	CE5: Cross-verification of subtest CE5.c of BBC (JCTVC-H0064) by Nokia	J. Kang, A. Hallapuro, J. Lainema (Nokia)
JCTVC-H0585	m23470	2012-01-23 12:28:14	2012-01-23 12:59:32	2012-01-23 12:59:32	Non-CE9: cross-check of JCTVC-H0279 on CU based parallel Inter	J. Jung (Orange Labs)
JCTVC-H0586	m23471	2012-01-23 13:44:39	2012-01-23 16:28:48	2012-02-02 18:23:54	Crosscheck of Cisco proposal JTCVC-H0066	Gordon CLARE, Felix HENRY
JCTVC-H0587	m23472	2012-01-23 13:50:49	2012-01-30 17:28:10	2012-02-01 18:09:12	Non-CE10: Cross check of the introduction of strong filter clipping in deblocking filter of Sony (JCTVC-H0275)	Matthias Narroschke, Anand Kotra, Semih Esenlik
JCTVC-H0588	m23473	2012-01-23 13:53:29	2012-01-23 13:54:47	2012-02-03 00:56:12	AHG13: Proposed interlace format indication for HEVC	K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-H0589	m23475	2012-01-23 16:10:18	2012-01-27 17:34:22	2012-02-01 03:45:08	CE7: Cross-check for Tests 1 and 2 (JCTVC-H0126) by BBC	M. Mrak, D.Flynn (BBC)
JCTVC-H0590	m23476	2012-01-23 16:54:46	2012-02-04 00:21:28	2012-02-04 00:21:28	Non-CE1: Cross-check of proposal H0265 on rLPSTable	V. Sze (TI)
JCTVC-H0591	m23479	2012-01-23 18:40:47	2012-01-26 03:42:35	2012-02-01 19:14:59	AhG10: Cross-verification of JCTVC-H0090 on unified design on parallel merge/skip	V. Seregin, X. Wang, J. Chen (Qualcomm)

JCTVC-H0592	m23480	2012-01-23 18:40:56	2012-01-26 03:46:01	2012-01-26 03:46:01	Non-CE9: Cross-verification of JCTVC-H0278 on CU-based parallel merge mode	V. Seregin, X. Wang, J. Chen (Qualcomm)
JCTVC-H0593	m23481	2012-01-23 18:41:02	2012-01-30 23:36:55	2012-01-30 23:36:55	Cross-verification of JCTVC-H0348 on simplification on tiles and slices	V. Seregin, M. Coban (Qualcomm)
JCTVC-H0594	m23482	2012-01-23 20:15:52	2012-01-26 01:23:07	2012-01-26 01:23:07	Cross-check of RIM's significant coefficient flag context models for modular processing (JCTVC-H0411)	J. Sole
JCTVC-H0595	m23483	2012-01-23 20:15:54	2012-01-26 20:36:25	2012-01-26 20:36:25	Cross-check of Canon's harmonisation of 8x8 TU residual scan (JCTVC-H0145)	J. Sole
JCTVC-H0596	m23484	2012-01-24 01:21:51	2012-01-26 03:29:46	2012-01-26 03:29:46	Non-CE6: Cross-verification of Qualcomm's intra mode coding simplification (JCTVC-H0563)	S. Fukushima, T. Kumakura (JVC Kenwood)
JCTVC-H0597	m23486	2012-01-24 03:52:01	2012-01-25 01:20:18	2012-01-25 01:20:18	Non-CE6: Cross-verification of Canon's adaptations of Intra mode coding (JCTVC-H0175)	K. Chono, H. Aoki (NEC)
JCTVC-H0598	m23487	2012-01-24 04:00:03	2012-01-25 01:28:54	2012-01-25 01:28:54	Cross-verification of Sony's Bypass coding in chroma intra modes (JCTVC-H0405)	K. Chono, H. Aoki (NEC)
JCTVC-H0599	m23488	2012-01-24 04:18:51	2012-01-27 03:48:07	2012-01-27 03:54:52	Cross-verification of Mitsubishi's improvement on parallelism for context derivation process of significant_coeff_flag (JCTVC-H0253)	K. Chono, H. Aoki (NEC)
JCTVC-H0600	m23489	2012-01-24 04:32:06	2012-01-26 06:16:26	2012-02-03 08:10:18	AHG7: Level definition to limit memory bandwidth of MC	K. Kondo, Y. Morigami, T. Suzuki (Sony)
JCTVC-H0601	m23490	2012-01-24 04:53:02	2012-01-25 00:26:40	2012-01-25 00:26:40	Non-CE4: Crosscheck report of Compatible QP prediction with RC and AQ (JCTVC-H0204)	M. Shima (Canon)
JCTVC-H0602	m23491	2012-01-24 04:53:26	2012-02-01 06:10:43	2012-02-01 06:10:43	Non-CE4: Crosscheck report of High-level Syntaxes for the Scaling List Matrices Parameters and Parametric coding (JCTVC-H0460)	M. Shima (Canon)
JCTVC-H0603	m23493	2012-01-24 11:07:46	2012-01-24 11:16:45	2012-01-24 11:16:45	Crosscheck of Samsung additional results JCTVC-H0559 for proposals JCTVC-H0125 and JCTVC-H0126	Felix HENRY
JCTVC-H0604	m23494	2012-01-24 11:35:15	2012-01-31 09:23:03	2012-01-31 09:23:03	Cross-check of JCTVC-H0549	T. Davies (Cisco)
JCTVC-H0605	m23495	2012-01-24 11:47:22	2012-01-24 13:20:04	2012-01-24 13:20:04	Cross-check of JCTVC-H0492 on Clean-up of NSQT implementation	Edouard François (Canon)
JCTVC-H0606	m23498	2012-01-24 18:26:53	2012-01-26 00:44:16	2012-01-26 00:44:16	Non-CE 9:Cross-Check of H0316 on simplification of AMVP	Ankur Saxena, Felix Fernandes
JCTVC-H0607	m23501	2012-01-24 23:48:50	2012-01-31 01:22:34	2012-01-31 01:22:34	Cross-check of JCTVC-H0497: Improving coeff_abs_level_minus3 coding performance under high bitrate	X. Zhang, S. Liu (MediaTek)
JCTVC-H0608	m23502	2012-01-25 02:11:41	2012-01-26 12:16:52	2012-02-01 15:30:01	CE3: Cross-check for half-pel Chroma interpolation filter modification (JCTVC-H0494) by Samsung	E. Alshina, A. Alshin, J. H. Park
JCTVC-H0609	m23503	2012-01-25 02:12:41	2012-01-31 05:23:59	2012-01-31 05:23:59	Crosscheck on Complexity reduction of significance map coding (JCTVC-H0383)	T. Tsukuba T. Yamamoto (Sharp)

