Joint Collaborative Team on Video Coding (JCT-VC)
of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11
7th Meeting: Geneva, CH, 21–30 Nov 2011

Document: JCTVC-G1100

Title: **Meeting report of the seventh meeting of the Joint Collaborative Team on Video Coding (JCT-VC), Geneva, CH, 21–30 Nov. 2011**

Status: Report Document from Chairs of JCT-VC

Purpose: Report

Author(s) or Contact(s):

Gary Sullivan
Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052 USA
Tel: +1 425 703 5308
Email: garysull@microsoft.com

Jens-Rainer Ohm
Institute of Communications Engineering
RWTH Aachen University
Melatener Straße 23
D-52074 Aachen
Tel: +49 241 80 27671
Email: ohm@ient.rwth-aachen.de

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 seventh meeting during 21–30 Nov. 2011 at the ITU-T premises in Geneva, CH. During the first two days of the meeting, a room at the nearby WMO headquarters was also used. 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 in section 1.13 of this document.

The JCT-VC meeting sessions began at approximately 1100 hours on Monday 21 Nov 2011. Meeting sessions were held on all days (including weekend days) until the meeting was closed at approximately 1335 hours on Wednesday 30 Nov. Approximately 284 people attended the JCT-VC meeting, and approximately 1000 input documents were discussed. The meeting took place in a co-located fashion with a meeting of ITU-T SG16 – 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 now referred to 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 sixth JCT-VC meeting in implementing the 4th HEVC Test Model (HM4) and editing the 4th HEVC specification Working Draft (WD4), review the results from interim Core Experiments (CE), review technical input documents, further develop Working Draft and HEVC Test Model (HM), 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 5 (HM5), the HEVC specification Working Draft 5 (WD5), and a document specifying common conditions and software reference configurations for HEVC coding experiments. Moreover, 11 documents describing the planning of future CEs were drafted.

For the organization and planning of its future work, the JCT-VC established 22 "Ad Hoc Groups" (AHGs) to progress the work on particular subject areas. The next four JCT-VC meetings are planned for 1–10 February 2012 under WG 11 auspices in San José, USA, 30 April – 8 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 16–23 January 2013 under ITU-T auspices in Geneva, CH.

AMAZON-1044
Amazon v. InterDigital, IPR2026-00195

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 seventh meeting during 21–30 Nov 2011 at the ITU-T premises (and, for two days, also at the nearby WMO headquarters) in Geneva, CH. 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 1100 hours on Monday 21 Nov 2011. Meeting sessions were held on all days (including weekend days) until the meeting was closed at approximately 1335 hours on Wednesday 30 Nov. 2011. Approximately 284 people attended the JCT-VC meeting, and approximately 1000 input documents were discussed. The meeting took place in a co-located fashion with a meeting of ITU-T SG16 at the ITU headquarters facility – one of the two parent bodies of the JCT-VC. During the first two days of the meeting, a meeting room at the nearby WMO headquarters was also used. The subject matter of the JCT-VC meeting activities consisted of work on the new next-generation video coding standardization project now referred to as High Efficiency Video Coding (HEVC).

Some statistics for historical reference purposes:

- 1st meeting (Dresden): 188 people, 40 input documents
- 2nd meeting (Geneva): 221 people, 120 input documents
- 3rd meeting (Guangzhou): 244 people, 300 input documents
- 4th meeting (Daegu): 248 people, 400 input documents
- 5th meeting (Geneva): 226 people, 500 input documents
- 6th meeting (Torino): 254 people, 700 input documents
- 7th meeting (Geneva) 284 people, 1000 input documents

Information regarding logistics arrangements for the meeting had been provided at http://wftp3.itu.int/av-arch/jctvc-site/2011_11_G_Geneva/JCTVC-G_Logistics.doc.

1.3 Primary goals

The primary goals of the meeting were to review the work that was performed in the interim period since the sixth JCT-VC meeting in producing the 4th HEVC Test Model (HM) software and editing the 4th HEVC specification Working Draft (WD4), review the results from interim Core Experiments (CEs), review technical input documents, and establish fifth versions of the Working Draft (WD5) and HEVC Test Model (HM5).

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 (which, for this meeting, was in the same timezone).

Decisions made by the group that affected 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 affected the reference software but had 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 Tuesday, 8 Nov 2011.

Non-administrative documents uploaded after 2359 hours in Paris/Geneva time Wednesday Nov 9 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-G867 to JCTVC-G1045 were registered after the "officially late" deadline (and therefore were also uploaded late). Some documents in this range included 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-G279 [uploaded 11-19]

- JCTVC-G358 [uploaded 11-10]
- JCTVC-G387 [uploaded 11-10]
- JCTVC-G516 [uploaded 11-18]
- JCTVC-G685 [uploaded 11-10]
- JCTVC-G692 [uploaded 11-11]
- JCTVC-G705 [uploaded 11-10]
- JCTVC-G710 [uploaded 11-10]
- JCTVC-G712 [uploaded 11-10]
- JCTVC-G715 [uploaded 11-12]
- JCTVC-G716 [uploaded 11-12]
- JCTVC-G717 [uploaded 11-10]
- JCTVC-G722 [uploaded 11-12]
- JCTVC-G807 [uploaded 11-11]
- JCTVC-G865 [uploaded 11-12]

A substantial number of cross-verification reports and other documents other than normative technical proposals were uploaded late. Please see Annex A for full details.

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.

"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-G512 (a cross-verification report, corrected 11-11)
- JCTVC-G625 (a cross-verification report, corrected 11-15)
- JCTVC-G626 (a cross-verification report, corrected 11-16)
- JCTVC-G627 (a cross-verification report, corrected 11-21)
- JCTVC-G694 (a cross-verification report, corrected 11-10)
- JCTVC-G795 (a cross-verification report, corrected 11-17)

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).

1.4.3 Measures to facilitate the consideration of contributions

It was agreed that, due to the increasingly 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-F800, the HEVC Test Model (HM) JCTVC-F802, and the Working Draft (WD) JCTVC-F803, were approved. The HM reference software produced by the AHG on software development and HM software technical evaluation was also approved.

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.

Some such issues had been brought up on the reflector for group clarification on how to proceed.

It was remarked that in some cases (none specifically mentioned) 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).

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

The activities in some CEs may have diverged from the original plans by bringing in somewhat different technology that may not have been fully understood even by the cross-checking participants.

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).

CE9 was suggested as a CE where there has been a need for greater discipline and where the situation became confusing.

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.

S. Wenger volunteered to help with document archive coordination toward improved harmonization of the document archives on these sites.

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 the result of private communication only cannot be considered as 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.
- **APS: Adapation parameter set.**
- **AMVR**: Adaptive motion vector resolution.
- **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.
- **BUDI**: Bidirectional UDI.
- **CABAC**: Context-adaptive binary arithmetic coding.
- **CBF**: Coded block flag(s).
- **CE**: Core experiment – a coordinated experiment conducted after the 3rd or 4th meeting.
- **CRA**: Clean random access – the ability to begin the decoding process of a bitstream at a point other than the start of the bitstream, while avoiding visual artifacts resulting from references to unavailable reference pictures.
- **DCT**: Discrete cosine transform (sometimes used loosely to refer to other transforms with conceptually similar characteristics).
- **DCTIF**: DCT-derived interpolation filter.
- **DIF**: Directional interpolation filter.
- **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.
- **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).
- **JM**: Joint model – the primary software codebase developed for the AVC standard.
- **LB** or **LDB**: Low-delay B – the variant of the LD conditions that uses B frames.
- **LC**: Low complexity – a set of coding capabilities designed for reduced implementation complexity (contrast with HE). Often loosely associated with LD.
- **LCEC**: Low-complexity entropy coding.
- **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.
- **MC**: Motion compensation.
- **MDDT**: Mode-dependent directional transform.
- **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).
- **MRG**: block merging mode for CUs.
- **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).
- **QP**: Quantization parameter.
- **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.
- **RPLM**: Reference picture list modification.
- **ROT**: Rotation operation for low-frequency transform coefficients.
- **RQT**: Residual quadtree.
- **RVM**: Rate variation measure.
- **SAO**: Sample-adaptive offset.
- **SDIP**: Short-distance intra prediction.
- **SEI**: Supplemental enhancement information (as in AVC).
- **SPS**: Sequence parameter set (as in AVC).
- **TE**: Tool Experiment – a coordinated experiment conducted after the 1st or 2nd 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.
- **TPE**: Transform precision extension.
- **UDI**: Unified directional intra.
- **Unit types**:
    - **CU**: coding unit.
    - **LCU**: (formerly LCTU) largest coding unit (synonymous with 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 – and 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).

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 Jens-Rainer Ohm, and discussions on topic categorized as "Track B" were primarily chaired by Gary Sullivan.

Note: The listed contribution counts may not be 100% precise.

- AHG reports (22) Track P (section 2)

- Project development, status, and guidance (0) Track P (section 3)
- CE summary reports (13) – Reviewed in plenary or tracks
- CE1: Entropy coding investigation (26) Track A (section 4.1)
- CE2: Motion partitioning and OBMC (6) Track A (section 4.2)
- CE3: Motion compensation (33) Track A (section 4.3)
- CE4: Quantization (45) Track B (section 4.4)
- CE5: CAVLC entropy coding improvement (13) Track B (section 4.5)
- CE6: Intra prediction improvement (48) Track B (section 4.6)
- CE7: Additional transforms (14) Track B (section 4.7)
- CE8: Non-deblocking loop filtering (36) Track A (section 4.8)
- CE9: MV coding and skip/merge operation (30) Track A (section 4.9)
- CE10: Core transform design (8) Track B (section 4.10)
- CE11: Coefficient scanning and coding (15) Track B (section 4.11)
- CE12: Deblocking filter (38) Track A (section 4.12)
- CE13: Motion data parsing robustness and throughput (17) Track A (section 4.13)
- Clarifications and bug fix issues (1) Track P (section 5.1)
- HM settings and common test conditions (8) Track P (section 5.2)
- Source video test material (1) Track P (section 5.3)
- Functionalities (10) Track A (section 5.4)
- Loop filtering (85) Track A (section 5.5)
- Block structures and partitioning (22) Track A (section 5.6)
- Motion compensation operation and interpolation filters (31) Track A (section 5.7)
- Motion and mode coding (81) Track A (section 5.8) incl. parsing robustness (previous 5.17)
- High-level syntax and slice structure (54) Track B (section 5.9)
- Quantization (35) Track B (section 5.10)
- Alternative coding modes (22) Track A (section 5.11)
- Entropy coding (38) Track A (section 5.12)
- Transform coefficient coding (60) Track B (section 5.13)
- Intra prediction and mode coding (72) Track B (section 5.14)
- Transforms (31) Track B (section 5.15)
- IBDI and memory compression (2) Track A (section 5.16)
- Complexity assessment (3) Track A (section 5.17)
- Encoder optimization (6) Track P (section 5.18)

Overall Track P: 59; Track A: 428; Track B: 439

2 AHG reports

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

JCTVC-G001 JCT-VC AHG Report: Project Management (AHG 1) [G. J. Sullivan, J.-R. Ohm (AHG chairs)]

This document reports on the work of the JCT-VC ad hoc group on Project Management.

The work of the JCT-VC overall had proceeded well in the interim period. A large amount of discussion was carried out on the group email reflector. All report documents from the preceding meeting have been made available at the ITU-based JCT-VC site (http://ftp3.itu.int/av-arch/jctvc-site/2011_07_F_Torino) or the new "Phenix" site (http://phenix.it-sudparis.eu/jct/), particularly including the following:

- The meeting report (JCTC-F800)
- The HM 4 encoder description (JCTVC-F802)
- The HEVC Working Draft (JCTVC-F803)
- Common HM test conditions and software reference configurations (JCTVC-F900)
- Finalized core experiment descriptions (JCTVC-F901 through JCTVC-F913)

Additional important current JCT-VC documents are noted as follows:

- HEVC software guidelines (JCTVC-F688)
- HEVC Reference Software Manual (JCTVC-F634)

The various ad hoc groups and core experiments had made progress, and various reports from those activities had been submitted.

Since the approval of software copyright header language at the March 2011 parent-body meetings, this topic seems to be resolved.

No major news has been received regarding future meeting plans, etc.

No particular problems were noted with the produced outputs in this discussion.

JCTVC-G002 JCT-VC AHG report: HEVC Draft and Test Model editing (AHG 2) [B. Bross, K. McCann, W.-J. Han, J.-R. Ohm, S. Sekiguchi, G. J. Sullivan, T. Wiegand]

One draft of JCTVC-F802 and six drafts of JCTVC-F803 were published by the Editing AHG between the 6th JCT-VC meeting in Torino (14–22 July, 2011) and the 7th Meeting in Geneva (21–30 November, 2011). JCTVC-F802 still needs significant further improvement, whilst the final draft of JCTVC-F803 is reasonably complete.

The main changes in JCTVC-F803, relative to the previous JCTVC-E603, were listed. Some specific open issues remaining for JCTVC-F803 were also noted.

NSQT integration was particularly difficult. A mismatch was reported between the software and the text submitted by the proponents. It was noted that there are relevant input contributions to address this.

In the discussion, the importance of confirming the correctness of text when performing cross-checking of proposals was emphasized.

CAVLC proposals not yet integrated into WD.

Tiles, wavefronts, and weighted prediction had not yet been integrated, not necessarily due to problems with those aspects, but rather due to the scheduling of other activities that preceded it in integration order. The work was prioritized to first integrate aspects likely to affect coding efficiency behaviour.

The general list of key HEVC issues that need to be addressed was identified to be:

- Entropy coding architecture (see AHG9)
- Transform and dynamic range (see AHG5 and AHG7)
- Picture buffering and high-level syntax (see AHG21)
- Picture resolution adaptation (see AHG18)
- Non-4:2:0 colour formats (see AHG20)
- 10 bit vs. 8 bit decoding capability
- Simplification of MV coding
- In-loop filtering clean-up
- Profiles and Levels
- Parallel processing clean-up

A particular recommendation was to ensure that, when considering the addition of new tools to HEVC, properly drafted text for addition to both the HEVC Working Draft and the HM Test Model (if appropriate) is made available in a timely.

NSQT: Deviation between text and software, more difficult to integrate than anticipated

CAVLC proposals not integrated yet

Tools from H4.1 are not yet included (not due to technical problems):

- Tiles and wavefront
- Weighted prediction

Encoder description should become mandatory

JCTVC-G003 JCT-VC AHG report: Software development and HM software technical evaluation (AHG 3) [F. Bossen, D. Flynn, K. Suehring]

(Reported verbally prior to upload.)

This report summarizes the activities of the AhG on Software development and HM software technical evaluation that have taken place between the 6th and 7th JCT-VC meeting. Activities focused on integration of tools adopted at the 6th meeting into a common code base.

The first version 4.0 of the HM 4 software (primarily items affecting coding efficiency) – was integrated quickly, and individual tools were re-tested to confirm that the results were as expected. This generally worked well.

Development of the software was coordinated with the parties needing to integrate changes. Several tracks were typically pursued in parallel to speed up development. The distribution of the software was made through the SVN servers set up at HHI and BBC, as announced on the jct-vc email reflector.

Version 4.0 of the software was delivered according to schedule and reference configuration encodings were provided according to the common test conditions through an ftp site at the BBC (ftp://ftp.kw.bbc.co.uk/hevc/hm-4.0-anchors/).

All tools integrated into version 4.0 were individually retested. No unexpected result was reportedly observed. It can be noted that substantial coding efficiency improvements were achieved for all configurations, and for low-delay configurations in particular. Tabulated results were provided in the report.

Version 4.1 of the software was delivered on Nov. 10, ahead of the 7th JCT-VC meeting. It can be noted that a slight coding efficiency degradation was observed in the 4.1 release. The reason of this degradation should be further identified.

In addition to the regular HM development process, one branch was created to expose tools to a wider audience: HM-4.0-dev-ahg21-picbuffer which contains an implementation of the picture buffer management technique studied in AHG 21

Some mismatches between text and software were identified, particularly in regard to NSQT, and it was suggested for this topic to be addressed at the 7th meeting.

Multiple versions of the HM software were produced and announced on the jct-vc email reflector. The following sections give a brief summary of the changes made for each version. A detailed history of changes made to the software can be viewed at http://hevc.kw.bbc.co.uk/trac/timeline

Released versions of the software are available on the SVN server set up at the following URL: https://hevc.hhi.fraunhofer.de/svn/svn_HEVCSoftware/tags/version_number where version_number corresponds to one of the versions described below (e.g., HM-2.0). Intermediate code submissions can be found on a variety of branches available at https://hevc.hhi.fraunhofer.de/svn/svn_HEVCSoftware/branches/branch_name where branch_name corresponds to a branch (e.g., HM-2.0-dev).

As noted above, NSQT integration was reportedly particularly difficult.

The encoder behaviour for AMP was noted to be different than what may have been expected, as further discussed in CE9.