JCTVC-H0610	m23504	2012-01-25 02:14:45	2012-01-26 12:17:29	2012-01-26 12:17:29	Non-CE3: Cross-check for phase adjustment of interpolation filter (JCTVC-H0180) by Samsung	E. Alshina, A. Alshin, J. H. Park (Samsung)
JCTVC-H0611	m23505	2012-01-25 06:46:42	2012-01-27 03:31:27	2012-01-27 04:56:46	Crosscheck of NEC's proposal(JCTVC-H0051) on Burst transmission of I_PCM blocks	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-H0612	m23506	2012-01-25 06:48:13	2012-01-27 03:31:58	2012-01-27 04:57:39	Crosscheck of Qualcomm's proposal(JCTVC-H0537) on CABAC Contexts Reduction for Last Position Coding	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-H0613	m23507	2012-01-25 07:08:04	2012-01-30 01:57:26	2012-02-01 17:41:07	Non-CE6: Cross-verification of Samsung's DC mode as a default intra mode (JCTVC-H0242)	S. Fukushima, T. Kumakura (JVC Kenwood)
JCTVC-H0614	m23508	2012-01-25 08:45:17	2012-01-27 03:32:24	2012-01-27 04:58:10	Crosscheck of ETRI's proposal(JCTVC-H0238) on simplification of intra vertical/horizontal prediction	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-H0615	m23509	2012-01-25 10:27:40	2012-01-27 05:35:06	2012-01-30 06:20:13	Cross-check of JCTVC-H0526 on multi-level significance maps for small TU	Y. Piao, E. Alshina, J. H. Park(Samsung)
JCTVC-H0616	m23510	2012-01-25 10:33:16	2012-01-27 05:35:54	2012-01-27 05:35:54	CE11: Cross-check of subtest 3.1.2 (JCTVC-H0282)	Y. Piao, J. H. Park(Samsung)
JCTVC-H0617	m23511	2012-01-26 01:06:06	2012-01-26 23:59:08	2012-01-26 23:59:08	Cross-verification of Flexible Band Offset Mode in SAO (JCTVC-H0406)	W.-S. Kim, M. Zhou (TI)
JCTVC-H0618	m23516	2012-01-26 01:58:39	2012-01-27 08:23:26	2012-01-30 13:34:54	Cross-verification of Ericsson's proposal on deblocking filter simplifications (JCTVC-H0473)	S. Park, B. Jeon (LG)
JCTVC-H0619	m23518	2012-01-26 02:10:43	2012-01-26 13:38:11	2012-01-26 13:38:11	Non-CE11: Cross-check report for JCTVC-H0285 on Block-based significance map context selection	H. Sasai, K. Terada, T. Nishi (Panasonic)
JCTVC-H0620	m23519	2012-01-26 02:12:18	2012-01-30 23:53:38	2012-01-30 23:53:38	Non-CE11: Cross-check report	H. Sasai, K. Terada, T. Nishi (Panasonic)
JCTVC-H0621	m23520	2012-01-26 02:12:46	2012-01-31 00:00:08	2012-01-31 00:00:08	Cross-check report	H. Sasai, T. Nishi (Panasonic)
JCTVC-H0622	m23521	2012-01-26 05:15:11	2012-01-31 22:34:25	2012-01-31 22:34:25	CE8.f : Crosscheck report on objective evaluation of visual testing	O. Nakagami, M. Ikeda, T. Suzuki (Sony)
JCTVC-H0623	m23523	2012-01-26 06:18:36	2012-01-30 03:51:01	2012-01-30 03:51:01	AHG15: Crosscheck of JCTVC-H0269 on independent control of Max CU and LCU size for small LCU	Y. Jeon, B. Jeon (LG)
JCTVC-H0624	m23524	2012-01-26 06:25:55	2012-02-01 03:06:04	2012-02-01 03:06:04	Cross-check of JCTVC-H0464 and JCTVC-H0490	D. Hoang (Zenverge)
JCTVC-H0625	m23526	2012-01-26 08:05:38	2012-01-27 06:48:52	2012-01-27 06:48:52	CE9: Cross-check report on experiment BP07 and BP08 of JCTVC-H0111	I.-K Kim (Samsung)
JCTVC-H0626	m23527	2012-01-26 11:27:53	2012-01-30 15:07:33	2012-01-30 15:07:33	Cross-check of Sony's proposal on context reduction of split transform flag in CABAC (JCTVC-H0397)	H. Yang, H. Yu (Huawei)
JCTVC-H0627	m23528	2012-01-26 11:29:39	2012-02-01 20:30:18	2012-02-01 20:30:18	Cross-check of Motorola's proposal on chroma context reduction for last coefficient position coding (JCTVC-H0514)	H. Yang, H. Yu (Huawei)

JCTVC-H0628	m23529	2012-01-26 11:30:42	2012-02-04 18:23:33	2012-02-04 18:23:33	Cross-check of Motorola's proposal on significance map contexts reduction for small TU (JCTVC-H0547)	H. Yang, H. Yu (Huawei)
JCTVC-H0629	m23531	2012-01-26 12:19:47	2012-01-27 10:31:13	2012-01-27 10:31:13	Non-CE9: cross-check of H0240 on throughput improvement for merge/skip mode	P. Onno (Canon)
JCTVC-H0630	m23537	2012-01-27 00:25:57	2012-01-27 00:36:58	2012-02-04 03:31:56	Non-CE11: Cross-check of Low complexity parallel significance map coding by Qualcomm and Sharp (H0445)	C. Rosewarne, M. Maeda (Canon)
JCTVC-H0631	m23538	2012-01-27 00:46:08	2012-01-27 00:53:11	2012-01-27 00:53:11	Non-CE6: Cross-check of Modifications of intra mode coding by Qualcomm (H0534)	C. Rosewarne, M. Maeda (Canon)
JCTVC-H0632	m23539	2012-01-27 00:54:59	2012-01-27 01:00:51	2012-01-27 01:00:51	Non-CE6: Cross-check of Postpone MPM sorting by Qualcomm (H0428)	C. Rosewarne, M. Maeda (Canon)
JCTVC-H0633	m23540	2012-01-27 01:02:52	2012-02-04 03:39:03	2012-02-04 03:39:03	Cross-verification of Simplified coeff_abs_level_minus3 coding from Motorola Mobility (JCTVC-H0498)	L. Guo (Qualcomm)
JCTVC-H0634	m23541	2012-01-27 01:18:51	2012-01-27 07:23:47	2012-01-27 07:23:47	Non-CE9: Cross-check report of ETRI's simplification on AMVP list construction (JCTVC-H0239) by Panasonic	T. Sugio, T. Nishi (Panasonic)
JCTVC-H0635	m23543	2012-01-27 01:53:51	2012-02-02 02:57:24	2012-02-02 02:57:24	Cross verification of AHG10: Unified design on parallel merge/skip with reduced candidates	C.Kim (Samsung)
JCTVC-H0636	m23544	2012-01-27 03:47:09			Withdrawn (duplicate registration)	
JCTVC-H0637	m23545	2012-01-27 03:57:05	2012-01-27 04:09:56	2012-02-01 01:46:47	Profiles and Levels for HEVC	Ajay Luthra
JCTVC-H0638	m23546	2012-01-27 04:08:09	2012-01-30 08:00:12	2012-01-30 08:00:12	Cross-check report on PU structure for intra NxN (JCTVC-H0202)	I.-K Kim (Samsung)
JCTVC-H0639	m23547	2012-01-27 04:09:12	2012-01-30 06:43:23	2012-01-30 06:43:23	Cross-check report on Removing QP line buffer (JCTVC-H0281)	I.-K Kim (Samsung)
JCTVC-H0640	m23548	2012-01-27 04:10:12	2012-01-30 04:04:56	2012-01-30 04:04:56	Cross-check report on Splitting contexts for MVD coding (JCTVC-H0431)	I.-K Kim (Samsung)
JCTVC-H0641	m23550	2012-01-27 05:08:38	2012-01-27 06:54:38	2012-01-27 23:22:20	Cross-check report for MediaTek's quantization matrix compression (JCTVC-H0387))	J. Lou, L. Wang (Motorola Mobility)
JCTVC-H0642	m23551	2012-01-27 06:55:56	2012-02-01 07:56:51	2012-02-01 07:56:51	Cross-verification of JCTVC-H0515 on On Entropy Slices	T. Lee, J. Park (Samsung)
JCTVC-H0643	m23553	2012-01-27 08:47:47	2012-01-30 06:31:12	2012-02-06 00:01:12	Cross-check report of weighted prediction precision reduction (JCTVC-H0546)	A. Tanizawa, T. Chujoh, T. Yamakage (Toshiba)
JCTVC-H0644	m23554	2012-01-27 09:16:32	2012-02-04 03:16:35	2012-02-04 03:16:35	Non-CE10: Cross-verification report for difference-QP-based deblocking (JCTVC-H0190)	H. Aoki, K. Chono (NEC)
JCTVC-H0645	m23555	2012-01-27 09:28:13	2012-01-30 00:45:08	2012-02-01 06:07:55	CE11.1 Cross-check report for Sharp's method 2.1 of simplified significant_coeff_flag context derivation at high frequency area (JCTVC-H0095)	T.Chujoh (Toshiba)

JCTVC-H0646	m23556	2012-01-27 10:14:01	2012-01-30 09:39:49	2012-01-30 09:39:49	Reduction of initialization tables for CABAC contexts	K. Sugimoto, A. Minezawa, S. Sekiguchi, K. Asai, T. Murakami (Mitsubishi)
JCTVC-H0647	m23559	2012-01-27 12:27:02			Withdrawn	
JCTVC-H0648	m23560	2012-01-27 12:28:08	2012-01-31 05:09:07	2012-01-31 05:09:07	AHG9: Cross-check result of MediaTek's CABAC with constrained outstanding bits (JCTVC-H0271)	K. Kazui (Fujitsu)
JCTVC-H0649	m23562	2012-01-27 13:41:55	2012-02-02 04:44:33	2012-02-02 04:44:33	AHG10: Cross Check for JCTVC-H0010 PME A	X. Wen, O. Au
JCTVC-H0650	m23563	2012-01-27 13:46:36	2012-01-30 09:41:15	2012-01-30 09:41:15	AHG20: 4:2:2 support in HEVC	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-H0651	m23571	2012-01-27 20:46:50	2012-01-27 20:51:19	2012-01-27 20:51:19	CE11: cross verification of sign data hiding from Orange Labs (H0224)	Zhan Ma, Ankur Saxena
JCTVC-H0652	m23572	2012-01-27 21:02:49	2012-01-31 03:55:38	2012-01-31 03:55:38	CE1: Cross-verification of Qualcomm's Adaptive initialization for CABAC with fixed probability contexts (sub-test D2)	Gergely Korodi, Dake He
JCTVC-H0653	m23575	2012-01-27 23:17:21	2012-01-31 02:35:40	2012-01-31 02:35:40	AHG21: Cross-verification of Reference picture lists combination syntax from InterDigital (JCTVC-H0137)	L. Guo (Qualcomm)
JCTVC-H0654	m23582	2012-01-28 01:27:12	2012-01-28 01:39:56	2012-01-28 01:39:56	Modifications on sequence parameter set RBSP syntax, picture parameter set RBSP syntax and slice header syntax	J. Lou, Y. Yu, L. Wang (Motorola Mobility)
JCTVC-H0655	m23583	2012-01-28 04:41:45	2012-01-28 05:09:04	2012-02-03 13:19:24	CE9: Motion information derivation of deformable block	Na Zhang, Xiaopeng Fan, Siwei Ma, Debin Zhao
JCTVC-H0656	m23584	2012-01-28 06:17:51	2012-01-28 07:06:16	2012-01-31 16:12:37	CE10 Subtest 4: Cross-check of Qualcomm's Transform Dependent Deblocking Filter Parameter Adjustment JCTVC-H0398	T. Yamakage, S. Asaka (Toshiba)
JCTVC-H0657	m23594	2012-01-28 18:11:55	2012-01-29 08:04:39	2012-01-29 08:04:39	Non-CE5: A crosscheck report on complexity reduction for transform skipping mode (JCTVC-H0141)	R. Joshi (Qualcomm)
JCTVC-H0658	m23596	2012-01-28 18:49:41	2012-01-30 12:17:42	2012-01-30 12:17:42	AHG4: Crosscheck for Canon's storage reduction for dependent tiles in JCTVC-H0179	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-H0659	m23597	2012-01-28 18:50:36	2012-01-30 11:53:53	2012-01-30 11:53:53	Non-CE11: Crosscheck for Qualcomm's context assignment for parallel coefficient level coding in JCTVC-H0550	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-H0660	m23598	2012-01-28 18:51:55	2012-01-29 01:17:28	2012-01-29 01:17:28	Non-CE1: Crosscheck for Qualcomm's throughput improvement on CABAC coefficients level coding in JCTVC-H0554	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-H0661	m23599	2012-01-28 18:59:05	2012-01-30 11:54:30	2012-01-30 11:54:30	Non-CE8: Crosscheck for Panasonic's line memory reduction fix at independent slice and tile boundaries in JCTVC-H0372	C.-Y. Chen, Y.-W. Huang (MediaTek)
JCTVC-H0662	m23600	2012-01-28 22:56:22	2012-01-28 23:05:52	2012-01-28 23:05:52	Non-CE11: Cross check of Mediatek’s proposal JCTVC-H0284	J. Kim, C. Kim
JCTVC-H0663	m23601	2012-01-28 23:08:29	2012-01-29 08:06:01	2012-02-01 22:27:37	Non-CE11 : Cross check of Qualcomm’s proposal JCTVC-H0427	J. Kim, C. Kim