The next version (4.1) was developed more slowly than expected, particularly due to difficulty of integrating the tiles and wavefronts features. Weighted prediction was also included in the 4.1 version. The re-testing to confirm the intended behaviour was reported to not yet have been completed. Some drop in coding efficiency was reported for the 4.1 version – not so much – perhaps 0.5%, but this should be investigated to determine why.

The software coordinator indicated concerns about the quality of some of the software submissions.

The coordinator emphasized the importance of filing bug reports (and providing the associated fixes) for tracking any observed problems with the software.

It was noted that in addition to testing for the behaviour when using the common conditions, it is also important to test with other conditions (e.g. higher bit rates).

In the discussion, it was noted that slice boundary padding behaviour for ALF had changed, and that the previous behaviour may be better to use. Another participant remarked that the change had been made in order to make the software match the text. See below for action on this.

The software coordinator remarked that the ALF software was particularly poor quality code, and needs lots of work. He also said that the deblocking filter code has substantial problems. This was the subject of some BoG work and also put into AHG plans.

In general, ALF and de-blocking were suggested not to be in such good shape.

Cross-checkers of software should confirm that the WD text matches software (esp. in NSQT case). One issue related to AMP (see CE9), where encoder behaviour was different than expected.

The 4.0 software version was developed as planned, but 4.1 (particularly tiles and wavefront) was more difficult to implement than expected (and also loses approx. 0.5% due to overhead).

Concerns were expressed about the quality of some delivered submissions.

Any bug reports should be filed by ticket, not just verbally. Experts are encouraged/urged not only to report bugs, but also to contribute fixing them.

Slice boundary padding order was changed from 4.0 to 4.1 (mismatch between text and software). Some concern was raised regarding whether this change was appropriate. This was discussed again on Nov. 29.

Decision: Revert software and WD to 4.0 version of the padding.

JCTVC-G004 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 (vice chairs)]

The main focus was the combination wavefront and tiles. No conclusion was reached in reflector discussions. This could be a profiling issue which combinations are allowed. As far as the discussion went, combination of slices, entropy slices, wavefronts and tiles do seem to work together technically. The question to what extent specific combinations of the partitioning tools should be disallowed was briefly discussed but no conclusions were made.

Investigation on slice overhead (in HM 4.1) unveiled that nothing substantially changed.

JCTVC-G005 JCT-VC AHG Report: Spatial Transforms (AHG 5) [P. Topiwala (AHG Chair), M. Budagavi, R. Cohen, R. Joshi (vice chairs)]

This AhG was quite active in this reporting cycle. Work progressed on the two CEs within this AhG: CE7 on Alternative Transforms, and CE10 on Core Transforms. Within CE10, four proposed transform designs were submitted and evaluated using a variety of performance and complexity metrics (tabulated in the AHG report), which are reported in JCTVC-G040. For CE7, two of the proposed tools were reportedly unified during conduct of the CE. CE7's activities were summarized in JCTVC-G037. Proposals for CE7 and CE10 were listed in tables in the AHG report. In addition to submissions directly related to CEs, there were also documents in the general AhG topic area, related to topics such as dynamic range analysis, hardware implementation analysis, and analysis of SIMD implementation. This AhG naturally interacts with several other AhGs, notably on Complexity Assessment and Quantization.

It was asked whether there could be a problem with precision at low QP values, and this topic was requested to be further studied and clarified.

JCTVC-G006 JCT-VC AHG report: In-loop and post-processing filtering (AHG 6) [T. Yamakage, K. Chono, Y. J. Chiu, I. S. Chong, M. Narroschke]

There were a few email exchanges on the JCT-VC reflector relating to AHG6 and the related CEs (CE8 and CE12) were active.

There were reportedly 52 technical contributions and 30 cross-checks related to this AHG6. It was recommended to study line buffer reduction jointly for all loop filters in a BoG.

It was recommended to discuss some CE related contributions (JCTVC-G211, JCTVC-G212, JCTVC-G656 and JCTVC-G691) in the context of CE8.

It was recommended to work on cleanup of software and text.

JCTVC-G007 JCT-VC AHG report: Transform dynamic range (AHG 7) [A. Segall (Sharp), E. Alshina (Samsung)]

Results of email discussion were reported with the following observations and recommendations:

- Dynamic range restriction should be defined for the dequantized coefficients.
- Dynamic range restriction should be defined after the first inverse transform.
- Dynamic range restriction should not be defined after second inverse transform, if input to second inverse transform is restricted to 16-bits.
- Dynamic range following the first transform can exceed 16-bit in the worst case.
- Clipping is preferred to restrict dynamic range for the dequantized coefficients and after the first inverse transform.

The AHG recommended to nclude dynamic range restrictions for dequantized coefficients and the first inverse transform stage in the HEVC design, but not to include dynamic range restriction following second inverse transform.

Two experts commented that limiting at the output of the second transform could also be considered, but according to previous discussions might not have a relevant benefit.

JCTVC-G008 JCT-VC AHG report: Reference pictures memory compression (AHG 8) [K. Chono (chair), T. Chujoh, D. Hoang, C. S. Lim, A. Tabatabai, M. Zhou (vice-chairs)]

It was reported that HM 4 slightly increased memory access bandwidth, mostly in LD settings (most likely due to using a modified picture referencing structure).

The report recommended to review JCTVC-G430. 10 bit support reportedly gives approximately 2.5–2.8% luma BR reduction vs. 8 bit, whereas memory bandwidth reportedly increases by 35% on average and 50% maximum (probably due to the relatively small access block sizes investigated and byte alignment).

A related technical proposal from Qualcomm (JCTVC-G328) was noted in the report. The contribution proposes to signal the output bit depth of decoded pictures to indicate an output bit depth that is less than the bit depth of the decoded pictures. The contribution proposes a new SPS parameter to signal output bit depth and a new DPB management.

JCTVC-G009 JCT-VC AHG report: Entropy Coding Architecture (AHG 9) [K. McCann (chair), A. Fuldseth, D. Marpe, A. Segall, K. Sugimoto, V. Sze, W. Wan, X. Wang (vice chairs)]

Two basic approaches to the entropy coding architecture were considered:

- Single entropy coder technology with a single operating point, and
- Encoder architecture with two (or more) technologies or operating points.

Switchable (2 operating points) vs. scalable (multiple operating points) entropy coding were discussed.

Multiple operating points could be achieved through some form of switchable or scalable architecture. In principle, such an architecture could support a large number of operating points. However, no interest was expressed in examining more than 2 operating points. Recommendations were as follows:

- HEVC should include only a single entropy coding technology with a single operating point unless adding a second option provides a significantly different performance/complexity trade-off which substantially facilitates the use of HEVC in a class of applications for which it would not otherwise provide an appropriate solution
- JCT-VC should analyse input contributions relating to entropy coding with the aim of making a decision on the HEVC entropy coding architecture during the 7th JCT-VC meeting

Complexity (both hardware and software) is difficult to quantify.

JCTVC-G010 JCT-VC AHG report: Quantization (AHG 10) [M. Budagavi, M. Karczewicz, G. Martin-Cocher, K. Sato]

Quantization-related contributions are categorized as follows:

- CE4 (general)
- CE4 subtest1: QP coding
- CE4 subtest2: De-quantization Offset

- CE4 subtest3: Quantization Matrices
- Non-CE4: QP Coding
- Non-CE4: De-quantization Offset
- Non-CE4: Quantization Matrices

The AHG recommended reviewing all relevant input contributions.

JCTVC-G011 JCT-VC AHG Report: Video test material selection (AHG 11) [T. Suzuki]

Under-represented categories of test material were identified as: High bit depth, and 4:4:4.

It was discussed whether there was a sufficient variety of noise conditions.

Compressed material in class E was noted.

No new test material was reported to be available.

JCTVC-G012 JCT-VC AHG report: Complexity assessment (AHG 12) [D. Alfonso (AHG chair), J. Ridge, X. Wen (vice-chairs)]

Considering that complexity assessment experiments are almost totally executed in the scope of other Ad-Hoc Groups and Core Experiments, rather than in this group, the chairs proposed to discontinue the activity of the Complexity Assessment AHG at the current meeting.

Thanks was expressed to Daniele Alfonso for contributions in CE10.

JCTVC-G013 JCT-VC AHG report: Screen Content Coding (AHG 13) [O. Au, J. Xu, H. Yu (AHG chairs)]

Results with new screen content sequences with transform skipping were noted (various input docs).

It was somewhat questioned whether this AHG is still needed.

JCTVC-G014 JCT-VC AHG Report (AHG14) [Stephan Wenger]

Error burst patterns were proposed with 3, 5, 7, 10% packet loss rates (see JCTVC-G150).

The decoder no longer crashes when a coded picture is lost. (The decoder is not yet resilient against losses of individual slices.)

Discussion: Adopt conditions of burst patterns? Even if they are not perfect, it would at least be more useful than having anybody proposing error resilience tools uses his own. Discussed below in the context of JCTVC-G150.

JCTVC-G015 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 (vice chairs)]

This report summarized the activities of the high-level syntax ad hoc group between the 6th JCT-VC meeting held in Torino in July 2011 and the current meeting in Geneva, and lists the related input documents submitted to this meeting according to their topics.

It was reported that there were some discussions on slice header syntax element organization, including whether to put the slice_address syntax element first in the slice header, whether to keep the first_slice_in_pic_flag syntax element, whether the presence of the cabac_init_idc syntax element should depend on the value of slice_type, which is not present in a short slice header, and whether to put all syntax elements that are only present in a full slice header in consecutive order.

Related contributions and relevant other AHGs were noted.

JCTVC-G016 JCT-VC AHG report: Padding process (AHG 16) [V. Wahadaniah, K. Chono, Y. Lin]

It was reported that there were 4 relevant input docs related to various aspects of padding in context of intra prediction.

JCTVC-G017 JCT-VC AHG Report: Scalable coding investigation (AHG 17) [J. Boyce, J. Kang, K. Minoo, W. Wan, Y.-K. Wang]

There was no activity on the JCT-VC e-mail reflector related to scalable coding investigation, although there was considerable discussion about requirements on the mpeg-hevc-ext reflector. Relevant contributions were noted.

JCTVC-G018 JCT-VC AHG report: Resolution adaption (AHG 18) [T. Davies (AHG chair), P. Topiwala, P. Wu (Vice-chairs)]

A kick-off email was sent on 15/9/2011. There were 7 further messages exchanged on the reflector concerning AHG 18.

There was discussion of the priorities for study. It was remarked that the details of the design and the affected parts of the specification need to be determined.

It was reported that one participant mentioned a desire for flexibility of the design such that perhaps ratios of 3/2 and 2/3 should be supported as well as dyadic scaling. In response it was suggested to focus on dyadic scaling for the moment and consider more flexible filtering later. One participant also reportedly remarked that it is advantageous to have co-designed up- and down-scaling filters for best performance.

In the discussion of the report it was suggested that there is potential synergy with scalability.

It was discussed how to try to measure quality in the context of resolution adaptation, and suggested that PSNR is not particularly useful across differing resolutions.

Resolution adaptation is not necessarily only about better subjective quality, but also complexity adjustment. Usage of resolution adaptation for computational load management was mentioned in the discussion.

JCTVC-G019 JCT-VC AHG Report: Transform Skipping (AHG19) [M. Mrak (AHG chair), J. Sole, I.-K. Kim, J. Xu, H. Yu (vice chairs)]

The recommendations of the AHG were

- To study feasibility and effectiveness of integrated transform skipping – related proposals
- To discuss transform skipping options as default parameters for HM
- To study further transform skipping harmonization with NSQT tools

Some experts expressed interest in better understanding the characteristics of the technology (e.g. regarding complexity of entropy coding) – see docs JCTVC-G575, JCTVC-G577, JCTVC-G663.

JCTVC-G020 JCT-VC AHG report: Chroma format support (AHG 20) [David Flynn, Dzung Hoang, Ken McCann]

Not much activity was reported. Input documents (JCTVC-G967, JCTVC-G862) on the topic were noted and discussed in breakout discussions (coordinated by D. Flynn).

JCTVC-G021 JCT-VC AHG report: Reference picture buffering and list construction (AHG21) [D. Flynn, R. Sjöberg (AHG chairs), Y. Chen, T.K. Tan, W. Wan, Y.-K. Wang (vice chairs)]

The reference picture set concept was proposed in JCTVC-F493. It includes describing the reference pictures in the decoded picture buffer (DPB) in an absolute manner in the header data of pictures instead of in a relative manner (through AVC-like MMCO and sliding window processing).

The WD text was extensively discussed on the JCT-VC reflector. Several candidate WD documents were produced and uploaded to ftp://ftp.hhi.de/ahg21/. The final candidate WD text submitted by the AHG was attached together with the AHG report. This document used change-bars to show the text changes relative JCTVC-F803_d5.doc.

The first version of the AHG21 source code was made available on October 28 in the HM-4.0-dev-ahg21-picbuffer branch. A number of features were implemented, including "rudimentary" error concealment for lost reference picture slices. The modified decoder does not crash on picture losses. Instead, frame copy concealment is done.

Further information was provided in the report, and related contributions were reviewed.

Open issues noted included: long-term pictures, filling of reference picture lists, and the CRA issue.

A question was asked regarding PPS versus APS usage for buffer set descriptions – the intent is to avoid sending the RPS in the slice header – it was noted that the APS concept has only recently been used, and that it may not be fully clear what the APS would ultimately become.

Issues relating to detection of lost pictures were discussed.

WD text and software were developed and agreed (via reflector). Only loss of complete pictures is supported in the modified software.

Open issues included addressing of long-term pictures, construction of lists, and pictures following a CRA (e.g. whether the can reference pictures before the CRA).

It was discussed whether the reference picture list information should be in PPS or rather in the APS.

Lambda was adjusted – this could be of concern when used in CEs.

Source code was noted to not be fully aligned with the WD text.

Related input contributions (most building on top of the AHG WD text) were noted in the report.

AHG recommendations:

- JCT-VC to review the candidate WD text on picture buffer management and consider it for adoption
- To use the HM-4.0-dev-ahg21-picbuffer source code for comparisons in picture buffer management proposals
- JCT-VC to review all picture buffer management and list construction related input document.

A BoG was suggested to be coordinated on the topic by Ye-Kui Wand & Rickard Sjoberg. Later, J. Boyce was asked to coordinate.

JCTVC-G022 JCT-VC AHG report: Lossless Coding (AHG22) [W. Gao (chair), K. Chono, J. Xu, M. Zhou (vice chairs)]

The contributions on lossless coding (JCTVC-G092, JCTVC-G093, JCTVC-G268, JCTVC-G664) were noted.

It was suggested that a locally lossless mode should be considered (e.g. at the LCU level).

3 Project development, status, and guidance

See the sections discussing particular functionalities for relevant contributions.

4 Core experiments

4.1 CE1: Entropy coding investigation

4.1.1 Summary and general discussion

JCTVC-G031 CE1: Summary report of core experiment on entropy coding [R. Joshi, E. Alshina, H. Sasai, H. Kirchhoffer, J. Lainema (CE coordinators)]

Subtest A

a) Delayed probability update (JCTVC-G576, JCTVC-G349)

Proponent	Description	BD-rate (Y)	BD-rate, (U)	BD-rate, (V)
Qualcomm JCTVC-G576	Delay 1 bin (all syntax elements)	0,1%	0,1%	0,2%
	Delay 2 bins (all syntax elements)	0,6%	0,4%	0,5%
	Delay 3 bins (all syntax elements)	1,0%	0,4%	0,7%
Panasonic JCTVC-G349	Delay all coefficient coding parameters until end of block	0,2%	0,1%	0,1%
	Delay all coefficient coding parameters except for significant_coeff_flag" parameters until end of block	0,1%	−0,1%	−0,1%
	Delay "last_significant_coeff_x" and "last_significant_coeff_y" parameters until end of block	0,0%	−0,1%	−0,1%
	Delay "coeff_abs_level_greater1_flag"and "coeff_abs_level_greater2_flag" parameters until end of block	0,1%	0,0%	0,0%
	Delay "significant_coeff_flag" parameters until end of block	0,2%	0,1%	0,2%

Comment by one expert: It should be observed if the delayed update affects the probability model and estimation (may be implementation specific and not be critical for the 1 bin delay case).

Another comment: In hardware, delaying the update may not help to increase the throughput. Particularly, delaying more than one bin produces unacceptable losses.

This was revisited after presentation of other contributions that target increase of CABAC throughput.

For the one bin delay case, some doubt is expressed by other experts that it would help increasing the throughput. JCTVC-G349 (updating probabilities of some syntax elements at the end of TC block) is an even less systematic approach and decrease the regularity. No action.

b) Line buffer reduction (JCTVC-G200, JCTVC-G769)

Proponent	Description	BD-rate, Y	BD-rate, U	BD-rate, V
MediaTek JCTVC-G200	Split LCU	0,0%	0,0%	−0,1%
	Skip LCU	0,0%	0,0%	0,0%
	Spli&Skip LCU	0,0%	0,0%	−0,1%
Samsung JCTVC-G769	Split CU	0,1%	0,0%	0,0%

Note: JCTVC-G200 uses 3 additional context models (6 instead of 3 in original contribution JCTVC-F060).