JCTVC-H0664	m23602	2012-01-28 23:10:49	2012-01-29 08:07:10	2012-01-29 08:07:10	Cross check of KAIST's proposal JCTVC-H0154	J. Kim, C. Kim
JCTVC-H0665	m23606	2012-01-29 16:27:08	2012-01-31 23:58:14	2012-02-02 02:06:36	Cross-check of Motorola Mobility's proposal on intra mode coding (H0516)	C. Yeo, Y. H. Tan (I2R)
JCTVC-H0666	m23364	2012-01-21 02:06:03	2012-01-21 22:34:50	2012-01-25 13:43:00	Interlace Indicators	Chad Fogg, Aaron Wells, Paul Haskell
JCTVC-H0667	m23365	2012-01-21 02:10:03	2012-02-04 09:14:59	2012-02-06 01:53:40	Implementation issues with frequent slices	C. Fogg, A. Wells
JCTVC-H0668	m23366	2012-01-21 02:12:09	2012-01-21 18:51:28	2012-01-21 18:51:28	Profiles and Level considerations	Aaron Wells, Chad Fogg
JCTVC-H0669	m23618	2012-01-30 03:09:30	2012-01-30 03:48:45	2012-02-06 01:38:19	Sharp's proposals for HEVC scalability Extension	H. Kumai, T. Yamamoto, A. Segall, N. Ito
JCTVC-H0670	m23485	2012-01-24 02:07:13	2012-01-26 04:23:10	2012-02-15 18:35:53	Downsampling filter for anchor generation for scalable extensions of HEVC	Jie Dong, Yong He, Yan Ye(InterDigital)
JCTVC-H0671	m23609	2012-01-29 18:56:51	2012-02-01 09:40:07	2012-02-01 09:40:07	Cross-check for Qualcomm's CABAC Initialization in JCTVC-H0561	X. Guo (MediaTek)
JCTVC-H0672	m23610	2012-01-29 18:57:17	2012-02-01 16:43:04	2012-02-01 16:43:04	Non-CE7: Cross-check for Samsung's Results for Secondary transforms in JCTVC-H0559	J. An, X. Guo (MediaTek)
JCTVC-H0673	m23615	2012-01-30 02:11:43	2012-02-01 09:46:38	2012-02-01 09:46:38	AHG19: Cross-check of H528 and H530 on lossless coding	Y. H. Tan, C. Yeo, Z. Li (I2R)
JCTVC-H0674	m23616	2012-01-30 02:15:32	2012-02-01 21:02:31	2012-02-07 20:04:59	Non-CE8: Cross-check of H0409 on Harmonization of number of ALF classes between RA and BA modes	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-H0675	m24000	2012-02-10 04:32:37	2012-02-10 04:44:59	2012-02-10 04:44:59	Non-CE4: Cross verification of low complexity dQP coding (JCTVC-H0189)	M. Coban (Qualcomm)
JCTVC-H0676	m23656	2012-01-30 11:18:04	2012-02-02 02:53:23	2012-02-02 02:53:23	Cross verification of crosscheck of AHG10(JCTVC-H0010) HM5 PME B	Jongbum Choi (Samsung)
JCTVC-H0677	m23715	2012-01-30 16:18:45	2012-02-01 09:40:52	2012-02-01 09:40:52	Non-CE11: Crosscheck for Intel's Coefficient Sub-sampling for Large Transform in JCTVC-H0249	Q. Huang, X. Guo (MediaTek)
JCTVC-H0678	m23751	2012-01-30 18:05:28	2012-01-30 20:28:31	2012-01-30 20:28:31	Non-CE11: Signaling of significant_coeffgroup_flag for significance map	V. Sze, A. Osamoto (TI)
JCTVC-H0679	m23752	2012-01-30 18:36:15	2012-02-01 03:16:03	2012-02-01 03:16:03	AHG21: Cross-check of H0138 on Unification of reference picture list modification processes	E. François (Canon)
JCTVC-H0680	m23761	2012-01-30 19:26:01	2012-01-31 16:11:56	2012-01-31 16:11:56	Cross-check of Modified LPS range and state transition tables combined with 8-bit Linear Initialization for CABAC	N. Nguyen, T. Ji, D. He, G. Martin-Cocher (RIM)
JCTVC-H0681	m23777	2012-01-30 20:40:33	2012-01-31 09:11:21	2012-01-31 09:11:21	AHG10: Cross-check of TI's configurable and CU-group level parallel merge/skip (JCTVC-H0082) by Sony	J. Xu, A. Tabatabai (Sony)

JCTVC-H0682	m23794	2012-01-30 21:51:58	2012-02-02 17:10:11	2012-02-02 17:10:11	Cross-check of BBC's proposal on "On Just Noticeable Distortion Quantization in the HEVC Codec" (JCTVC-H0477)	J. Wang, X. Yu, D. He
JCTVC-H0683	m23801	2012-01-30 23:45:54	2012-01-30 23:48:37	2012-01-30 23:48:37	Non-CE8: Cross check of Modification of ALF BA classification	I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-H0684	m23802	2012-01-30 23:47:02	2012-02-01 19:28:29	2012-02-03 20:34:29	Cross-verification of JCTVC-H0399 on harmonization of coefficient coding	V. Seregin, J. Sole (Qualcomm)
JCTVC-H0685	m23803	2012-01-30 23:47:09	2012-02-01 04:36:48	2012-02-01 04:36:48	Cross-verification of JCTVC-H0559 on boundary dependent transform	V. Seregin (Qualcomm)
JCTVC-H0686	m23824	2012-01-31 05:02:21	2012-02-01 07:36:12	2012-02-01 07:36:12	Crosscheck of JCTVC-H0244 on Intra-mode bypass parallelism	W.-J. Chien (Qualcomm)
JCTVC-H0687	m23825	2012-01-31 05:03:20	2012-02-01 10:06:40	2012-02-01 10:06:40	Cross-check of JCTVC-H0099 on CABAC context for partition mode	J. Chen, W.-J. Chien (Qualcomm)
JCTVC-H0688	m23826	2012-01-31 05:15:32	2012-02-01 18:28:09	2012-02-01 18:28:09	Cross-check of JCTVC-H0286 on Parallel significance map context assignment	W. -J. Chien, J. Sole (Qualcomm)
JCTVC-H0689	m23827	2012-01-31 05:38:21	2012-01-31 05:49:53	2012-01-31 05:49:53	Cross-check of JCTVC-H0559 on the combination of secondary transform and SDIP	H. Yang (Huawei)
JCTVC-H0690	m23828	2012-01-31 05:41:35	2012-02-01 14:51:23	2012-02-03 19:51:07	Cross-check of JCTVC-H0062 on context simplification of coeff_abs_level_greater1_flag	H. Yang (Huawei)
JCTVC-H0691	m23832	2012-01-31 08:53:38	2012-01-31 09:00:03	2012-01-31 09:00:03	non-CE6.a: A joint contribution of cross-channel prediction method for chroma	K. Kawamura, T. Yoshino, H. Kato, S. Naito (KDDI), Y. Chiu, Y. Han, L. Xu, W. Zhang, H. Jiang (Intel),
JCTVC-H0692	m23840	2012-01-31 14:40:24	2012-02-01 12:55:42	2012-02-01 12:55:42	Non-CE7: Cross-check for Samsung's Results for Secondary transforms in JCTVC-H0559	Andrea Gabriellini, Marta Mrak (BBC)
JCTVC-H0693	m23912	2012-02-02 19:02:15	2012-02-02 19:05:27	2012-02-02 19:05:27	A real-time ARM HEVC decoder implementation	K. Veera, R. Ganguly, B. Zhou, N. Kamath, S. Chowdary, J. Du, I. S. Chong, M. Coban
JCTVC-H0694	m23850	2012-01-31 19:10:38	2012-01-31 21:44:03	2012-02-04 06:06:33	Long-term picture coding	K. Suehring, H. Schwarz, T. Wiegand (Fraunhofer HHI)
JCTVC-H0695	m23852	2012-02-01 01:53:29	2012-02-03 17:28:04	2012-02-03 17:28:04	Cross check report of Motorola Mobility's proposal JCTVC-H0548	Y. He (InterDigital)
JCTVC-H0696	m23860	2012-02-01 03:18:04	2012-02-01 18:45:12	2012-02-01 18:45:12	Cross-check of JCTVC-H0461 on HVS only Default Scaling List Matrices	E. François (Canon)
JCTVC-H0697	m23861	2012-02-01 04:28:22	2012-02-03 18:39:57	2012-02-03 18:39:57	Cross-check report of adjusted significant coefficient map context for non-square blocks (JCTVC-H0476)	J. Kim, M. Kim
JCTVC-H0698	m23862	2012-02-01 04:36:41	2012-02-03 19:03:15	2012-02-03 19:10:40	Cross-check report of extending 4×4 sub-block diagonal scan to 8×8 TU (JCTVC-H0524)	J. Kim, M. Kim
JCTVC-H0699	m23886	2012-02-01	2012-02-03	2012-02-03	Non-CE11: Cross-check of proposal JCTVC-H0228 on transform coefficient	V. Sze (TI)