Side activity was suggested to suggest common solution (coordinated by proponents of JCTVC-G200, JCTVC-G769, V. Sze and T. Nguyen).

JCTVC-G1022 On line buffer removal for CU split flag and skip flag context model [T. Lee, J. Chen, J. Park (Samsung), T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek), W.-J. Chien, M. Karczewicz (Qualcomm)] [late]

This document reports the results of line buffer removal in context models. By disabling dependency on upper blocks on split flag and skip flag, the line buffer is totally removed in the current HM model. In this contribution which is based on JCTVC-G769, JCTVC-G200 and JCTVC-G829, it is proposed to use the depth information of the current block and the left block for the context formation of split_coding_unit_flag and to use the data of the left block for the context formation of skip_flag when the upper block belongs to the upper LCU. It is reported that the proposed context modeling for split flag and split flag causes 0.01%, 0.05, 0.12% BD rate loss for, respectively, all intra, random access and low delay configuration.

Some concern was expressed whether the loss in LD B is too high. It is mentioned that the loss in LD B is mainly from class E (0.31%) and class B (0.11%).

The loss might be higher when smaller LCU size was used.

The benefit by saving the line buffer is small.

The context models are re-designed and were trained (which is not the case for the current HM). It is reported that this training gave approx. 0.02% gain.

Several experts expressed concerns whether this is a good trade-off between complexity reduction and loss. No action.

Subtest B (JCTVC-G764)

Summary of tests results (single parameter probability update model):

	All Intra HE			Random Access HE			Low delay B HE		
	Y	U	V	Y	U	V	Y	U	V
Class A	−0.8%	0.0%	0.0%	−0.8%	0.8%	1.5%			
Class B	−0.6%	−0.7%	−0.6%	−0.5%	−0.2%	0.0%	−0.4%	0.2%	0.0%
Class C	−0.6%	−0.9%	−0.8%	−0.4%	−0.6%	−0.3%	−0.4%	−0.3%	−0.5%
Class D	−0.7%	−1.5%	−1.5%	−0.4%	−0.6%	−1.1%	−0.4%	−0.4%	−0.6%
Class E	−0.6%	−0.8%	−0.9%				−0.1%	−1.5%	−0.6%
Overall	−0.7%	−0.8%	−0.8%	−0.6%	−0.2%	0.0%	−0.3%	−0.4%	−0.4%
Enc Time[%]	101%			101%			100%		
Dec Time[%]	101%			100%			100%		

Summary of tests results (multi-parameter probability update model):

	All Intra HE			Random Access HE			Low delay B HE		
	Y	U	V	Y	U	V	Y	U	V

Class A	−1.1%	−0.7%	−0.7%	−1.2%	−0.2%	−0.3%			
Class B	−0.9%	−1.1%	−1.2%	−1.0%	−0.7%	−0.7%	−0.8%	−0.8%	−1.1%
Class C	−0.9%	−1.2%	−1.2%	−0.9%	−0.9%	−0.9%	−0.8%	−0.7%	−1.2%
Class D	−0.9%	−1.7%	−1.7%	−0.9%	−1.1%	−1.3%	−0.8%	−1.0%	−1.0%
Class E	−0.9%	−1.8%	−1.8%				−0.9%	−2.0%	−0.4%
Overall	−0.9%	−1.3%	−1.3%	−1.0%	−0.7%	−0.8%	−0.8%	−1.1%	−0.9%
Enc Time[%]	103%			103%			102%		
Dec Time[%]	101%			101%			102%		

Note: JCTVC-G326, JCTVC-G413, JCTVC-G547 propose similar approaches but most likely in better implementation.

Subset C

Test results summary (BD-rate difference is averaged across AI, RA, and LD, Class F not included):

Test	Proponent	Description	HE		LC	
			BD-rate, (Y)	BD-rate, (U+V)/2	BD-rate, (Y)	BD-rate, (U+V)/2
		BAC, LC configuration			−5.99%	+4.47%
1	HHI (JCTVC-G633)	BAC, LCmod, 8-bit init			−0.45%	+8.78%
2	HHI (JCTVC-G633)	V2V, LCmod, Multi-bin, 8-bit init, TBC			−0.45%	+7.80%
3	HHI (JCTVC-G633)	V2V, LCmod, Multi-bin, Low delay, 8-bit init, TBC			−0.14%	+8.13%
4	HHI (JCTVC-G633)	V2V, 8-bit init, TBC	+0.14%	−0.74%	−5.85%	+3.78%
5	HHI (JCTVC-G633)	V2V, LowDelay, 8-bit init, TBC	0.32%	−0.58%		
6	HHI (JCTVC-G633)	BAC, 8-bit init	−0.24%	−0.18%	−6.20%	4.45%
7	HHI (JCTVC-G633)	BAC, 8-bit init, Alt. PMU, TBC	−0.79%	−0.58%		
8	Mitsubishi (JCTVC-G458)	V2F, 8-bit init			−3.27%	7.44%
9	Mitsubishi (JCTVC-G458)	V2F, LowDelay, 8-bit init			−3.27%	7.44%
10	Mitsubishi (JCTVC-G458)	V2F, MC mod., LowDelay, 8-bit init			−3.04%	9.48%
11	Samsung/HH	V2V, 8-bit init,				

	I (JCTVC-G771)	Alt. PMU, TBC				
12	Cisco (JCTVC-G210)	BAC, RDOQ off, RDO PMU off			−5.20%	−0.16%
13	Cisco (JCTVC-G233)	BAC, RDOQ off PMU off			5.99%	4.63%
14	HHI (JCTVC-G633)	BAC, LCmod, 8-bit init, RDOQ off			−0.31%	+2.63
15	HHI (JCTVC-G633)	V2V, LCmod, 8-bit init, Multi-bin, RDOQ off			−0.27%	+1.97
16	withdrawn					
17	Docomo (JCTVC-G763)	BAC, TBC	0.0%	0.0%	−5.96%	+4.52%

Note: JCTVC-G837, JCTVC-G155 also suggest new 8 bit initialization – further investigation may be needed.

Test 1 is using HM replacing CAVLC vs. CABAC in LC.

Not clear: Is test 13 showing results relative to test 1?

Test	V2F	V2V	BAC	LC mod.	MC mod.	PMU off	Multi bin	Low delay	8-bit Init	Alt. PMU	RDOQ off	RDO PMU off	TBC	Config. tested
1			x	x			n/a		x					LC
2		x		x			x		x				x	LC
3		x		x			x	x	x				x	LC
4		x							x				x	HE, LC
5		x						x	x				x	HE
6			x				n/a		x					HE, LC
7			x				n/a		x	x			x	HE
8	x								x					LC
9	x							x	x					LC
10	x				x			x	x					LC
11		x							x	x			x	HE
12			x								x	x		LC
13			x			x					x			LC
14			x	x			n/a		x		x			LC
15		x		x			x		x		x		x	LC
16	x			x			x		x		x			LC
17			x										x	HE, LC

Conclusions of subtest C:

- No further consideration on V2V and V2F is planned (see below)
- One entropy coder? (looking at tests 12 and 13): Whereas test 12 is encoder only and loses only slightly compared to the test 1 case, test 13 also changes the decoder.

Two experts stressed that runtime is not the only issue, as we should also consider throughput which may be a problem with CABAC (noting that contribution JCTVC-G569 proposes to address this issue by having an asserted "not two but 1.2" entropy coders).

Decision: Only one entropy coder is to be retained in the design (with the current CABAC as the starting point for that, as modified by decisions recorded elsewhere, and this design may be further optimized in terms of throughput, performance etc.). This was reported to a plenary for confirmation on Tue. morning.

4.1.2 Contributions

Subtest A

JCTVC-G200 CE1.A.3: Reducing line buffers for CABAC [T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)]

This contribution reports results of CE1.A.3. In HM-4.0, split_coding_unit_flag and skip_flag are the only two CABAC syntax elements that still have dependency on upper LCUs and need line buffers. In this contribution, it is proposed to use the depth information of the current block and the left block for the context formation of split_coding_unit_flag and to use the data of the left block for the context formation of skip_flag when the upper block belongs to the upper LCU. In this way, all CABAC line buffers can be removed. It is reported that the proposed context modeling causes less than 0.08% bit rate increase.

JCTVC-G298 CE1: Cross-check report for CE1 Subset A MediaTek's proposal on Reducing Line Buffers for CABAC [H. Sasai, T. Nishi (Panasonic)]

JCTVC-G349 CE1: SubsetA: Parallel context processing for coefficient coding using block-based context updates [H. Sasai, T. Nishi (Panasonic)]

This contribution is a test report for JCTVC-E226 listed in CE1 Subset A. Proposed technique is aimed to improve the throughput of the entropy coder for CABAC. The context updates make difficult to increase throughput due to their serial dependencies. The proposed modifications have been implemented in HMv4 and their coding efficiencies were evaluated for coefficient cording parameters "last_significant_coeff_x","last_significant_coeff_y","significant_coeff_flag","coeff_abs_level_greater1_flag"and"coeff_abs_level_greater2_flag" respectively. The parallelization capability by the proposal comes at a cost of less than 0.1% performance loss.

JCTVC-G471 CE1.A.2: Crosscheck for Panasonic's parallel context processing for coefficient coding using block-based context updates in JCTVC-G349 [T.-D. Chuang, Y.-W. Huang (MediaTek)]

JCTVC-G576 CE1: Delayed state update for CABAC [R. Joshi, J. Sole, M. Karczewicz (Qualcomm)]

Context update is a known bottleneck in hardware implementation of a CABAC decoder. This is because the state of the context is updated based on the decoded bin. Previous efforts to mitigate this problem have included delaying the context update by one during transform coefficient coding and delaying the

update till the end of a TU. In this proposal the state update delay is extended to bins from all syntax elements. Results are presented for update delays of 1, 2 and 3 bins. For update delays of 1, 2, and 3 bins, average BD-rates of 0.1%, 0.6% and 0.9%, respectively, are reported for HE configurations.

JCTVC-G822 CE1: Cross-check for delayed probability up-date from Qualcomm by Samsung [E. Alshina, J.H. Park] [late]

JCTVC-G769 CE1 subtest A: Line buffer removal for CU split flag context model [T. Lee, J. Chen, J. H. Park (Samsung)]

This document reports the results of "Line buffer removal for CU split flag context model" method proposed in document JCTVC-F497 within the context of CE1. In this proposed method, the context model split_coding_unit_flag is selected based on value of left block and coding unit size to avoid access the context of Context of above block. Experiments show that 0.01%, 0.03, 0.11% BD rate loss is observed for, respectively, all intra, random access and low delay configuration by removing the line buffer for split_coding_unit_flag.

JCTVC-G472 CE1.A.4: Crosscheck for Samsung's line buffer removal for CU split flag context model in JCTVC-G769 [T.-D. Chuang, Y.-W. Huang (MediaTek)]

JCTVC-G763 CE1: Table-based bit estimation for CABAC [F. Bossen (DOCOMO Innovations)]

In the RDO process of the HM, a block may be encoded multiple times using different modes before a best mode is selected based on a rate-distortion criterion. When using CABAC, each of these encodings use the CABAC engine itself to count a number of bits. In this experiment the bit counting procedure is simplified wherein bit counts are estimated using tables. This simplification does not impact rate-distortion performance (all recorded luma BD-rate averages are 0.0%) while reducing the encoding time by 1 to 5%.

Non-normative improvement – Decision (SW): Adopt.

Subtest B

JCTVC-G764 CE1 (subset B): Multi-parameter probability up-date for CABAC [Alexander Alshin, Elena Alshina, JeongHoon Park (Samsung)]

In the RDO process of the HM, a block may be encoded multiple times using different modes before a best mode is selected based on a rate-distortion criterion. When using CABAC, each of these encodings use the CABAC engine itself to count a number of bits. In this experiment the bit counting procedure is simplified wherein bit counts are estimated using tables. This simplification does not impact rate-distortion performance (all recorded luma BD-rate averages are 0.0%) while reducing the encoding time by 1 to 5%.

JCTVC-G553 CE1: Cross-check of Samsung's Multi-parameter probability model up-date for CABAC (JCTVC-F254) [J. Stegemann (HHI)]

Subtest C

JCTVC-G210 CE1: Subtest 12, Entropy coding comparisons with simplified RDO [T. Davies (Cisco)]

Various coding conditions are simulated with both CAVLC and CABAC. Under low-complexity (LC) common conditions it is reported that CABAC provides gain between 5.4% and 6.2% (6.8% including class F). The performance of the entropy coders is also investigated with two encoder restrictions: no RDOQ, and no adaption during RDO mode search. These assumptions together reduce the gap between CABAC and CAVLC by 0.775% (0.875% including class F) averaged across LC settings. When RDOQ is off and RDO adaption is off the gap is reported to be between 5.0% and 5.5% for LC settings (4.9% and 5.9% including class F).

JCTVC-G233 CE1: Subtest 13, Disabling CABAC PMU [T. Davies (Cisco)]

This contribution presents the results of Subtest 13 of Core Experiment 1 on disabling PMU in CABAC. With RDOQ on, BD-Rate differences of 2.8–6.2% are observed. With RDOQ off, BD-Rate differences of 4.0–7.3% are observed. It is noted that BD-Rate differences are very much higher for Class F sequences, and that this is likely due to unsuitable initialization tables.

JCTVC-G765 CE1: Crosscheck of Subtest C - Tests 12 and 13 (JCTVC-G210 and JCTVC-G233) [R. Joshi (Qualcomm)]

JCTVC-G458 CE1c: results of PIPE/V2F [K. Sugimoto, R. Hattori, A. Minezawa, S. Sekiguchi (Mitsubishi)]

This contribution reports results on tests 8, 9, and 10 in CE1 Subtest C that evaluates PIPE/V2F. The verification work was performed using the software implemented PIPE/V2F on top of HM-4.0. Reported performance results were obtained by building and running the provided software on 64bit Linux platform. It is reported that overall BD-rate gain compared to CAVLC is 2.9%, 3.8%, 3.2% and 3.2% for AI-LC, RA-LC, LB-LC and LP-LC settings respectively, with around 5% and 1% encoder and decoder run-time increase. It is also reported that Low delay tool for PIPE/V2F does not affect coding performance and run-time. It is reported that medium complexity configuration for context model derivation gives around 0.3% bit increase with 1% decoding run-time improvement.

Note: Chroma BD rates are 10–15% worse.

The proponent requested to replace CAVLC by this and keep CABAC.

No support was expressed by other companies.

JCTVC-G435 CE1 subtest C: Cross-checking reports of PIPE/V2F for low complexity entropy coding (JCTVC-F176) [A. Tanizawa, T. Shiodera, T. Yamakage (Toshiba)]

JCTVC-G459 CE1c: crosscheck of PIPE/V2V, CABAC [K. Sugimoto, R. Hattori, A. Minezawa, S. Sekiguchi (Mitsubishi)]

JCTVC-G633 CE1: Report of test results related to PIPE-based Unified Entropy Coding [Heiner Kirchhoffer, Benjamin Bross, Anastasia Henkel, Detlev Marpe,

Tung Nguyen, Matthias Preiß, Mischa Siekmann, Jan Stegemann, Thomas Wiegand (Fraunhofer HHI)]

This contribution reports results for tests related to the "unified" PIPE-based entropy coding scheme using v2v codes in CE1. Various combinations of the tools PIPE/v2v, BAC, LC modeling, low delay, 8-bit init, and table-based bit counting were analysed to identify the influence of the tools on BD rate and codec runtime. Furthermore, hardware implementation aspects are analysed for PIPE/v2v with low delay constraint.

A new concept of "chunk interleaving" is presented (not in any proposal before) which reportedly solves some of the multiplexing and low delay issues (for a pre-defined number of parallel encoders/decoders).

No analysis was provided about concrete statistics of bins that can be processed in parallel. The main limitation may come from the parser.

No support was expressed by other companies.