		15:03:27	05:45:13	05:45:13	coding	
JCTVC-H0700	m23887	2012-02-01 15:06:31	2012-02-06 04:10:13	2012-02-06 04:10:13	Non-CE4: Crosscheck report of Weighted predictive coding for Quantization matrices (JCTVC-H0522)	M. Shima (Canon)
JCTVC-H0701	m23889	2012-02-01 17:02:59	2012-02-01 17:11:44	2012-02-06 21:58:26	Hooks for scalable extensions	M. M. Hannuksela (Nokia)
JCTVC-H0702	m23891	2012-02-01 18:39:29	2012-02-02 18:06:20	2012-02-02 18:06:20	Cross-verification for RIM's (JCTVC-H0411) by Samsung	E. Alshina
JCTVC-H0703	m23892	2012-02-01 18:42:28	2012-02-02 21:32:38	2012-02-02 21:32:38	Cross-verification for HHI's (JCTVC-H0458) by Samsung	E. Alshina
JCTVC-H0704	m23893	2012-02-01 19:20:10	2012-02-02 18:53:50	2012-02-03 18:14:48	Cross-check of JCTVC-H0510: High Throughput Binarization (HTB) method with modified level coding	J. Lainema, A. Hallapuro, K. Ugur (Nokia)
JCTVC-H0705	m23898	2012-02-01 22:14:12	2012-02-05 22:02:39	2012-02-05 22:02:39	CE11.3.1.3: Crosscheck for Motorola Mobility's simplification of significant map coding for CABAC in JCTVC-H0509	S.-T. Hsiang, T.-D. Chuang (MediaTek)
JCTVC-H0706	m23899	2012-02-01 22:35:34	2012-02-01 22:44:59	2012-02-01 22:44:59	Cross-check report for Samsung's constraint the number of motion vector for memory bandwidth reduction (128-MV restriction in JCTVC-H0267)	S.-C. Lim, H. Y. Kim, J. Lee (ETRI)
JCTVC-H0707	m23902	2012-02-02 01:38:47	2012-02-02 01:44:44	2012-02-02 01:44:44	HEVC software guidelines	K. Suehring, D. Flynn, F. Bossen, (software coordinators)
JCTVC-H0708	m23905	2012-02-02 05:52:12	2012-02-05 18:30:48	2012-02-05 18:30:48	Non-CE8: Crosscheck for Motorola Mobility's harmonization of LCU-based SAO in JCTVC-H0553	C.-M. Fu, Y.-W. Huang (MediaTek)
JCTVC-H0709	m23917	2012-02-03 01:45:21	2012-02-03 01:47:38	2012-02-09 09:49:45	BoG Report on MV Coding	B. Bross
JCTVC-H0710	m23918	2012-02-03 02:30:10	2012-02-03 02:35:08	2012-02-03 04:41:57	BoG Report on Quantization Matrices	T. Suzuki, K. Sato
JCTVC-H0711	m23919	2012-02-03 02:38:47	2012-02-03 03:12:18	2012-02-03 03:12:18	Cross-verification of Non-CE8.a.2: SAO with LCU-based syntax (JCTVC-H0067)	W.-S. Kim, M. Zhou (TI)
JCTVC-H0712	m23922	2012-02-03 08:00:00	2012-02-03 20:58:51	2012-02-09 12:36:10	BoG Report on Intra mode coding cleanup and simplification	K. Chono
JCTVC-H0713	m23941	2012-02-04 03:29:28	2012-02-04 05:03:14	2012-02-05 21:36:48	BoG report on subjective viewing test for CE10 deblocking filter proposals	A. Norkin, K. Andersson, M. Narroschke, X. Guo, G. van der Auwera
JCTVC-H0714	m23934	2012-02-03 18:26:48	2012-02-03 19:11:58	2012-02-03 19:11:58	CE8.f: ALF subjective testing results	A. Tabatabai (Sony), M. Budagavi (TI), D. Flynn (BBC), P. Chen, W. Wan (Broadcom), K. Minoo (Motorola Mobility), T. Suzuki, C. Auyeung, J. Xu (Sony), D-K. Kwon, M. Zhou (TI)
JCTVC-H0715	m23943	2012-02-04	2012-02-04	2012-02-05	BoG report on Decoded picture buffering and reference picture signaling	J. Boyce

		05:24:45	05:35:12	18:23:03		
JCTVC-H0716	m23946	2012-02-04 18:06:52	2012-02-04 18:21:22	2012-02-04 18:21:22	Crosscheck of JCTVC-H0067 on “Non-CE8.a.2: SAO with LCU-based syntax”	C. Auyeung
JCTVC-H0717	m23949	2012-02-04 18:54:58	2012-02-04 22:14:55	2012-02-04 22:14:55	Non-CE6: Cross-check report for Canon's proposal on intra mode coding (H0175)	X. Zheng, J. Zhou, H. Yu
JCTVC-H0718	m23950	2012-02-04 20:45:49	2012-02-04 21:14:38	2012-02-04 21:14:38	Cross-check of JCTVC-H0510 on Non-CE1:High Throughput Binarization (HTB) method with modified level coding	W.-J. Chien
JCTVC-H0719	m23951	2012-02-04 21:28:45	2012-02-05 00:44:28	2012-02-05 22:03:58	BoG report on significance map	G.Martin-Cocher
JCTVC-H0720	m23952	2012-02-04 22:19:02	2012-02-05 21:57:00	2012-02-10 19:24:27	BoG report on interlace indicators	K. Chono, C. Fogg, D. Flynn, S. Sekiguchi
JCTVC-H0721	m23955	2012-02-05 07:15:36	2012-02-05 07:21:11	2012-02-05 07:21:11	Intra mode coding : Combination of H0075 and H0175	E. François (Canon), C. Yeo (I2R)
JCTVC-H0722	m23959	2012-02-05 09:22:25	2012-02-05 09:24:54	2012-02-05 09:24:54	Clarification request on varying QP in deblocking	M. Horowitz (eBrisk)
JCTVC-H0723	m23961	2012-02-05 09:51:35	2012-02-05 17:01:08	2012-02-05 17:01:08	Cross Verification of JCTVC-H0721 on Intra Mode Coding	Guichun Li, Lingzhi Liu
JCTVC-H0724	m23963	2012-02-05 16:34:28	2012-02-05 19:10:01	2012-02-05 19:10:01	BoG report on coefficient level coding	V. Sze
JCTVC-H0725	m23964	2012-02-05 17:24:02	2012-02-09 02:51:45	2012-02-22 18:15:56	Common conditions for reference picture marking and list construction proposals	Ye-Kui Wang, Miska M. Hannuksela, T. K. Tan, Rickard Sjöberg, Yan Ye
JCTVC-H0726	m23965	2012-02-05 17:57:11	2012-02-05 18:12:55	2012-02-05 18:12:55	BoG report on reduction of SAO BO offset buffer	T. Yamakage
JCTVC-H0727	m23967	2012-02-05 21:24:56	2012-02-05 21:37:12	2012-02-05 21:37:12	JCT-VC BoG report: tiles and wavefront parallel processing	M. Horowitz
JCTVC-H0728	m23969	2012-02-06 02:58:32	2012-02-06 09:26:08	2012-02-10 00:39:10	BoG report on High throughput binarization for CABAC	Alberto Duenas
JCTVC-H0729	m23970	2012-02-06 04:53:03	2012-02-06 17:21:54	2012-02-06 17:21:54	BoG report on motion compensation operation and interpolation filters	T.Chujoh
JCTVC-H0730	m23971	2012-02-06 05:03:40	2012-02-07 00:50:20	2012-02-07 00:50:20	Report on Quantization Matrices Subjective Viewing	T Suzuki, K.Sato, X.Zhang, R.Joshi, J.Zheng, M.Zhou,
JCTVC-H0731	m23981	2012-02-07 01:22:20	2012-02-07 01:26:19	2012-02-07 01:26:19	CE2: Additional tests on reducing Max chroma RQT depth	X. Zhao, J. An, X. Guo, S. Lei (MediaTek), L. Guo, X. Wang, M. Karczewicz (Qualcomm), A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi), A. Ichigaya, S. Sakaida (NHK), S. Ma, W. Gao (PKU)

JCTVC-H0732	m23984	2012-02-07 04:46:46	2012-02-07 05:03:39	2012-02-08 01:43:55	BoG report on Adaptive Loop Filtering	T. Yamakage
JCTVC-H0733	m23989	2012-02-07 20:20:00	2012-02-07 21:01:54	2012-02-07 21:01:54	Response to clarification request on varying QP in deblocking in JCTVC-H0722	C.-W. Hsu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-H0734	m23991	2012-02-07 21:49:45	2012-02-07 22:16:34	2012-02-07 22:29:07	Straw man for Profiles and levels	M. Horowitz (eBrisk Video), A. Ichigaya (NHK), K. McCann (Samsung/ZetaCast), T. Nishi (Panasonic), S. Sekiguchi (Mitsubishi), T. Suzuki (Sony Corporation), T. K. Tan (NTT DOCOMO), W. Wan (Broadcom), M. Zhou (TI)
JCTVC-H0735	m23995	2012-02-08 19:54:48	2012-02-08 20:35:30	2012-02-09 23:42:28	Analysis of differences of various ALF signalling schemes	T. Yamakage
JCTVC-H0736	m23997	2012-02-09 12:47:01	2012-02-09 14:42:48	2012-02-09 17:20:51	Clarification on Tickets 313 and 315	K. Chono (NEC), K. Sugimoto (Mitsubishi),
JCTVC-H0737	m23998	2012-02-09 19:28:25	2012-02-09 19:56:05	2012-02-09 19:56:05	Text for tiles, WPP and entropy slices	Y. -K. Wang (Qualcomm), A. Segall (Sharp), M. Horowitz (eBrisk), Hendry (LG Electronics), W. Wade (Broadcom), F. Henry (Orange), T. Lee (Samsung)
JCTVC-H0738	m24002	2012-02-10 17:18:30	2012-02-10 17:22:37	2012-02-10 23:28:17	JCT-VC BoG report on profiles & levels	K. McCann, T. K. Tan (BoG coordinators)
JCTVC-H1000	m24008	2012-02-13 02:05:18			Meeting Report of the 8th JCT-VC Meeting	G. J. Sullivan, J.-R. Ohm
JCTVC-H1001	m24003	2012-02-10 20:49:45	2012-02-10 20:50:43	2012-02-10 20:50:43	HEVC software guidelines	K. Suehring, D. Flynn, F. Bossen, (software coordinators)
JCTVC-H1002	m24009	2012-02-13 06:07:46			High Efficiency Video Coding (HEVC) Test Model 6 (HM 6) Encoder Description	I.-K. Kim, K. Sugimoto, K. McCann, B. Bross, W.-J. Han, J.-R. Ohm, G.J. Sullivan (editors)
JCTVC-H1003	m24004	2012-02-10 20:59:41	2012-02-10 21:11:24	2012-04-02 13:54:25	High Efficiency Video Coding (HEVC) text specification draft 6	B. Bross, W.-J. Han, G. J. Sullivan, J.-R. Ohm, T. Wiegand (Editors)
JCTVC-H1004	m24007	2012-02-13 01:53:07			Report on preliminary subjective testing of HEVC compression capability	G. J. Sullivan, J.-R. Ohm
JCTVC-H1100	m24011	2012-02-28 00:12:56	2012-04-16 00:53:39	2012-04-16 00:53:39	Common test conditions	F. Bossen
JCTVC-H1101	m24014	2012-03-03 09:45:22	2012-03-04 15:55:54	2012-03-10 02:43:12	Description of Core Experiment 1 (CE1): Sample adaptive offset filtering	Y.-W. Huang, E. Alshina, I. S. Chong, W. Wan, M. Zhou (CE

						coordinators)
JCTVC-H1102	m24012	2012-03-02 11:19:00	2012-03-02 18:18:32	2012-03-23 11:03:09	Description of Core Experiment 2 (CE2): Adaptive loop filtering	T. Yamakage, I. S. Chong, Y.-W. Huang, M. Narroschke, M. Budagavi
JCTVC-H1103	m24010	2012-02-14 17:36:26	2012-02-22 06:28:01	2012-03-03 22:37:56	Description of Core Experiment (CE3): Coefficient scanning and coding	V. Sze, T. Nguyen, K. Panusopone, Y. Piao, J. Sole (CE coordinators)
JCTVC-H1104	m24006	2012-02-11 02:13:13	2012-02-29 02:59:12	2012-03-27 11:28:50	Core Experiment 4 (CE4): Quantization matrices	K. Sato, R. Joshi, S. Liu, M. Zhou, (CE coordinators)