JCTVC-G753 CE1: Crosscheck of CE1 subtest C.6 (JCTVC-G633) proposed by HHI [X. Zheng (HiSilicon)] [late]

JCTVC-G932 CE1: Cross-check for bug-fix version of test 12 in subset C from HHI (JCTVC-G633) by Samsung [E. Alshina, J.H. Park (Samsung)] [late]

JCTVC-G072 CE1: Cross-check of Subtest C (Tests 1, 2, 4, 6, 17) [C. Yeo (I2R)]

JCTVC-G300 CE1: Cross-check report for CE1 Subset C Test 7 [H. Sasai, T. Nishi (Panasonic)]

JCTVC-G612 CE1: Cross-check of test 9: Mitsubishi's study on PIPE/V2F with LowDelay buffer control [M. Siekmann (Fraunhofer HHI)]

JCTVC-G641 CE1: Cross-check of Subtest C (test 1 and test 11) and Subtest B - multi-parameter probability update for CABAC (test 11) [Jinwen Zan, Dake He] [late]

JCTVC-G766 CE1: Crosscheck of Subtest C - Test 5 (JCTVC-G633) [R. Joshi (Qualcomm)]

JCTVC-G771 CE1 (subset C, test 11): Multi-parameter probability up-date for PIPE [A. Alshin, E. Alshina, J.H. Park (Samsung), H. Kirchhoffer (HHI)]

In this contribution, a multi-parameter probability update technique is proposed for the relatively new entropy coding scheme known as PIPE. It should be noted that probability update for PIPE coincides with CABAC probability update. The proposed method allows more precise probability estimation for each current bin, which means that more accurate distribution between different bin-encoders becomes

possible. In terms of coding efficiency, the presented probability update technique on top of PIPE reportedly shows an average BD rate gain about 0.4% in HE configuration.

4.2 CE2: Motion partitioning and OBMC

4.2.1 Summary and general discussion

JCTVC-G032 CE2: Summary report of core experiment on Motion Partitioning and OBMC [X. Zheng, I. S Chong, I.-K Kim]

This document summarizes the activities of CE2 related to Motion Partitioning and OBMC. The description of the experiment can be found in JCTVC-F902. In this CE, six subtests have been studied and evaluated. Among those subtests, proponent of subtest B.1 and C.1 have released software before 13 September, and other subtests have been withdrawn.

4.2.2 Contributions

JCTVC-G517 CE2 subtest C.1: Harmonization of unified scan and NSQT [X. Zheng (HiSilicon), Y. Yuan, Y. He (Tsinghua)]

This document provides a harmonization of unified scan and non-square quadtree transform (NSQT). At the proposed solution, the non-square to square reordering process for transform coefficient coding is removed. The experimental results reportedly show that no coding loss is incurred under common test conditions. Encoding and decoding time for the proposed solution were almost same as for the HM4.0 anchor.

The proposal consists of two parts: Harmonization of scans and a solution for the divergence between SW and WD.

See also the transform coefficient coding section.

JCTVC-G518 CE2 subtest C.1: Non-square quadtree (NSQT) with 2x8 and 8x2 transform [Y. Yuan (Tsinghua), X. Zheng (HiSilicon), Y. He (Tsinghua)]

This document provides the results of non-square quadtree (NSQT) operation with 2x8 and 8x2 transforms. For the proposed method, a 2x2 Hadamard-like transform is added to HEVC framework. The tests under common test condition reportedly show that average gains of 0.0% for RA, 0.0% for RA_LC, 0.1% for LD_B, 0.1% for LD_B_LC, 0.1% for LD_P and 0.2% for LD_P_LC can be achieved. Combined with non-square Hadamard transform, the average gain of 0.1% for RA, 0.2% for RA_LC, 0.3% for LD_B, 0.4% for LD_B_LC, 0.3% for LD_P and 0.4% for LD_P_LC can reportedly be achieved. Compared to HM4.0 anchor, encoding and decoding time were almost same as before.

2x8 and 8x2 were not adopted last time, as they could be problematic in terms of memory access. The gain is relatively small (0.1% without class F). JCTVC-G521 is an improvement by the proponents.

JCTVC-G571 CE2: Cross-check of Non-Square Quadtree Transform (NSQT) JCTVC-G517 & JCTVC-G518 [S. Oudin, B. Bross (Fraunhofer HHI)]

Some criticism was provided by the cross-checker: Unclear description of NSQT in general and unified scan, and low-quality implementation of software (e.g. unused variables).

Clarification was requested whether this was rather a problem of software implementation or WD text concepts? It was not fully clear (possibly both).

- It may not have been fully clear what was adopted last time

- This software came together with AMP, which also has some problems in SW implementation (see AHG3 report)
- A software bug was reported and a fix was provided that seemed to contain some new elements (as documented in JCTVC-G517). Another fix was announced by the proponents to be planned to be made available shortly.
- There are other proposals (by original proponents and other companies) which eventually are using better concepts for signalling/partitioning the NS blocks – JCTVC-G517 was discussed again in that context.

JCTVC-G749 CE2: Overlapped Block Motion Compensation [L. Guo, I.S. Chong, X. Wang, M. Karczewicz (Qualcomm)]

In this contribution, overlapped block motion compensation (OBMC) has been implemented and tested on HM 4.0. OBMC is applied to 2NxN, Nx2N and AMP motion partitions. To limit the worst case memory bandwidth of OBMC, the fetching of extra pixels is disabled for bi-prediction PUs in 8x8 CU. The method achieved a BD-rate reduction of 0.6%, 0.9% and 2.0% on average for RA-HE, LD-HE and LDP-HE respectively. For LC test, the average BD-rate reduction 0.6%, 0.8% and 2.0% for RA-LC, LD-LC and LDP-LC respectively.

Additional memory access may not be an issue (also confirmed by the cross-checkers), but the averaging operation reduces computational throughput and adds complexity at decoder.

One expert suggested that a disabling flag should be implemented.

Three companies expressed negative opinions. No support was expressed by other companies. It was suggested to consider discontinuation of experimentation on this topic due to complexity-benefit tradeoff concerns.

JCTVC-G432 CE2: Cross verification of Qualcomm's Overlapped Block Motion Compensation (JCTVC-G749) [S. Lee, S. Cho, N. Eum (ETRI)]

JCTVC-G939 Non-CE2: Crosscheck for Qualcomm's overlapped block motion compensation in JCTVC-G749 [C.-W. Hsu, Y.-W. Huang (MediaTek)] [late]

4.3 CE3: Motion compensation

4.3.1 Summary and general discussion

JCTVC-G033 CE3: Summary report of Core Experiment on Motion Compensation [T.Chujoh, E.Alshina (CE coordinators)]

The goal of this Core Experiment (CE) is to further investigate following aspects of motion compensation in HM:

- Simplification of interpolation MC and reduction of reference frame memory access bandwidth;
- Improve the trade-off between coding performance and complexity by MC optimization;
- Study complexity in terms for computations number and memory band-width with actual hit-ratio measurement ;

- Study possible reduction of the worst case of memory band-width;
- Study accuracy of MV resolution for HM.

Fixed filters (JCTVC-G775, JCTVC-G696, JCTVC-G778, JCTVC-G427, JCTVC-G698, JCTVC-G699, JCTVC-G058, JCTVC-G062, JCTVC-G697): JCTVC-G697 (0.55% gain) give best results, which is an extension of JCTVC-G778. For fixed filters, the problem of ripples (both in spatial and frequency) needs to be solved which is a problem with the current interpolation filters (particularly when SAO is off). It is said that other (e.g. shorter) filters investigated also have some problems with this regard.

There was general agreement from a design point of view that it would be desirable to keep any switching between different filters to a minimum (except for the subpel positions), as it would complicate motion estimation and compensation.

Adaptive resolution 1/2 | 1/4 | 1/8 (JCTVC-G535, JCTVC-G277, JCTVC-G727) gives mainly gain for LD P case and there only for some sequences, but there are losses in other cases. JCTVC-G277 is the best proposal in this category. Performance seems to be rather non-uniform over different sequences. Also there seems to be no doubt that this increases complexity (additional 1/8-pel filters, loading of coefficients). No support was expressed except by proponents.

AIF (JCTVC-G258, JCTVC-G259, JCTVC-G057, JCTVC-G063) mainly shows benefit when SAO is off (on average not more than 0.2..0.3% when SAO is on). Filter coefficients need to be changed/reloaded eventually per PU – clearly increasing complexity. No support was expressed except by proponents.

Memory bandwidth reduction (JCTVC-G390, JCTVC-G391, JCTVC-G392, JCTVC-G770, JCTVC-G780): JCTVC-G780 could be implemented in a “non-normative” way if it was only applied for luma. JCTVC-G392c is also “non-normative”. The memory bandwidth is said to be increased (see JCTVC-F487) compared to AVC (as luma is 8 instead of 6 tap filters which increases 40%, and chroma is 4 instead of 2 tap which increases by factor of 3). It is agreed that the memory bandwidth of motion compensation is approximately 60+% higher than for AVC (although this may need more study).

Note: “Non-normative”, as used above, refers to the decoder operation, but may involve imposing normative restrictions on the bitstream.

It is agreed that memory bandwidth of motion comp is a problem particularly for 4K and beyond. It would however be desirable not to modify tools for this purpose but rather to use methods of level restrictions; for example restricting usage of small PUs, restricting usage of 2D interpolation, restricting subpel accuracy vector values, etc. It was suggested to establish an AHG on this issue.

Follow-up discussion was held in plenary Wed morning:

- It is confirmed that using different tools at different levels would not be desirable
- How does this relate with the increased capability of parallelism in HEVC? Is it necessary at all? Several experts argue that this is the case, as also multi-core processors often need to access the same memory.
- Out of a similar purpose, 4x4 PUs were removed during the last meeting. Was this justified? (it was answered that this only produced a bit rate increase of 0.1–0.2% on average, which was acceptable to keep the consistency of the design over all levels).
- It is also mentioned by S. Wenger that it may be necessary to re-consider definition of levels under the paradigm of assuming increased parallelism.

Discussion: Would it be desirable to define additional testing conditions where mode decision is made without the result of motion compensation (as this may likely not be used in practice)? After discussion, there is agreement that we should stick with the current anchor settings, as it is beyond our purpose to consider the variety of possible optimizations and restrictions in the implementation of the standard.

4.3.2 Contributions

JCTVC-G057 CE3: An Adaptive Interpolation Filtering Technique [F. Kossentini, N. Mahdi, H. Guermazi, M. Horowitz (eBrisk Video Inc.)]

In this contribution, an Adaptive Interpolation Filtering (AIF) technique is proposed for interpolation filtering of the luminance samples of video sequences. For each video picture, the encoder first generates two new one-dimensional 8-tap filters: one ½-pel filter and another (¼-pel, ¾-pel) filter, also called a ¼-pel filter. Then, the encoder decides, for each reference picture, whether to use the HM 4.0 default ½-pel filter *or* the new ½-pel filter, and whether to use the HM 4.0 default ¼-pel filter *or* the new ¼-pel filter. The encoder then sends the resulting two-bit value of the *luma_filter_mode* field to the decoder. Compared to HM4.0, the proposed technique yields average BD-rate reductions of 2.5% for LDP/LC, 0.5% for LDP/HE, 0.8% for LD/LC, 0.0% for LD/HE, 0.4% for RA/LC and 0.0% for RA/HE, while maintaining the same average decoding times. The encoding time, however, increases by an average of 4%.

JCTVC-G395 CE3: Cross check for eBrisk's proposal JCTVC-G057 (tool 6) [K. Kondo, T. Suzuki (Sony)]

JCTVC-G058 CE3: Interpolation using different-length horizontal and vertical filters [F. Kossentini, N. Mahdi, H. Guermazi, M. Horowitz (eBrisk Video Inc.)]

In this contribution, an interpolation filtering technique is proposed for the motion compensation interpolation filtering of the luminance and chrominance samples of video sequences. This proposal consists of using one set of fixed vertical filters (V_F) for the vertical stage of filtering and a second set of fixed horizontal filters (H_F) for horizontal stage of filtering. Compared to HM4.0, the proposed technique yields average BD-rate impacts of −0.7% for LDP/LC, −0.2% for LDP/HE, −0.1% for LD/LC, 0.0% for LD/HE, 0.2% for RA/LC and 0.0% for RA/HE, while decreasing the decoding complexity. This technique reportedly reduces the required number of multiplications and additions by 5% and 6%, respectively.

JCTVC-G063 CE3: Adaptive interpolation using different-length horizontal and vertical filters [F. Kossentini, N. Mahdi, H. Guermazi, M. Horowitz (eBrisk Video Inc.)]

In this contribution, an Adaptive Interpolation Filtering (AIF) technique is proposed for interpolation filtering of the luminance samples of video sequences. This proposal consists of using one set of vertical filters (V_F1/2 and V_F1/4) for the vertical stage of filtering and a second set of horizontal filters (H_F1/2 and H_F1/4) for horizontal stage of filtering. Each one of the used filters may be a default fixed or a newly-generated filter and where the encoder first generates four new one-dimensional filters: one ½-pel (6-tap) filter for vertical filtering stage, one ½-pel (8-tap) filter for horizontal filtering stage, one (¼-pel, ¾-pel) (7-tap) filter for vertical filtering stage and another (¼-pel, ¾-pel) (7-tap) filter for horizontal filtering stage. Then, the encoder decides, for each reference picture, and for each filtering direction (horizontal or vertical) whether to use the corresponding default ½-pel filter or the new ½-pel filter, and whether to use the corresponding default ¼-pel filter or the new ¼-pel filter. The encoder then sends the resulting two-bit value of the luma_filter_mode field to the decoder.

Compared to HM4.0, the second proposed technique yields average BD-rate impacts of −2.7% for LDP/LC, −0.4% for LDP/HE, −0.5% for LD/LC, 0.3% for LD/HE, −0.4% for RA/LC and −0.1% for RA/HE, while decreasing the decoding complexity. This technique reportedly reduces the required number of multiplications and additions by 5% and 6%, respectively.

JCTVC-G821 CE3: Cross-check for eBrisk proposals on interpolation MC by Samsung. [E. Alshina, J.H. Park] [late]

JCTVC-G258 CE3: LCU-based adaptive interpolation filter [S. Matsuo, S. Takamura, H. Jozawa (NTT)]

This document reports the performance of an LCU-based adaptive interpolation filter that adjusts filter coefficients based on the characteristics of the input video signal. In the proposed method, a frame is segmented into multiple regions, and filter coefficients for each region are derived. The basic idea is that filter coefficients are designed for each region in a frame when the frame consists of multiple regions with different characteristics. The proposal was implemented in HM4.0 software to evaluate its performance. Compared to the HM4.0 anchor, the overall average coding gain was reportedly about 0.52%. The detailed coding gains for RA-HE, LB-HE, LP-HE, RA-LC, LB-LC and LP-LC were 0.05%, −0.02%, 0.1%, 0.4%, 0.5% and 2.1%, respectively. The maximum coding gain was about 10.0% for the sequence "Vidyo3" in LP-LC case. The runtimes for the encoder and decoder were 100.93% and 101.69% on average, respectively.

JCTVC-G379 CE3:Cross-check report of LCU-based adaptive interpolation filter (JCTVC-G258) [T. Yoshino, S. Naito (KDDI)]

JCTVC-G277 CE3: Progressive Motion Vector Resolution [J. An, X. Li, X. Guo, S. Lei (MediaTek)]

In JCTVC-F125, a progressive MV resolution (PMVR) method was proposed, which uses higher MV resolution near to the MV predictor (MVP) value and lower MV resolution far from the MVP value. Thresholds for 1/4- and 1/8-pixel resolution were used to indicate the range of corresponding MV resolutions. This contribution presents the results of PMVR method on top of HM4.0. For PMVR without 1/8-pixel resolution, it is reported that by using different thresholds, average BD-Rate reduction of 0.2% can be achieved with around 9% encoding time decrease for RA and LB cases, and average BD-Rate reduction of 0.1% can be achieved with around 4% encoding time decrease for LP case. For PMVR with 1/8-pixel resolution, it is reported that by using different thresholds, average BD-Rate reduction of 0.5% with around 8% encoding time decrease can be achieved for RA and LB cases, and average BD-Rate reduction of 2.6% with 5% encoding time increase can reportedly be achieved for LP case.

JCTVC-G178 CE3: Cross-check report for Tool 10 on Progressive MV Resolution [S. Park, B. Jeon (LGE)]

JCTVC-G189 CE3: Cross-verification result of Tool 10 [K.Kazui (Fujitsu)]

JCTVC-G534 CE3: Cross-check report of Tool 10 (Progressive MV resolution) by Panasonic [T. Sugio, T. Nishi(Panasonic)]

JCTVC-G390 CE3: MC boundary filter (tool 7) [K. Kondo, T. Suzuki (Sony)]

This contribution reports results of MC boundary filter (MBF) which is studied in core experiment (CE) 3. To reduce complexity both memory bandwidth (b/w) and computation, the MBF uses different filter

coefficients mear the MC block boundary. With the proposed method, the memory b/w can reportedly be reduced −44% and −17% for worst and actual in common test condition. The computation of multiplications can be reduced −28% and −9% for worst and actual case. The impact for coding efficiency are 0.3%, 0.2%, 0.3%, 0.1%, 0.3%, and 0.2% for RA_HE, RA_LC, LD_HE, LD_LC, LDP_HE and LDP_LC. The combination MBF with a restriction of PU 8x4 and 4x8 bi-prediction is additionally tested. The worst memory b/w can be reduced −58%. The impact for coding efficiency are 0.4%, 0.4%, 0.6%, 0.4%, 0.1%, and 0.1% for RA_HE, RA_LC, LD_HE, LD_LC, LDP_HE and LDP_LC.