Annex B to JCT-VC report:
List of meeting participants

The participants of the sixth meeting of the JCT-VC, according to a sign-in sheet passed around during the meeting (approximately 255 in total), were as follows:

1. Waqar Ahmad (Broadcom)
2. Rik Allen (Altera)
3. Elena Alshina (Samsung Electronics)
4. Peter Amon (Siemens AG)
5. Kenneth Andersson (LM Ericsson)
6. Ichiro Ando (Nikon)
7. Hirofumi Aoki (NEC)
8. Kohtaro Asai (Mitsubishi Electric)
9. Oscar Au (Hong Kong Univ. Sci. & Tech.)
10. Cheung Auyeung (Sony)
11. Osnat Bar-Nir (Harmonic)
12. Oguz Bici (Nokia)
13. Lazar Bivolarsky (Skype)
14. Gisle Bjøntegaard (Cisco Systems Norway)
15. Philippe Bordes (Technicolor)
16. Peter Borgwardt (Motorola Mobility)
17. Frank Bossen (Docomo Innovations)
18. Jill Boyce (Vidyo)
19. Benjamin Bross (Fraunhofer HHI)
20. Madhukar Budagavi (Texas Instruments)
21. Soo-Ik Chae (Seoul Natl. Univ.)
22. Ching-Yeh Chen (MediaTek)
23. Chun-Chi Chen (NCTU/ITRI)
24. Jianle Chen (Qualcomm)
25. Jianwen Chen (UCLA)
26. Peisong Chen (Broadcom)
27. Ying Chen (Qualcomm)
28. Wei-Jung Chien (Qualcomm)
29. Yi-Jen Chiu (Intel)
30. Hyomin Choi (Kwangwoon Univ.)
31. Kiho Choi (Hanyang Univ.)
32. In Suk Chong (Qualcomm)
33. Keiichi Chono (NEC)
34. Tzu-Der Chuang (MediaTek)
35. Takeshi Chujoh (Toshiba)
36. Sorin Cismas (Maxim Integrated Products)
37. Muhammed Coban (Qualcomm)
38. Robert Cohen (Mitsubishi Electric)
39. Chunghui Cui (ASTRI)
40. Thomas Davies (Cisco Systems Norway)
41. Jwalant Desai (Ittiam)
42. Sachin Deshpande (Sharp)
43. Wenping Ding (Beijing Univ. Tech.)
44. Jie Dong (InterDigital Commun.)
45. Alberto Duenas (Cavium)
46. Semih Esenlik (Panasonic)
47. Pascal Eymery (Allegro DVT)
48. Xue Fang (Motorola Moblity)
49. Eyal Farkash (NDS)
50. Felix Fernandes (Samsung Telecom. America)
51. Roberto Flaiani (Ministry of Commun.)
52. David Flynn (BBC R&D)
53. Chad Fogg (Harmonic)
54. Edouard François (Canon)
55. Shigeru Fukushima (JVC Kenwood)
56. Arild Fuldseth (Cisco Systems Norway)
57. Wen Gao (Huawei (USA))
58. Christophe Gisquet (Canon Research)
59. Qunshan Gu (Google)
60. Haitao (Harry) Guo (Apple)
61. Liwei Guo (Qualcomm)
62. Xun Guo (MediaTek (Beijing))
63. Miska Hannuksela (Nokia)
64. Munsi Haque (Sony)
65. Barry Haskell (Apple)
66. Yong He (InterDigital Commun.)
67. Philipp Helle (Fraunhofer HHI)
68. Tim Hellman (Broadcom)
69. Hendry (LG Electronics)
70. Felix Henry (Orange Labs FT)
71. Dzung Hoang (Zenverge)
72. Edward Hong (ViXS Systems)
73. Sung-Wook Hong (Sejong Univ.)
74. Yingjie Hong (ZTE)
75. Michael Horowitz (eBrisk Video)
76. Yu-Wen Huang (MediaTek)
77. Atsuro Ichigaya (NHK)
78. Masaru Ikeda (Sony)
79. Ren Imaoka (Renesas Electronics)
80. Russell James (Altera)
81. Wonkap Jang (Vidyo)

82. Byeungwoo Jeon (Sungkyunkwan Univ. (SKKU))
83. Yongjoon Jeon (LG Electronics)
84. Sangoh Jeong (LG Electronics)
85. Minqiang Jiang (Huawei)
86. Rajan Joshi (Qualcomm)
87. Joël Jung (Orange Labs FT)
88. Tae-Young Jung (Chips & Media)
89. Rafael Kaliski (Santa Clara Univ.)
90. Jung Won Kang (ETRI)
91. Marta Karczewicz (Qualcomm)
92. Kei Kawamura (KDDI)
93. Kimihiko Kazui (Fujitsu Labs)
94. Abdellatif Khindouf (Allegro DVT)
95. Chanyul Kim (Samsung Electronics)
96. Hui Yong Kim (ETRI)
97. Il-Koo Kim (Samsung Electronics)
98. Jae-Gon Kim (Korea Aerosp. Univ.)
99. Jaeil Kim (KAIST)
100. Jungsun Kim (LG Electronics)
101. Kyung Yong Kim (Kyunghee Univ.)
102. Munchurl Kim (KAIST)
103. Woo-Shik Kim (Texas Instruments)
104. Heiner Kirchhoffer (Fraunhofer HHI)
105. Faouzi Kossentini (eBrisk Video)
106. Jumpei Koyama (Fujitsu Labs)
107. Sanjeev Kumar (Qualcomm)
108. Hideyasu Kuniba (Nikon)
109. JaeHee Kwak (Sejong Univ.)
110. Do-Kyoung Kwon (Texas Instruments)
111. Changcai Lai (Huawei)
112. PoLin (Wang) Lai (Samsung Telecom. America)
113. Jani Lainema (Nokia)
114. Jinho Lee (ETRI)
115. Tammy Lee (Samsung Electronics)
116. Yung-Lyul Lee (Sejong Univ.)
117. Shawmin Lei (MediaTek)
118. Athanasios Leontaris (Apple)
119. Billy Li (ViXS Systems)
120. Chia Chi Li (Huawei (USA))
121. Guichun Li (Huawei (USA))
122. Guo-Long Li (ITRI International)
123. Junlin Li (Cisco Systems)
124. Ming Li (ZTE)
125. Liwei Liang (ZTE)
126. Chongsoon Lim (Panasonic)
127. Sung-Chang Lim (ETRI)
128. Yongbing Lin (Huawei)
129. Shan Liu (MediaTek)
130. Jian Lou (Motorola Mobility)
131. Ajay Luthra (Motorola Mobility)
132. Zhan Ma (Samsung)
133. Detlev Marpe (Fraunhofer HHI)
134. Gaëlle Martin-Cocher (Research in Motion)
135. Masaake Matsumura (NTT)
136. Shohei Matsuo (NTT)
137. Ken McCann (Zetacast / Samsung Electronics)
138. Akira Minezawa (Mitsubishi Electric)
139. Koohyar Minoo (Motorola Mobility)
140. Kiran Misra (Sharp)
141. Marta Mrak (BBC)
142. Matteo Naccari (BBC R&D)
143. Ohji Nakagami (Sony)
144. Hiroya Nakamura (JVC Kenwood)
145. Matthias Narroschke (Panasonic R&D Germany)
146. Nguyen Nguyen (Research in Motion)
147. Tung Nguyen (Fraunhofer HHI)
148. Takahiro Nishi (Panasonic)
149. Andrey Norkin (Ericsson AB)
150. Hideyuki Ohgose (Panasonic)
151. Jens-Rainer Ohm (RWTH Aachen Univ.)
152. Patrice Onno (Canon Research)
153. Feng Pan (ViXS Systems)
154. Krit Panusopone (Motorola Mobility)
155. Dong-Jin Park (Chips & Media)
156. Jeonghoon Park (Samsung Electronics)
157. Youngo Park (Samsung Electronics)
158. Stéphane Patëux (Orange Labs FT)
159. Florelle Pauchet (Envivio)
160. Nicolas Pellerin (STMicroelectronics)
161. Yinji Piao (Samsung Electronics)
162. Mohamad Raad (RaadTech Consulting)
163. Shevach Riabtsev (CSR)
164. Justin Ridge (Nokia)
165. Christopher Rosewarne (Canon)
166. Shinichi Sakaida (NHK)
167. Jesus Sampedro (Polycom)
168. Jonatan Samuelsson (LM Ericsson)
169. P. Sankaranaraganan (Ittiam)
170. Hisao Sasai (Panasonic)
171. Kazushi Sato (Sony)
172. Ankur Saxena (Samsung Telecom. America)
173. Heiko Schwarz (Fraunhofer HHI)
174. Andrew Segall (Sharp)
175. Shun-ichi Sekiguchi (Mitsubishi Electric)
176. Stian Selnes (Cisco Systems Norway)

177. Bazhong ("BZ") Shen (Broadcom)
178. Youji Shibahara (Panasonic)
179. Masato Shima (Canon)
180. Shinya Shimizu (NTT)
181. Mischa Siekmann (Fraunhofer HHI)
182. John Sievers (LifeSize Commun.)
183. Rickard Sjöberg (LM Ericsson)
184. Joel Sole (Qualcomm)
185. Jin Song (Huawei)
186. Partha Sriram (Nvidia)
187. Kazuo Sugimoto (Mitsubishi Electric)
188. Toshiyasu Sugio (Panasonic)
189. Karsten Sühring (Fraunhofer HHI)
190. Gary Sullivan (Microsoft)
191. Huifang Sun (Mitsubishi Electric)
192. Teruhiko Suzuki (Sony)
193. Yoshinori Suzuki (NTT Docomo)
194. Yasser Syed (Comcast)
195. Vivienne Sze (Texas Instruments)
196. Ali Tabatabai (Sony)
197. Seishi Takamura (NTT)
198. Thiow Keng Tan (NTT Docomo)
199. Yih Han Tan (Inst. Infocomm Res. (I2R))
200. Akiyuki Tanizawa (Toshiba)
201. Ikai Tomohiro (Sharp)
202. Pankaj Topiwala (FastVDO)
203. Matsunobu Toru (Panasonic)
204. Alexandros Tourapis (Magnum Semiconductor)
205. Yi-Shin Tung (MStar Semiconductor)
206. Kemal Ugur (Nokia)
207. Geert Van der Auwera (Qualcomm)
208. Sebastiaan Van Leuven (Ghent Univ. - IBBT)
209. Glenn Van Wallendael (Ghent Univ. - IBBT)
210. Anthony Vetro (Mitsubishi Electric)
211. Viktor Wahadaniah (Panasonic Singapore Labs)
212. Wade Wan (Broadcom)
213. Jing Wang (Research in Motion)
214. Xianglin Wang (Qualcomm)
215. Ye-Kui Wang (Qualcomm)
216. Hitoshi Watanabe (Sigma Designs)
217. Thomas Wedi (Panasonic)
218. Aaron Wells (Ambarella)
219. Xing Wen (Hong Kong Univ. Sci. & Tech.)
220. Stephan Wenger (Vidyo)
221. Thomas Wiegand (Fraunhofer HHI)
222. Adrian Wise (Aspex Semiconductor)
223. Kwanghyun Won (Sungkyunkwan Univ. (SKKU))
224. Ping Wu (ZTE (UK))
225. Jizheng Xu (Microsoft)
226. Jun Xu (Sony)
227. Lidong Xu (Intel)
228. Xiaozhong Xu (Zenverge)
229. Tomoo Yamakage (Toshiba)
230. Tomoyuki Yamamoto (Sharp)
231. Haitao Yang (Huawei)
232. Yan Ye (InterDigital Commun.)
233. Sehoon Yea (LG Electronics)
234. Chuohao Yeo (Inst. Infocomm Res. (I2R))
235. Peng Yin (Dolby Labs)
236. Haoping Yu (Huawei (USA))
237. Lu Yu (Zhejiang Univ.)
238. Xiang Yu (Research in Motion)
239. Yong Yu (Broadcom)
240. Yue Yu (Motorola Mobility)
241. Yuan Yuan (Tsinghua Univ.)
242. Lei Zhang (Broadcom)
243. Li Zhang (Qualcomm)
244. Wenhao Zhang (Intel)
245. Ximin Zhang (MediaTek)
246. Xingyu Zhang (Hong Kong Univ. Sci. & Tech.)
247. Yichen Zhang (Zhejiang Univ.)
248. Wilf Zhao (ViXS Systems)
249. Xin Zhao (Peking Univ.)
250. Yin Zhao (Zhejiang Univ.)
251. Jianhua Zheng (Huawei)
252. Xiaozhen Zheng (Huawei)
253. Minhua Zhou (Texas Instruments)
254. Feng Zou (HKUST)
255. Wen Zuo (ZTE)