JCTVC-G428 CE3: Cross-check report for Sony's tool 7 (JCTVC-G390) [T.Chujoh (Toshiba)]

JCTVC-G391 CE3: Tap length reduction for small block (tool 8) [K. Kondo, T. Suzuki (Sony), K. Ugur (Nokia)]

This contribution reports results of MC boundary filter (MBF) which is studied in core experiment (CE) 3. To reduce complexity both memory bandwidth (b/w) and computation, the MBF uses different filter coefficients to MC block boundary. With the proposed method, the memory b/w can reportedly be reduced −44% and −17% for worst and actual in common test condition. The computation of multiplications can be reduced −28% and −9% for worst and actual case. The impact for coding efficiency are 0.3%, 0.2%, 0.3%, 0.1%, 0.3%, and 0.2% for RA_HE, RA_LC, LD_HE, LD_LC, LDP_HE and LDP_LC. The combination MBF with a restriction of PU 8x4 and 4x8 bi-prediction is additionally tested. The worst memory b/w can be reduced −58%. The impact for coding efficiency are reported as 0.4%, 0.4%, 0.6%, 0.4%, 0.1%, and 0.1% for RA_HE, RA_LC, LD_HE, LD_LC, LDP_HE and LDP_LC.

JCTVC-G250 CE3: Cross-check of JCTVC-G391 on MC memory band-width reduction (tool8) from Sony [E. François (Canon)] [late]

JCTVC-G427 CE3: Non-uniform tap length filtering (tool 2) [T.Chujoh, T.Yamakage (Toshiba)]

An experimental result of non-uniform tap length filters is reported. This is one of proposals of CE3 on motion compensation. The worst cases of complexity of interpolation process are two dimensional quarter pixel positions. The shorter tap length filters are introduced in those cases. As an experimental result, the gain coding efficiency is an average of 0.12%. The complexity analyses of 8/7-tap non-uniform tap length filters show worst case of computational complexity and average of computational complexity and memory bandwidth are reduced from them of 8-tap DCT-IF.

JCTVC-G393 CE3: Cross check for Toshiba's proposal JCTVC-G427 (tool 2) [K. Kondo, T. Suzuki (Sony)]

JCTVC-G535 CE3: Experimental Result on Tool 9 (Picture Adaptive 1/8-pel Motion Compensation Method) [T. Sugio, T. Nishi (Panasonic)]

This contribution is a report of CE3 experiment Tool 9 in JCTVC-F903. Experimental results reportedly showed 2.3% BR saving for HE and 2.0% BR saving for LC on average in the LD P scenarios. It also reportedly showed 0.2% BR saving for HE and 0.3% BR saving for LC in the RA scenarios, and 0.1% BR saving for LC on average in the LD B scenarios relative to the HM4.0.

JCTVC-G137 CE3 : Cross-check of Panasonic's Picture Adaptive 1/8-pel Motion Compensation : Test2b (F472) [S. Park (ETRI)]

JCTVC-G672 CE3: Crosscheck for Panasonic's Picture Adaptive 1/8 MC in JCTVC-G535 [J. An, X. Guo (MediaTek)]

JCTVC-G696 CE3: Fixed interpolation filter tests by Motorola Mobility [J. Lou, K. Minoo, D. Baylon, L. Wang, A. Luthra (Motorola Mobility)]

This document reports the results of Motorola Mobility's interpolation filters for HEVC. The simulations were conducted using HM4.0 software with Motorola Mobility's modifications. Four sets of fixed interpolation filters are tested. Compared with the current interpolation filter in HM4.0, the proposed 6-tap half-pel filter with 7-tap quarter-pel filter scheme with 13/64 offset achieves 0.0%, 0.3%, 0.1%, 0.2%, −0.3% and −0.4% bitrate differences in RAHE, RALC, LBHE, LBLC, LPHE and LPLC settings; the proposed 6-tap half-pel filter with 7-tap quarter-pel filter scheme with 3/16 offset achieves 0.4%, 0.9%, 0.3%, 0.5%, −0.4% and −1.2% bitrate differences in RAHE, RALC, LBHE, LBLC, LPHE and LPLC settings; the proposed 6-tap half-pel filter with 7-tap quarter-pel filter scheme with 15/64 offset achieves −0.1%, 0.0%, 0.1%, 0.2%, 0.3% and −0.3% bitrate differences in RAHE, RALC, LBHE, LBLC, LPHE and LPLC settings; the proposed 8-tap half-pel filter with 8-tap quarter-pel filter scheme with 3/16 offset achieves −0.1%, −0.3%, 0.1%, −0.4%, −0.8% and −0.3% bitrate differences in RAHE, RALC, LBHE, LBLC, LPHE and LPLC settings. Cross-check will be provided by Samsung.

JCTVC-G697 CE3: Joint sub-pixel interpolation filter tests for bi-predicted motion compensation by Motorola Mobility [J. Lou, K. Minoo (Motorola Mobility)]

This document reports the results of a Motorola Mobility proposal for Joint Sub-Pixel Interpolation Filters (JSPIF) for bi-predicted motion compensation for HEVC. The simulations were conducted using HM4.0 software with proposed modifications. Three sets of 6-tap fixed interpolation filters for bi-predicted motion compensation are used. For uni-prediction, 8H+7Q fixed filters with 3/16 offset are used. Compared with the current interpolation filter in HM4.0, set0 without bug-fix achieves −0.3%, −0.3%, −0.8% and −0.8% bitrate differences in RAHE, RALC, LBHE and LBLC settings; set1 without bug-fix achieves −0.2%, −0.2%, −0.7% and −0.7% bitrate differences in RAHE, RALC, LBHE and LBLC settings; set2 without bug-fix achieves −0.4%, −0.4%, −0.8% and −0.7% bitrate differences in RAHE, RALC, LBHE and LBLC settings; set2 with bug-fix achieves −0.4%, −0.3%, −0.8% and −0.7% bitrate differences in RAHE, RALC, LBHE and LBLC settings; All the three sets achieve −0.8% and −1.3% bitrate differences in LPHE and LPLC settings.

Some concern was expressed about additional complexity particularly for hardware. Depending on implementation, cost could be roughly 2x chip size for MC, depending on implementation.

No support was expressed except by proponents.

JCTVC-G820 CE3: Cross-check for Motorola Mobility proposals on interpolation MC by Samsung. [E. Alshina] [late]

In total, this proposal uses 11 different filters. It was estimated that this is 4x more complex, although it might not be a problem for software. The most gain was reported to be for the BQSquare test sequence.

JCTVC-G727 CE3: Adaptive resolution on motion vector difference [W.-J. Chien, X. Wang, M. Karczewicz]

This contribution presents a coding method to signal the resolution of the motion vector difference. The motion accuracy of the motion vector difference can be adaptively selected to be two different accuracy and signaled via a motion resolution flag. A joint coding of motion resolution flag and motion vector difference are also proposed. Two adaptations, half-pel/quarter pixel and quarter pixel/one-eighth pixel, are tested. Experimental results reportedly show 0.2% and 0.3% BD-rate saving on the adaptation of half-pel/quarter pixel and quarter pixel/one-eighth pixel, respectively. 2.5% BD-rate saving is observed for low delay P configuration with the adaptation of quarter pixel/one-eighth pixel.

JCTVC-G671 CE3: Crosscheck for Qualcomm's Adaptive MVD Resolution in JCTVC-G727 [J. An, X. Guo (MediaTek)]

JCTVC-G342 CE3: Cross-verification of Qualcomm's adaptive motion vector resolution (JCTVC-G727) by Intel [Y. Chiu, W. Zhang, L. Xu, Y. Han (Intel)]

JCTVC-G775 CE3: 7Q6H taps interpolation filters test by Samsung [E. Alshina, A. Alshin, J.H. Park (Samsumg)]

This is CE response from Samsung. The following combination: 7 taps quarter-pel and 6 taps half-pel interpolation filter was tested. In average across 6 test cases RA-HE/LC, LD-HE/LC and LD(P) –HE/LC this combination provides 0.07%(Y) −0.11% (U) −0.19% (V) BD-rate change (drop in Luma and gain for Chroma). Computation complexity of MC for this filter approaches to AVC interpolation filter which is 13% and 16% less in terms of number of mults and adds compare to HM4.0.

JCTVC-G394 CE3: Cross check for Samsung's proposal (tool 1) [K. Kondo, T. Suzuki (Sony)]

JCTVC-G695 CE3: Cross-check report for Samsung's interpolation filter 6H+7Q (JCTVC-G775) [J. Lou, K. Minoo, L. Wang (Motorola Mobility)]

JCTVC-G778 CE3: 7 taps interpolation filters for quarter pel position MC from Samsung and Motorola Mobility [E. Alshina, A. Alshin, J.-H. Park, (Samsung), J. Lou, K. Minoo, (Motorola Mobility)]

Two variants of 7 tap interpolation filters for quarter-pel position are tested here. Both were asserted to resolve a visual artifacts problem in the LD(P)-LC, SAO off test. Both show performance improvement compare to HM4.0. An average BD-rate for Y/U/V components across 6 test cases required in CE3: −0.1%/ −0.1%/−0.2% for variant A and −0.4%/0.0%/0.0% for variant B. Two variants of proposed 7 taps filters use different phase shift (1/4 for variant A and 3/16 for variant B) which results in the same worst case computational complexity and memory access while different hit-ratio for fractional position in MC process and so different statistical computation complexity was observed. For variant A the number of computations according to CE3 measure is 5–6% smaller compare to HM4.0. Variant B shows 1–2% higher computational complexity compare to HM4.0

Gain was reported for LD P only: 1/4 HE 0.1 LC 0.5; 3/16 HE 0.8 LC 1.3.

It was requested to be clarified whether there is visual advantage for ALF/SAO off and LD P, and no disadvantage for other cases. It was suggested to organize a viewing session and discuss the subject further after that.

A Report about the test was included in JCTVC-G033.

A test was performed at QP37 (with smaller QP, the artifacts would probably not have been visible).

Decision: Adopt Filter A.

JCTVC-G059 CE3: Cross-Verification of Samsung/Motorola's interpolation filter variant B (JCTVC-G778) [F. Kossentini, N. Mahdi (eBrisk Video Inc.)]

JCTVC-G636 CE3: Cross-Verification of Samsung/Motorola's interpolation filter variant A [K. Ugur, O. Bici (Nokia)] [late]

JCTVC-G780 CE3: The worst case memory band-width reduction by 2D->1D interpolation replacement (from Samsung). [E. Alshina, A. Alshin, J. Chen, J.H. Park (Samsung)]

High memory access during motion compensation is the main drawback for both bi-prediction and long-taps interpolation filters. In this contribution motion compensation process in bi-prediction is modified to reduce memory access: a motion vector which requires high memory access is replaced by nearest one with acceptable level for memory access.

4.4 CE4: Quantization

4.4.1 Summary and general discussion

JCTVC-G034 CE4: Summary report of Core Experiment on Quantization [K. Sato, M. Budagavi, M. Coban, H. Aoki, X. Li (CE coordinators)]

This document reports activity related to Core Experiment on Quantization (CE4).

This CE contained 3 subtests as follows:

- Subtest 1: QP Coding
- Subtest 2: De-quantization process modification
- Subtest 3: Quantization matrices

All mandatory results had been verified by cross-checkers.

Review of subtest 1:

JCTVC-G721 proposes QP control below the CU level (at TU level for TU larger than a particular size) – emphasis on visual quality (BD rate impact was not an improvement in this CE test, relative to the anchor). No action – for further study.

JCTVC-G773 proposes finer quant step size granularity (seems similar to proposal JCTVC-G850 in subtest 2 below).

Next idea tested is for prediction of QP value: HM uses left prediction unless not available; otherwise last in decoding order.

Anchor is "Step 3 of TM 5" (region characteristic-based QP control for visual quality – no buffer fullness feedback).

Proposals include taking into account things like modes, motion vectors, and intra prediction directions.

It was suggested to focus on 1.3.c (JCTVC-G067) and 1.4 as the best possibilities (0.4% benefit), but higher complexity than current method. But it was pointed out that 1.4 has temporal QP prediction, so it would have loss resilience issues.

It was remarked that this is emphasizing QP control for visual characteristics, while QP control for buffer fullness purposes is a different kind of usage – in that usage, predicting from the last QP in decoding order might be better.

It was suggested to make the qp prediction modal – having one mode that is more friendly to buffer control (changing QP and having that "stick" permanently).

Straw man: two modes (SPS level selection):

- Always using the preceding CU QP in coding order (+0.2%, measured previously).
- other mode is "1.3.c" (−0.4%) or HM 4 (0.0%), which one TBD.

After discussion, the group wanted to simplify this to just use the preceding QP in scan order. There was then a submission of JCTVC-G1028, and after further discussion, it was agreed to keep the WD and software stable for this meeting and to test two schemes in CE work:

- Always use the preceding CU QP in scan order
- HM 4 with reset to preceding CU QP in scan order at LCU boundary
- JCTVC-G1028

Review of subtest 2: Three proposals in this subtest:

- AQO (JCTVC-G278), one offset per colour component per frequency (offset is scaled by quantization weighting matrix entry and by step size as a function of QP)
- ARL (JCTVC-G382)
- Fine-QP (JCTVC-G843) – encoder can customize the scaling difference for a QP increment.

These proposals, along with a non-CE proposal, a modified Fine-QP scheme (JCTVC-G850), were tested in four ways.

Test results were not provided for some of the cases that were more difficult to test.

Comments in cross-check document JCTVC-G403:

- Most of the gain was from non-normative modifications.
- Did not seem to work with low QP. It was remarked that JCTVC-G278 did not exhibit this phenomenon. In the other two cases, the proponents had worked to address this issue with an encoder-only modification for JCTVC-G382, and with the modified fine QP proposal JCTVC-G850.
- Effects on luma and chroma somewhat different. Chroma gain is larger than luma gain.

It was suggested to emphasize consideration of JCTVC-G382 and JCTVC-G850.

Gain from normative aspect was estimated at 0.4% for luma and 4% for chroma.

(This was prior to new assertions reported together a newer revision of JCTVC-G403 as discussed below.)

There was a desire to understand the complexity impact (with quant matrix), including any dynamic range impact.

A BoG (chaired by M. Budagavi) was asked to study the complexity impact, and the subject was discussed again. Also see notes for JCTVC-G773.

The BoG report commented that an additional Intra/Inter parameter is needed to support JCTVC-G382. JCTVC-G382 also uses sgn() and abs() in the dequant equation. No consensus was reached in the BoG on the complexity impact of these. This was further discussed and effect of this was not considered to be significant.

It was commented that QP scaling is being done at a finer level. Will this be required if quantization matrices are used? Flat quantization matrices can also achieve QP scaling at a finer level.

A modified version of JCTVC-G382 was cross-checked in JCTVC-G1045 (RDO-Q On BD-Rate matches, code was studied). Modified version of JCTVC-G850 was cross-checked in JCTVC-G1040 (BD-Rate match was observed, and code was studied).

The JCTVC-G403 cross-checker commented that an updated version of their document asserts that all of the gain reported in JCTVC-G382 could be achieved by non-normative modifications only.

Comments: First test: Second bit-allocation in cross-check document JCTVC-G403 was asserted to be not constrained within 2%. CE submissions were reported to be within 2%. Second test: Encoder-only test reports more gain with a "two pass" algorithm.

Comments: Concerns were expressed with regards to complexity at the slice level. In worst case bitstreams, there could be many slices in bitstreams.

Suggestions: Study the RDOQ off case. What is the complexity impact? (On decoder side and on encoder side.) Also for the RDO-On case.

For further study in CE.

Comments: It would be interesting to study using period of 8 and period of 16 for quantizer step size doubling, rather than the current doubling period of 6.

JCTVC-G773:

Comments: It was asserted that the dQP rate could increase when QP starts changing.

Comments: Introduces functionality that allows for QP to change at a finer scale.

Comments: Asserted that JCTVC-G773 could be implemented using JCTVC-G850.

Comments: JCTVC-G773 was tested with perceptual quantization and not bit-rate control.

Comments: Provides new functionality, but the functionality is not proven.

Comments: In some implementations, this could lead to a doubling of quant matrix tables.

For further study in a CE.

Subtest 3: Quantization matrices

Three methods were evaluated:

- Same as AVC
- JCTVC-G083
- JCTVC-G434

It was recommended to adopt (slightly simplified) AVC method (SPS and PPS) as described in JCTVC-G434 as a starting point (no text was found! – T. Suzuki was asked to provide this – then a revised version of JCTVC-G1016 -v4 provided this). For non-square cases, use the even numbered column entries of the next larger square matrix.

Decision: Agreed.

Should we do something about big block sizes? For further study.

4.4.2 Contributions

Subtest 1 (delta QP)

JCTVC-G721 CE4 Subtest 1.1.a: QP adaptation at sub-CU level [Xue Fang, Jae Hoon Kim, Krit Panusopone, Limin Wang (Motorola Mobility)]

JCTVC-G071 CE4 Subset 1.1.a: Cross-verification of delta QP coding at sub_CU level from Motorola (JCTVC-F577) [R. Sjoberg, J. Sun (Ericsson)]

JCTVC-G113 CE4 Subtest 1.1.a: Cross-verification of Motorola's QP adaptation at sub_CU level (JCTVC-F577) [K. Chono, H. Aoki (NEC)]

JCTVC-G462 CE4 subset 1.2.a: results of Max/Min QP signaling [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]

JCTVC-G054 CE4 Subtest1.2.a: Study and cross-verification of Mitsubishi's signaling of Max and Min QP in slice (JCTVC-F174) [K. Chono, H. Aoki (NEC)]

JCTVC-G070 CE4 Subset 1.2.b: Ericsson's table-based delta QP coding method [R. Sjoberg, J. Sun (Ericsson)]

JCTVC-G055 CE4 Subtest 1.2.b: Cross-verification of Ericsson's table-based delta QP coding method (JCTVC-G70) [K. Chono, H. Aoki (NEC)]

JCTVC-G773 CE4 Subtest 1.2.c: Higher granularity of quantization parameter scaling [T. Lee, J. Chen, J. H. Park (Samsung), K. Chono (NEC)]

JCTVC-G508 CE4: cross-check result of subtest 1.2.c [K. Sato (Sony)]

JCTVC-G363 CE4: Improvement of delta-QP coding (1.3.a) [J. Xu, K. Kondo, K. Sato, A. Tabatabai (Sony)]

JCTVC-G755 CE4: Crosscheck of Sony's improvement of delta-QP coding [X. Zheng (HiSilicon)] [late]

JCTVC-G066 CE4 Subtest 1: Spatial QP prediction based on intra prediction (test 1.3.b) [H. Aoki, K. Chono (NEC), M. Kobayashi, M. Shima (Canon)]

JCTVC-G460 CE4 subset 1.3.b: crosscheck of QP prediction based on intra prediction [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]

JCTVC-G067 CE4 Subtest1: test 1.3.c [H. Aoki, K. Chono (NEC), M. Kobayashi, M. Shima (Canon), K. Sato (Sony)]

JCTVC-G313 CE4 Subtest 1.3.c: cross-verification of JCTVC-G067 [Y. Yasugi (Sharp)]

JCTVC-G731 CE4 Subtest 1.3.c: cross-verification of JCTVC-G067 [M. Coban (Qualcomm)] [late]

JCTVC-G728 CE4 Subtest 1: Spatial QP prediction (test 1.3.e): combination of test 1.3.b and test 1.3.d [M. Coban, M. Karczewicz (Qualcomm)]

JCTVC-G726 CE4 Subtest 1.3.d: Cross-check report for Qualcomm's JCTVC-G728 by Motorola Mobility [K. Panusopone (Motorola Mobility)]

JCTVC-G073 CE4: Cross-check of Subtest 1.3.e - Spatial QP prediction [C. Yeo (I2R)]

JCTVC-G068 CE4 Subtest1: QP prediction based on intra/inter prediction (test 1.4) [H. Aoki, K. Chono (NEC), M. Coban, M. Karczewicz (Qualcomm)]

JCTVC-G461 CE4 subset 1.4: crosscheck of QP prediction based on intra/inter prediction with QP buffer compression [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]

Subtest 2 (de-quantization offset)

JCTVC-G278 CE4 Subtest 2: Adaptive-Dequantization Offset [X. Li, X. Guo, S. Lei (MediaTek)]

JCTVC-G901 CE4 Subtest 2.1.b: Cross-verification of JCTVC-G278 [M. Yang (Huawei)] [late]

JCTVC-G074 CE4: Cross-check of Subtest 2 on de-quantization offset (2.1.a, 2.3.d) [C. Yeo (I2R)]

JCTVC-G140 CE4: Subtest 2.1.c Cross Check Report for Mediatek's AQO CaseC by HKUST [F. Zou, O.C. Au (HKUST)]

JCTVC-G660 Cross-check of MediaTek's CE4 Subtest2.1 Adaptive Quantization Offset [X. Yu, D. He (RIM)]

JCTVC-G382 CE4 Subtest-2 Adaptive Reconstruction Levels [X. Yu, J. Wang, D. He, G. M.Cocher, E. Yang (RIM)]

JCTVC-G141 CE4: Subtest 2.2.d Cross Check Report for RIM's ARL Case D by HKUST [F. Zou, O.C. Au (HKUST)]

JCTVC-G403 CE4-Subtest-2 Cross-check of Adaptive Reconstruction Levels for Quantization Design (JCTVC-G382) [B. Li (USTC), J. Xu, G. J. Sullivan (Microsoft)]

JCTVC-G902 CE4 Subtest 2.1.b: Cross-verification of JCTVC-G382 [M. Yang(Huawei)] [late]

JCTVC-G557 CE4.2.A: Cross-check of RIM's ARL [X. Li, X. Guo (MediaTek)] [late]

JCTVC-G823 CE4: Cross-check for ARL from RIM by Samsung [E. Alshina, J.H. Park] [late]

JCTVC-G843 CE4: Fine granularity QP offset [X. Wang, R. Joshi, G. Auwera, M. Karczewicz (Qualcomm)]

JCTVC-G560 CE4.3.A: Cross-check of Qualcomm's fine-QP [X. Li, X. Guo (MediaTek)] [late]

JCTVC-G662 Cross-check of QualCom's CE4 Subtest2.3 Fine QP [X. Yu, J. Wang, D. He (RIM)]

JCTVC-G400 CE4: Equal expected magnitude (EEM) encoder-only adaptive quantization rule for HEVC [B. Li (USTC), J. Xu, G. J. Sullivan (Microsoft)]

This contribution presents experiment results for a quantization method referred to as equal expected magnitude (EEM) quantization. The basic idea is from JVT-N011 (January 2005). When RDOQ is not used by the encoder, the experimental results reportedly show that the EEM quantization scheme can provide about a 6% bit rate savings for the low QP range of 2–17. As RDOQ substantially slows down the encoding process, it is suggested that EEM offers a useful alternative to RDOQ.

There was some difference in the described scheme relative to the original EEM proposal of JVT-N011.

The overall gain reported is about 0.55% (AI: 1.4%, RA: 0.7%, LB: 0.0%, LP: 0.1%) relative to RDOQ turned off for the common conditions. For the low QP range, the gain is substantially larger (AI: 2.2%, RA: 6.7%, LB: 6.8%, LP 5.6%).

RDOQ performs somewhat better (low QP results: AI: 3.7%, RA: 8.6%, LB: 9.3%, LP: 9.6%), but slows down the encoder substantially (17–38% slower).

It was remarked that the non-normative part of JCTVC-G382, as discussed in JCTVC-G403 (except for the low QP range), performs better than this and also does not significantly slow down the encoder, so maybe that should be put into the reference software instead of this.

Additionally, it was remarked that the two techniques can be used together to provide even more gain (perhaps 0.5% for the common conditions).

Decision (SW): It was agreed to adopt the non-normative part of JCTVC-G382 into the reference software.

Question: Should it be in the common conditions (together with RDOQ enabled)? Yes. Agreed.

Subtest 3 (quant matrices)

JCTVC-G083 CE4: Test results on compact representation of quantization matrices [M. Zhou, V. Sze (TI)]

JCTVC-G306 CE-4 Subset-3: Cross-check for TI's Proposal (JCTVC-G083) on Quantization Matrix [Z. Zhou, X. Zhang (MediaTek)]

JCTVC-G503 **CE4 Subtest 3.2: Crosscheck report of compact representation of quantization matrices proposed by TI (JCTVC-G083) [M. Shima (Canon)]**

JCTVC-G528 **CE4: Cross-Check report for CE4 subset3 of TI compact representation of quantization matrices (JCTVC-G083) [J. Zheng (HiSilicon)]**

JCTVC-G434 **CE4 subtest 3: Quantization matrix for HEVC based on JCTVC-F362 and F475 [Y. Morigami, J. Tanaka, T. Suzuki (Sony)]**

JCTVC-G303 **CE-4 Subset-3: Cross-check for Sony's Proposal (JCTVC-G434) on Quantization matrix [Z. Zhou, X. Zhang (MediaTek)]**

JCTVC-G502 **CE4 Subtest 3.1: Crosscheck report of AVC based quantization matrix support (JCTVC-G434) [M. Shima (Canon)]**

JCTVC-G505 **CE4 Subtest 3.3: Crosscheck report of Enhancement of quantization matrix coding of HEVC proposed by Sony (JCTVC-G434) [M. Shima (Canon)]**

JCTVC-G527 **CE4: Cross-Check report for CE4 subset3 of Sony proposal on Quantization matrix for HEVC (JCTVC-G434) [J. Zheng (HiSilicon)]**

4.5 CE5: CAVLC entropy coding improvement

4.5.1 Summary and general discussion

JCTVC-G035 **CE5: Summary report on CAVLC entropy coding improvements [X. Wang, P. Wu, C. Kim (CE Coordinators)]**

Considering action taken in regard to removing CAVLC from the design, the contributions in this area were not considered in detail.

4.5.2 Contributions

JCTVC-G310 **CE5: CAVLC Adaptation using Difference Counter [T. Yamamoto (Sharp)]**

JCTVC-G402 **CE5: Cross-check of CAVLC Adaptation using Difference Counter (JCTVC-G310) [B. Li (USTC), J. Xu (Microsoft)]**

JCTVC-G360 **CE5: Redundancy removal for Run-mode in CAVLC (JCTVC-F286) [J. Xu, A. Tabatabai (Sony)]**

JCTVC-G389 **CE5: CAVLC coding table modification [S. Kim, J. Lee, S. Lee (Yonsei Univ.), C. Kim, Y. Park, J. Park (Samsung)]**

JCTVC-G851 **CE5: Crosscheck of Yongsei and Samsung's contribution (JCTVC-G389) on CAVLC coding table modification [X. Wang (Qualcomm)] [late]**

JCTVC-G532 **CE5 2.1 : Improvement of CAVLC run- coding by prediction mode [C. Kim, Y. Park, K.P.Choi (Samsung)]**

JCTVC-G367 **CE5: cross-check for Samsung's CAVLC (JCTVC-G532) [J. Xu, M. Haque (Sony)]**

JCTVC-G563 **CE5 2.2 : Handling for exception cases longer than 32bit code-word in CAVLC [C. Kim, Y.Park, K.P. Choi(Samsung), M. Karczewicz, X. Wang, W.-J. Chien, L. Guo(Qualcomm)]**

JCTVC-G841 **CE5.2.2: Crosscheck for Samsung and Qualcomm's handling for exception cases longer than 32bit code-word in CAVLC in JCTVC-G563 [T.-D. Chuang, Y.-W. Huang (MediaTek)] [late]**

JCTVC-G674 **CE5: Sub-block coding of transform coefficients with CAVLC [M. Karczewicz, L. Guo, Y. Zheng, X. Wang (Qualcomm)]**

JCTVC-G340 **CE5: Cross-check of CAVLC coefficients coding (JCTVC-G674) [T. Yamamoto (Sharp)]**

JCTVC-G677 **CE5: Limitation on VLC codeword length [M. Karczewicz, X. Wang, W.J. Chien, L. Guo (Qualcomm)]**

JCTVC-G924 **CE5: Cross-verification of Qualcomm's proposal (JCTVC-G677) [C. Kim (Samsung)] [late]**

4.6 CE6: Intra prediction improvements

4.6.1 Summary and general discussion

JCTVC-G036 CE6: Summary Report on Intra Coding Improvements [A. Tabatabai, E. Francois, K. Chono, H. Yu, R. Joshi, J. Lainema]

This document provides a summary report of the Core Experiments (CE6) results on "Intra prediction and improvements". The experiments are divided into 4 subsets, as indicated below:

- Subset CE6a: Intra Chroma Prediction
  - CE6a.1 Modified down-sample filters T0L0I0 vs T0L2I2 some gain but longer filters
  - CE6a.2 Alpha and beta calculation complexity reduction
  - CE6a3 Reduction of Storage for Reconstructed Luma Pixels
- Subset CE6b: Intra Mode Coding
  - CE6b.1 MPM derivation
  - CE6b.2 Remaining mode coding
  - CE6b.3 Binarization of remaining mode coding
  - CE6b.4 Some different chroma stuff
  - CE6b.5 Combination of the above ideas JCTVC-G243 (AI HE 0.5% both in luma and chroma, most of which is from the first two techniques)

    It was suggested for a BoG [V. Sze] to dig into the details and report back on this and related non-CE proposals (JCTVC-G153, JCTVC-G145, JCTVC-G184, JCTVC-G119, JCTVC-G359, JCTVC-G358, JCTVC-G423)
  - CE6b.6 DCIM: Has some gain but substantial encoder complexity (16% runtime increase) – no action.
- Subset CE6c: Short Distance Intra Prediction (SDIP)
  - CE6c.1 HM 4 + SDIP (28% runtime increase)
  - CE6c.2 Fast non-square PU selection (encoder-only relative to CE6.2)
  - CE6c.3 NSQT related
  - CE6c.4 through CE6c.11 Several other SDIP related modifications
- Subset CE6ed: Intra Prediction with secondary boundary

CE6a.1 Modified down-sample filters: Best (T0L0I0 vs T0L2I2) has some gain (0.1% for luma and 0.3% for chroma) but longer filters. Seems like not enough gain.

CE6a.2 Alpha and beta calculation complexity reduction: Almost no loss was observed for 2:1 subsampling 16x16. It was commented that this does not help since it makes a special case out of a case that is not the worst case – whereas the worst case is 4x4.

It was noted that there is a relevant non-CE contribution by Canon (JCTVC-G244).

CE6a.3 Reduction of Storage for Reconstructed Luma Pixels – noting that the focus is now on the 8 bit case, which already is using 8 bit storage in this case – leaving it alone sounds reasonable.

Note also that the focus is now on the CABAC case – CAVLC is no longer particularly interesting.

CE6c. SDIP

Case 1: Performance of SDIP on HM AI HE: −1.35% (127% enc RT) → −2.14% (with class F)

Case 2: Each rectangular sub-PU are using different prediction mode −0.96% (113% enc RT) → −1.70 (with class F). case 2 is optimized mode selection vs. case 1

Case 3: All rectangular sub-PU are using same prediction mode for entire CU −0.96% (114% enc RT) → −1.39 (with class F)

Q: How are NSQT concerns on 8x2/2x8 throughput and coefficient scanning addressed as they also apply to SDIP? Expert comment that throughput for intra prediction may be more of an issue than inter prediction.

A: 16 sample block unit read for both 4x4 and 2x8/8x2.

Several experts noted gains desirable but requires discussion with hardware expert on complexity; multiple functions affected.

SDIP vs NSQT – SDIP has additional TUs, prediction affected

Similarity in spirit of SDIP and NSQT. Suggested separate profile to contain SDIP, NSQT, ALF, & SAO (?)

It was noted that, at the moment, NSQT does not have a syntax flag to disable its selection.

JCTVC-G556 was suggested as the primary document to review for study of SDIP.

Other SDIP related proposals that add about 0.4% (for luma AI) additional compression benefit (1.7% for chroma). There is a survey of this in JCTVC-G558.

Non-CE related SDIP-related contributions were noted JCTVC-G135, JCTVC-G354, JCTVC-G598.

CE6ed: Intra Prediction with secondary boundary handling

Various particular methods proposed.

Overall gain roughly 0.7% AI for the best-performing several of these (in terms of coding efficiency).

Some loss in some class F cases.

Filtering of one column or one row is the common theme between several of these approaches.

We already have a filtering for the DC mode. It was commented that this filtering makes that mode more difficult to vectorize.

Combinations 10 (combining 1, 7, and 8) and 13 were the primary group focus suggested during the discussion of the CE report. Combination 13 is more complex and has very slightly (0.1%) better compression. Only the proponent seemed to emphasize an interest in combination 13.

There are some related non-CE contributions with some possibilities for further improvement (e.g. for class F).

After further consideration, there seemed to be no problem with combination 10 relative to combination 13.

It was then suggested by a proponent to consider combination 11 as a less complex alternative to combination 10. It was then commented that combination 11 is not necessarily actually less complex.

In regard to the vectorization comment recorded above, it was commented that a transpose operation would be needed, and that the filtering for the planar mode was more of a complexity concern. The benefit of the filtering proposed to be added for the planar mode (test #8) was reported in the CE report as 0.1%. The filtering proposed for the planar mode is the same as the filtering applied for the DC mode.

The horizontal and vertical filtering gains alone (test #1), at 0.3%, provide roughly half of the total gain that is reported to be available, based on F172. Decision: Adopt this aspect.

Adding filtering for other various angles, JCTVC-F456 (test #7) has about 0.2% additional gain, and it applied the same type of filter to all of those other angles. There was very small gain in JCTVC-F456 for the "negative angles".

The π/4 (45º) diagonal case was also noted to be simpler to generate if treated as a special case in the decoder. However, it was suggested to avoid having special cases for different modes, such that all directions from 13º to 32º could be treated the same way by a decoder. If treated as a separate case, the special case treatment may need to be repeated for each block size.

No further action taken.

SDIP plenary discussion was held on Monday 28th (chaired by J.O.), with notes recorded as follows:

- 1.3% gain with the current version
- SDIP should be harmonized / unified with NSQT, which is not achieved yet
- Problem: So far NSQT and SDIP were discussed in different places
- Set up AHG to harmonize, with intention to have the unified solution in the standard by the next meeting.
- Basis for AHG is the “SDIP reference” JCTVC-G558 + JCTVC-G754. This is not to be further studied in CE. New SDIP proposals that build on top of this are to be investigated in CE6 (not in AHG)

4.6.2 Contributions

Experiment A

JCTVC-G129 CE6.a: Sub-sampling portion of neighboring pixels in calculation of LM parameters [M. Budagavi (TI), K. Sato (Sony)]

JCTVC-G297 CE6: Cross-check report for CE6a TI&Sony's proposal on Sub-sampling portion of neighboring pixels in calculation of LM parameters [H. Sasai, T. Matsunobu, T. Nishi (Panasonic)]

JCTVC-G172 CE6a: Modified down-sampling filter for LM mode of intra chroma prediction [Y. Chiu, Y. Han, L. Xu, W. Zhang, H. Jiang (Intel)]

JCTVC-G469 CE6a: Cross-check on LM mode of intra chroma prediction(JCTVC-G172) [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)] [late]

JCTVC-G455 CE6: results of filtering for LM_mode [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)]

JCTVC-G168 CE6: Cross-check report for Subtest CE6a on Intra Chroma Prediction [S. Cho, S. Lee (ETRI)] [late]

JCTVC-G169 CE6: Cross-check report for Subtest CE6a on Intra Chroma Prediction [S. Cho, S. Lee (ETRI)] [late]

JCTVC-G510 CE6.a: Result of Subtest 4.1.2.2 [K. Sato (Sony)]

JCTVC-G294 CE6: Cross-check report for CE6a Sony's proposal on Improvement to chroma intra prediction from luma [H. Sasai, T. Matsunobu, T. Nishi (Panasonic)]

JCTVC-G512 CE6: combination of subtest 4.1.2.1 & 4.1.2.2 [K. Sato (Sony)] [late]

JCTVC-G847 CE6: Cross-check results for combination of subtest 4.1.2.1 & 4.1.2.2 (JCTVC-G512) [S. Cho, S. Lee, N. Eum] [late]

Experiment B

JCTVC-G192 CE6b: Intra remaining mode coding with mode ranking [J. Park, B. Jeon (LG)]

JCTVC-G203 CE6b: Intra prediction mode coding [T.-D. Chuang, C.-Y. Chen, M. Guo, X. Guo, Y.-W. Huang, S. Lei (MediaTek), W.-J. Chien, X. Wang, M. Karczewicz (Qualcomm)]

JCTVC-G186 CE6: Cross-verification of MediaTek and Qualcomm's proposal (JCTVC-G203) by JVC KENWOOD [T. Kumakura, S. Fukushima (JVC Kenwood)]

JCTVC-G252 CE6b: Cross-check of JCTVC-G203 on intra mode coding from Qualcomm/MediaTek [E. François (Canon)] [late]

JCTVC-G242 **CE6b: Mode ranking for remaining mode coding with 2 or 3 MPMs [E. François, S. Pautet, C. Gisquet (Canon)]**

JCTVC-G243 **CE6b: Intra mode coding with 4 MPMs and mode ranking [E. François, S. Pautet (Canon), Joonyoung Park, Byeongmoon Jeon (LG), Tzu-Der Chuang, Ching-Yeh Chen, Mei Guo, Xun Guo, Yu-Wen Huang, Shawmin Lei (MediaTek), Wei-Jung Chien (Qualcomm), Ehsan Maani, Ali Tabatabai (Sony)]**

JCTVC-G311 **CE6b: Cross-check of Intra Mode Coding (JCTVC-G242 and JCTVC-G243) [T. Yamamoto (Sharp)]**

JCTVC-G869 **CE6: Combinations of MPM derivation and remaining mode coding [Ehsan Maani, Ali Tabatabai] [late]**

JCTVC-G080 **CE6: Cross-check report for Subtest CE6b on Intra Mode Coding [H. L. Tan, C. Yeo, Y. H. Tan (I2R)]**

JCTVC-G167 **CE6: Cross-check report for Subtest CE6b on Intra Mode Coding [S. Cho, S. Lee, N. Eum (ETRI)] [late]**

JCTVC-G276 **CE6: Cross-Check report for CE6b subtests of Intra Mode Coding (F062, F459, F091, F106, F269)) [G. Li, N. Ling (Santa Clara Univ.), L. Liu, J. Zheng, P. Zhang (Huawei)]**

JCTVC-G868 **CE6: Test results of DCIM [Ehsan Maani, Ali Tabatabai, Tomoyuki Yamamoto] [late]**

JCTVC-G789 **CE6.b Crosscheck for DCIM [C. Lai] [late]**

Experiment C

JCTVC-G142 **CE6.c: LM mode harmonization on SDIP [J. Lim, B. Jeon (LG)]**

JCTVC-G476 **CE6.c: Crosscheck for LG's LM mode harmonization on SDIP in JCTVC-G142 [T.-D. Chuang, Y.-W. Huang (MediaTek)]**

JCTVC-G143 **CE6.c: VLC improvement for intra partitioning on SDIP [J. Lim, B. Jeon (LG)]**

JCTVC-G478 **CE6.c: Crosscheck for LG's VLC improvement for intra partitioning on SDIP in JCTVC-G143 [T.-D. Chuang, Y.-W. Huang (MediaTek)]**

JCTVC-G800 **CE6.c Crosscheck report for LG's JCTVC-G142 and JCTVC-G143 [C. Lai] [late]**

JCTVC-G267 **CE6.c Report on SDIP chroma extension scheme [J. Song, C. Lai, H. Yang, H. Yu (Huawei)]**

JCTVC-G836 **CE6.c: Cross-verification of Huawei's SDIP chroma extension scheme (JCTVC-G267) [T. Lee, J. Chen, J. H. Park (Samsung)]**

JCTVC-G322 **CE6.c: Harmonization of HE residual coding with non-square block transforms [J. Sole, R. Joshi, X. Wang, M. Karczewicz (Qualcomm)]**

JCTVC-G797 **CE6.c Crosscheck report for JCTVC-G322 [C. Lai (HiSilicon)] [late]**

JCTVC-G890 **CE 6: Cross-check of JCTVC-G322 on harmonization of non-square residual coding [Marta Mrak, Andrea Gabriellini (BBC) [late]**

JCTVC-G556 **CE6.c Report on Simplification of Short Distance Intra Prediction (SDIP) Method [X. Cao, Y. He (Tsinghua), X. Peng (USTC), C. Lai, L. Liu, J. Zheng (HiSilicon), J. Xu (Microsoft), H. Yang, H. Yu (Huawei)]**

JCTVC-G558 **CE6.c Report on Combination of SDIP and Its Improvements [X. Cao, Y. He (Tsinghua), X. Peng (USTC), C. Lai, L. Liu, J. Zheng (HiSilicon), J. Xu (Microsoft), H. Yang, J. Song, H. Yu (Huawei), J. Lim, B. Jeon(LGE), J. Sole, R. Joshi, X. Wang, M. Karczewicz (Qualcomm), J. Xu, E. Maani, A. Tabatabai (Sony)]**

Contains multiple topics; some of it was in the CE and some is different.

JCTVC-G895 **CE6: Cross-verification of Combination of SDIP and Its Improvements (JCTVC-G558) [K. Chono, H. Aoki (NEC)] [late]**

JCTVC-G260 **CE6.c: cross-check of case 1, 2 and 3 (Huawei JCTVC-Gxxx) J. Jung (Orange Labs) [late]**

JCTVC-G369 **CE6.c: cross-check for SDIP (JCTVC-F532) [J. Xu, A. Tabatabai (Sony)]**

Experiment D

JCTVC-G279 **CE6 Subtest d: direction-based angular intra prediction [M. Guo, X. Zhao, X. Guo, S. Lei (MediaTek)] [late]**

JCTVC-G280 **CE6 Subtest d: Intra Prediction with Secondary Boundary [M. Guo, X. Guo, X. Zhao, S. Lei (MediaTek), J. Lainema, K. Ugur (Nokia), K. Sugimoto, S. Sekiguchi, A. Minezawa (Mitsubishi), J. Lee, S.-C. Lim, H.Y. Kim, J.S. Choi (ETRI)]**

JCTVC-G420 **CE6.d: Results of experiment 4.4.3 [J. Lee, S.-C. Lim, H. Y. Kim (ETRI)]**

JCTVC-G457 **CE6: Results of intra vertical and horizontal prediction [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)]**

JCTVC-G565 **CE6.d: Nokia report on intra prediction with secondary boundary [J. Lainema, K. Ugur (Nokia)]**

JCTVC-G081 **CE6: Cross-check report for Subtest CE6d on Intra prediction with secondary boundary (Test 7) [H. L. Tan, Y. H. Tan, C. Yeo (I2R)]**

JCTVC-G293 **CE6.d: Cross Check of Category 4 on Tool Combinations for Intra Prediction with Secondary Boundary [G. Van der Auwera (Qualcomm)]**

JCTVC-G361 **CE6.d: Crosscheck of JCTVC-F122 on gradient based intra prediction for vertical and horizontal set secondary boundary intra prediction from MediaTek [C. Auyeung (Sony)]**

JCTVC-G436 **CE6.d category 2: Cross-checking reports of intra prediction with secondary boundary (JCTVC-F172 and JCTVC-F456) [A. Tanizawa, T. Shiodera (Toshiba)]**

JCTVC-G561 **CE6d: Cross-check report on Intra prediction with secondary boundary (Test 7) (JCTVC-F456) [T Guionnet, L Guillo]**

JCTVC-G790 **CE6.d crosscheck [C. Lai] [late]**

4.7 CE7: Additional transforms

4.7.1 Summary and general discussion

JCTVC-G037 **CE7: Summary report of Core Experiment on additional transforms [R. Cohen, C. Yeo, R. Joshi, F. Fernandes] (CE coordinators)**

The purpose of Core Experiment 7 (CE7) is to characterize the performance, in terms of both compression efficiency and complexity, of several transforms other than those currently defined in HM 4.0. Three tools that operate on Intra blocks have been evaluated: A mode-dependent secondary transform applied for luma after the HM core transform (a unified Tool 1 and 2 from the CE description JCTVC-F907), a secondary rotational transform applied for luma after the HM core transform (Tool 3), and a mode-dependent DCT/DST for chroma (Tool 4), which replaces the HM core transform for chroma. This document provides a summary of activities and results for this core experiment.

Tools 1 and 2 were already similar – now a "unified" JCTVC-G108 secondary transform is proposed (mode-dependent selection of whether to apply a horizontal or vertical secondary transform, or both).

Tested with various sizes of secondary transform: performance in AI configuration saturates at 6x6 with 0.7% luma benefit, 4x4 transform (applied to intra block sizes from 8 to 32) has 0.5% luma benefit. In RA, 4x4 has 0.2% luma benefit. (Can be further extended to inter also, as reported in JCTVC-G632, and can be combined additively with SDIP as reported JCTVC-G629.)

It has a significant complexity impact.

It was remarked that the 8x8 case would be roughly as complex (or more complex) as the 32x32 case.

Gain is concentrated on higher-resolution sequences.

It was commented that latency is increased in some variations of this scheme; this is discussed in JCTVC-G108, which indicated that there is no additional latency in some hardware implementations with the 4x4 secondary transform.

The possibility of applying this only for 16x16 and 32x32 block sizes.

It was commented that for the 8x8 case, it would be faster to just apply one transform rather than a cascade of two of them.

No action due to concern over complexity and gain specific to AI use.

Further study as CE was suggested, including combination with inter.

Tool 3 JCTVC-G304 secondary rotational transform (switched with syntax)

More encoder complexity for searching than tools 1 & 2, 0.9% luma benefit.

Tool 4 JCTVC-G107 mode-dependent 4x4 DCT/DST for chroma (like what we have for luma).

In spirit, this is the same thing that we do for luma. Various particular decision-making methods were tested.

Gains generally in range of 0.5–0.7% in chroma only, helps in both RA and AI.

Test 5 seems the most straightforward.

Due to the desire for stability and the relative unimportance of chroma gains, no action taken.

4.7.2 Contributions

JCTVC-G108 CE 7: On secondary transforms for intra prediction residual [A. Saxena (Samsung), Y.Shibahara (Panasonic), F. Fernandes (Samsung), T.Nishi (Panasonic)]

JCTVC-G1018 Cross-check of modified JCTVC-G108 on secondary transforms for intra prediction residual [V. Seregin, R. Joshi (Qualcomm)] [late]

JCTVC-G075 CE7: Cross-check of Unified Tools 1 & 2 - Mode-Dependent Secondary Transform [C. Yeo, Y. H. Tan, Z. Li (I2R)]

JCTVC-G425 CE7: Cross-check of the unified design on mode-dependent secondary transform (JCTVC-G108) by Huawei [H. Yang, H. Yu (Huawei)]

JCTVC-G581 CE7: Crosscheck of combination of tool 1 and tool 2 for mode dependent secondary transform sizes 3x3 and 4x4 (JCTVC-G108) [R. Joshi (Qualcomm)]

JCTVC-G814 CE7: Cross verification of JCTVC-G108, On secondary transforms for intra prediction residual [R. Cohen (MERL)]

JCTVC-G888 **CE 7: Crosscheck of JCTVC-G108 on secondary transforms [Marta Mrak, Andrea Gabriellini (BBC)] [late]**

JCTVC-G930 **CE7: Cross check report of "On secondary transforms for intra prediction residual (JCTVC-G108)" [A. Ichigaya, (NHK)] [late]**

JCTVC-G304 **CE 7: Experimental Results for the ROT [Z. Ma, F. Fernandes, E. Alshina, A. Alshin (Samsung)]**

JCTVC-G375 **CE7: Cross Check Report for CE7 Tool 3, Rotational Only Transform [Y. Shibahara, T. Nishi (Panasonic)]**

JCTVC-G580 **CE7: Crosscheck of rotational transform (JCTVC-G304) [R. Joshi (Qualcomm)]**

JCTVC-G734 **CE 7: Crosscheck of JCTVC-G304 ROT Transform [P. Topiwala (FastVDO)]**

JCTVC-G107 **CE 7: Mode-Dependent DCT/DST for 4x4 Chroma Blocks [A. Saxena, F. Fernandes, E. Alshina, J. Chen (Samsung)]**

JCTVC-G076 **CE7: Cross-check of Tool 4 - DST for Intra Chroma Residual Coding [C. Yeo, Y. H. Tan, Z. Li (I2R)]**

JCTVC-G376 **Cross-check report of CE7 Tool 4, Mode-Dependent DCT/DST for 4x4 Chroma Blocks (JCTVC-G107) [Y. Shibahara, T. Nishi (Panasonic)]**

4.8 CE8: Non-deblocking loop filtering

4.8.1 Summary and general discussion

JCTVC-G038 **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 is reported. There are eight Subtests in CE8, Subtest a: Block level filter adaptation with directional feature (three proposals), Subtest b: Sub-frame delay adaptive loop filter (one proposal), Subtest c: Line Memory reduction in ALF and

SAO decoding (seven proposals), Subtest d: Filter shapes and coefficient constraints, for both luma and chroma (three proposals), Subtest e: Prediction of filter coefficients (three proposals), Subtest f: Filter switching reduction at LCU boundary for LCU friendly decoding (one proposal), Subtest g: Chroma filter control (one proposal) and Subtest h: Other in-loop filters (one proposal). These are evaluated based on the common test conditions in JCTVC-F900 and additional conditions in JCTVC-F908. All mandatory results are verified by cross-checkers.

Note: JCTVC-G038 v4 includes a Powerpoint deck with the results of the informal viewing.

According to the cross-checkers' comments and further study such as unification and harmonization in some subtests (i.e., CE8.a and CE8.c), it is suggested to consider those unification and harmonization to regard them as additional CE contributions. As for CE8.c, CE8 is planning to conduct an informal subjective viewing (at least for CE8.c.5, Non-CE8.c.6 and Non-CE8.c.7).

Results on "subtest 0" (encoder only) which shows that 1-pass ALF can be operated with 0.2% bit rate increase, and 2-pass with 0.1% bit rate increase, compared to the current 14-pass in HM (also JCTVC-G146 refers to that). Decide to use one of these (or switchable) for upcoming default settings (was reviewed in the BoG on ALF and decided after that). Adopt the method according to JCTVC-G038 table 2 right column (two-pass method) for the common test conditions (also JCTVC-G1023).

Subtest A:

Adaptation is on level of 4x4 blocks. JCTVC-G609 (−0.1/−0.2/−0.2/−0.4 for AI/RA/LDB/LDP). Has advantage of reduced line buffer from 5 to 4 due to reduced vertical filter size. The proposal uses 8 points instead of 4 for BA classification. In BA mode classification, it uses diagonal instead of hor/vert analysis for the star-shaped filter (hor/vert for cross-shaped still). With proper implementation (re-usage of results) this increases number of additions by 1.5. JCTVC-G316 (0.0/−0.1/−0.1/−0.1) proposes 2D merging instead of 1D (imposes syntax change); does this increase latency? JCTVC-G691 is a combination of both which shows that the gains are additive.

JCTVC-G656 is another combination of tools that was considered in this context.

JCTVC-G647 uses 8 classes in BA classification such that 8 filters are used instead of 16. This produces loss of 0.1%. Opinions: For high resolutions, larger number of classes may be needed. Restrictions could eventually be considered in the context of level definition

Decision: Adopt 4x4 classification, but not the other elements of JCTVC-G609 and JCTVC-G316 which would increase complexity. Keep number of classes 16 in BA classification.

General note: In ALF, modifications should target complexity reductions mainly; only proposals which are giving a decent gain/complexity benefit (regardless which direction should be considered); i.e. complexity decrease should not penalize and complexity increase should give sufficient gain.

Subtest B:

JCTVC-G498 Simplified ALF design. Only 5x5 diamond shape, no pixel classification, no DC offset. More coarse quantization and coding.

Current implementation does not process chroma and does not include slice boundary processing.

Looking at the loss of 1%, several experts expressed the opinion that we should not replace the current ALF by this. Note: JCTVC-G499 is an improved version with lower loss.

Subtest C:

JCTVC-G212, presented in this context, is combination of JCTVC-G208 / JCTVC-G206 ("option 1"), and something new on SAO LB reduction ("option 2"). Also JCTVC-G211 was considered here.

JCTVC-G208 uses "virtual boundary processing" = specific boundary padding method with some irregularity which could also be implemented differently e.g. by adjusting filter coefficients.

It was suggested to investigate visual quality of JCTVC-G212 option 1 against HM, and adopt if it does not produce artifacts.

20 viewers “Score based method” was used, where experts gave 1 point for the anchor and prop each when they were equal, and otherwise 2/0 or 0/2 if one was better.

(anchor/proposal) BQM 18/22, Cactus 22/18, Vidyo3 15/25, Vidyo4 20/20.

Conclusion: No visual difference. Even 15/25 means that still 75% of the subjects thought both are equal.

Decision: Adopt JCTVC-G212 option 1

JCTVC-G207 (c.5) proposes a method to perform padding for SAO at slice boundaries (which would obviously increase the complexity). This shall also be investigated in the subjective test to identify whether there is a problem with SAO at slice boundaries (in case where across-boundary processing is disabled), but we would not adopt it at this meeting as it appears inconsistent to have something for SAO but not for de-blocking where the same problem occurs. There may also be other solutions such as post-processing of boundaries. (Note JCTVC-G194 is also related). Result of subjective viewing: It looks better than anchor. Investigate combined solution for ALF and SAO for slice and tile boundaries in CE, for de-blocking currently no proposal on the table, but a solution which also includes de-blocking would be desirable.

Subtest D:

JCTVC-G208 (9x9 cross shape) performs best and has better performance than JCTVC-G648 (7x11). JCTVC-G208 will be tested together with JCTVC-G206 such that reducing line buffers by decreasing vertical filter size is not relevant anymore (same applies to JCTVC-G130 which reduces vertical filter size only for chroma and produces losses)

Subtest E:

(JCTVC-G665) Prediction of filter coefficients from other coefficients of the same filter (instead of from one filter to the next). Gain of 0.1% observed in LD B and P cases. Note: JCTVC-G610 is a similar idea that provides more gain.

Does not add or remove complexity (or stability). Several experts support it as the design of prediction from the same filter seems to be more straightforward than from different filter. The gain would increase when APS is sent more frequently for error resilience. Revisited in the context of JCTVC-G610. Decision: Adopt.

Subtest G:

Adds a third mode where within a slice the ALF applied to chroma is invoked whenever luma is filtered (currently it is either entirely on or off). Only marginal gain (0.2% for chroma only). – also one more encoder decision.

No support by other companies. No action.

Note: Question was raised what would be the performance when chroma always follows luma, and some experts expressed that they would like such a solution, however other experts expressed it might be dangerous to do this, as there may be good reasons to switch it entirely on/off.

Subtest H (JCTVC-G235): NLM filter.

Benefit around 0.1–0.3% for different test cases, encoder/decoder runtime increase up to 12% (encoder) / 5% (decoder). NLM operated alternatively with ALF. In worst case, runtime increase could be dramatically higher (if it were used everywhere).

No support by other experts – no action.

4.8.2 Contributions

JCTVC-G1023 CE8 subset 0: Improved ALF N pass encoding [I. S. Chong, M. Karczewicz, T. Yamakage, T. Watanabe, T. Chujoh, C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei] [late]

This evaluates a modified ALF N pass encoding algorithm. This includes improvement and bugfix of ALF N pass encoding. Coding efficiency gain for luma is 0.0%, 0.0%, 0.1% and 0.2% in HE-AI, RA, LB, and LP without encoding/decoding time increase on average.

(non-normative)

Subtest A

JCTVC-G316 CE8.a.1: 2-D mergeable syntax [T. Ikai (Sharp), I. S. Chong, M. Karczewicz (Qualcomm), T. Yamakage, T. Watanabe, T. Chujoh (Toshiba), C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)]

This contribution reports evaluation results of 2-D mergeable syntax technique (JCTVC-F384). This technique aims to free the restriction on block classification in the HM-4.0 ALF. The coding gains of 0.0%, 0.1%, 0.1% and 0.1% in HE-AI, RA, LB, and LP were reported. The decoding time ratio was 100% to 101% and the encoding time ratio was 99% to 100% in HE case. The proposal was cross-checked by Samsung (JCTVC-G649). Harmonization of the other proposal "CE8.a.2: Directional feature calculation on subset of pixels" (JCTVC-G609) is also tested in JCTVC-G649.

JCTVC-G649 CE8 Subtest a: Cross-check of Tool 1 (JCTVC-G316) 2-D mergeable syntax [P. Lai, F. C. A. Fernandes (Samsung)]

JCTVC-G609 CE8.a.2: Directional feature calculation on subset of pixels [T. Yamakage, T. Watanabe, T. Chujoh (Toshiba), C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), M. Karczewicz, I. S. Chong (Qualcomm), T. Ikai, A. Segall, T. Yamamoto (Sharp)]

This evaluates a directional feature calculation on subset of pixels to improve coding efficiency. This technique uses the internal and the surrounding pixels (window pixels) of the 4x4 block unit which have different complexity and performance tradeoff. It also evaluates the changes in computational direction to diagonal directions from horizontal/vertical directions. Coding efficiency gain for luma is 0.1%, 0.2%, 0.2% and 0.4% in HE-AI, RA, LB, and LP without encoding/decoding time increase on average. When merged with CE8.a.1 the coding efficiency is improved by is 0.2%, 0.3%, 0.3% and 0.4% in HE-AI, RA, LB, and LP.

JCTVC-G464 CE8 subtest a tool 2: crosscheck of Directional feature calculation on subset of pixels [K. Sugimoto, K. Miyazawa, A. Minezawa, S. Sekiguchi (Mitsubishi)]

JCTVC-G650 CE8 Subtest a: Cross-check of Tool 2 (JCTVC-G609) Directional feature calculation on subset of pixels [P. Lai, F. C. A. Fernandes (Samsung)]

JCTVC-G647 CE8 Subtest a, Tool 3: Block-based filter adaptation with up to 8 filters (HV8) [P. Lai, F. C. A. Fernandes, I.-K. Kim (Samsung)]

This contribution presents a filter adaptation design with unified and reduced number of initial filter classes for both block-based and region-based filter adaptations (BA and RA). For BA, 2 directional classes are produced by directly comparing directional features, each directional class has 4 magnitude levels, leading to 8 initial filter classes; while HM4.0 has 3 directional classes with 5 magnitude levels (15 initial classes). RA is modified to partition a frame into 8 regions corresponding to 8 initial filter classes. Such design reduces the number of testing in filter-class merging process at encoder, and unifies the syntax of merging flags under BA and RA.

The proposed method reports 0.1% BD-rate loss for AI, RA, LDB structures; and 0.2% BD-rate loss for LDP structure. The enc / dec time have no measurable changes as compared to HM4.0.

JCTVC-G611 CE8.a.3: Cross check of Samsung's directional feature calculation on subset of pixels [I. S. Chong, M. Karczewicz (Qualcomm)]

Subtest B

JCTVC-G498 CE8: ALF with low latency and reduced complexity [A. Fuldseth, G. Bjøntegaard (Cisco)]

The document describes a "low complexity" ALF technique asserted to be suitable for low latency applications. One single set of ALF filter coefficients are computed, quantized and transmitted sequentially for each block using a single pass technique. The proposed ALF also reportedly has low complexity by using only a 5x5 diamond shape and no decoder-side variance calculations. When applied to low complexity configurations, BD-rate gains between 1.4% and 3.7% are reported. When applied to high efficiency configurations, BD-rate losses between 0.5% and 1.1% are reported.

JCTVC-G371 CE8 Subset b: cross-check for Cisco’s ALF (JCTVC-G498) [J. Xu, A. Tabatabai (Sony)]

JCTVC-G864 CE8 Subset b.1: Cross check of Cisco's ALF with low latency and reduced complexity [I. S. Chong, M. Karczewicz]

Subtest C

JCTVC-G564 CE8 subtest c tool 1: Line memory reduction for ALF and SAO decoding [S. Esenlik, M. Narroschke, T. Wedi (Panasonic)]

This contribution is a part of CE8 on in-loop filtering. Proposed is a method to reduce the line memory which is required by consecutive filtering operations in the decoder. In the current HM 4.0, Deblocking Filter (DF), Sample Adaptive Offset (SAO) and Adaptive Loop Filter (ALF) all pose difficulties related to storage requirements in the block-based decoding procedure. Namely, for the purpose of filtering across the boundaries of LCUs (Largest Coding Unit), horizontal and vertical line memory need to be employed which is increases the implementation complexity of decoder chips. This contribution focuses on the reduction of the line memory for LCU-based decoding. The main focus is the reduction in the so called horizontal line memory, whose size is directly proportional to the width of the decoded picture. With the help of the proposed technique the horizontal line memory that needs to be employed is reduced

from 9 lines to 5 lines for the luminance component and from 7 lines to 4 lines for the chrominance components.

JCTVC-G051 CE8 Subset 3: Cross-check of Panasonic's line memory reduction for in-loop filtering (JCTVC-F272) [S. Park, S. Lee, N. Eum (ETRI)]

JCTVC-G479 CE8.c.1: Crosscheck for Panasonic's line memory reduction for ALF and SAO decoding in JCTVC-G564 [C.-Y. Chen, Y.-W. Huang (MediaTek)]

JCTVC-G204 CE8.c.2: Single-source SAO and ALF virtual boundary processing [C.-M. Fu, C.-Y. Chen, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)]

This contribution reports results of CE8.c.2. In HM-4.0, SAO requires 0.2 luma pixel line buffers (PLB) and 0.2 chroma PLB, and ALF requires 4.1 luma PLBs and four chroma PLBs for practical real-time decoders. In JCTVC-F054 and JCTVC-F055, virtual boundary (VB) processing was proposed in order to achieve zero line buffer and good visual quality for SAO and ALF. Due to the DF in HM-4.0, luma VBs and chroma VBs are set as four and two pixels above horizontal LCU boundaries, respectively. For a to-be-processed pixel on one side of a VB, any pixel on the other side of the VB is avoided by modifying pixel classification for SAO and filter shapes for ALF. When compared with the JCTVC-F900 anchor, the proposed method reportedly causes 0.1%, 0.2%, 0.3%, and 0.4% coding efficiency losses for HE-AI, HE-RA, HE-LDB, and HE-LDP, respectively, and is claimed to have similar visual quality as the anchor. VB artifacts can only be seen in few pictures.

JCTVC-G559 CE8 Subtest c: Cross-Check report for JCTVC-G204 [S. Esenlik, A. Kotra, M. Narroschke(Panasonic)]

JCTVC-G614 CE8 Subset c.2: Cross-Verification of MediaTek's Line memory reduction in ALF and SAO [I. S. Chong, M. Karczewicz (Qualcomm)]

JCTVC-G205 CE8.c.3: Multi-source SAO and ALF virtual boundary processing [C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), S. Esenlik, M. Narroschke, T. Wedi (Panasonic)]

This contribution reports results of CE8.c.3. In HM-4.0, SAO requires 0.2 luma pixel line buffers (PLBs) and 0.2 chroma PLBs, and ALF requires 4.1 luma PLBs and four chroma PLBs for practical real-time decoders. In JCTVC-F054 and JCTVC-F055, virtual boundary (VB) processing was proposed to remove all these line buffers. In JCTVC-F272, partial use of pre-DF pixels as SAO and ALF inputs was proposed to reduce line buffers. In order to achieve zero line buffer and good visual quality for SAO and ALF, the two methods are combined as follows. Due to the DF in HM-4.0, luma VBs and chroma VBs are set as four and two pixels above horizontal LCU boundaries, respectively. For to-be-processed pixels above the VB, any required pixel below the VB is replaced by a pre-DF pixel. For to-be-processed pixels below the VB, any pixel above the VB is avoided by modifying pixel classification for SAO and filter shapes for ALF. When compared with the JCTVC-F900 anchor, the proposed method reportedly causes 0.1%, 0.1%, 0.1%, and 0.2% coding efficiency losses for HE-AI, HE-RA, HE-LDB, and HE-LDP, respectively, and is claimed to have similar visual quality as the anchor. Very minor VB artifacts can only be seen in very few pictures.

JCTVC-G234 CE8.c.3: Cross-verification of MediaTek's and Panasonic's proposal on multi-source SAO and ALF virtual boundary processing (JCTVC-G205) [M. Matsumura, S. Takamura, H. Jozawa (NTT)]

JCTVC-G206 CE8.c.4: SAO and ALF virtual boundary processing with cross9x9 [C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), S. Esenlik, M. Narroschke, T. Wedi (Panasonic)]

This contribution reports results of CE8.c.4-1 and CE8.c.4-2, which are a combination of CE8.c.2 using single-source SAO and ALF virtual boundary (VB) processing and CE8.d.1 using cross9x9 and snowflake5x5 and a combination of CE8.c.3 using multi-source SAO and ALF VB processing and CE8.d.1, respectively. When compared with the JCTVC-F900 anchor, CE8.c.4-1 reportedly achieves 0.0%, −0.2%, −0.3%, and 0.1% BD-rates for HE-AI, HE-RA, HE-LDB, and HE-LDP, respectively, and CE8.c.4-2 reportedly achieves 0.0%, −0.2%, −0.4%, −0.1% BD-rate differences for the four conditions respectively, where negative numbers mean gains and positive numbers mean losses. The gain of using cross9x9 is roughly unchanged when CE8.c.2 and CE8.c.3 are considered. It is also reported that both CE8.c.4-1 and CE8.c.4-2 have subjective qualities close to HM-4.0, and CE8.c.4-2 is better than CE8.c.4-1.

JCTVC-G433 CE8.c.4: Cross-check of MediaTek/Panasonic's SAO and ALF virtual boundary processing with cross9x9 JCTVC-G206 [T. Yamakage, T. Watanabe (Toshiba)]

JCTVC-G207 CE8.c.5: Non-cross-slices SAO [C.-M. Fu, C.-Y. Tsai, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek), M. Budagavi (TI)]

This contribution reports results of CE8.c.5. In HM-4.0, non-cross-slices SAO skips each to-be-processed pixel requiring any pixel from any other slice. However, the skipping technique may cause some potential problem in visual quality. In JCTVC-F093 and JCTVC-F232, any pixel from any other slice is avoided by using a padding technique and by modifying pixel classification patterns, respectively. In this proposal, it is found that the padding technique and modification of pixel classification patterns are conceptually the same and can be combined into one single solution. Simulation results reportedly show that the proposed method achieves no coding efficiency loss and better subjective quality in comparison with the anchor when non-cross-slices SAO and multiple slices per picture are used.

JCTVC-G414 CE8.c.5: Cross-check of MediaTek/TI's non-cross-slices SAO JCTVC-G207 [T. Yamakage, T. Watanabe (Toshiba)]

Subtest D

JCTVC-G208 CE8.d.1: Snowflake5x5 and cross9x9 for luma and chroma ALF shapes [C.-Y. Tsai, C.-Y. Chen, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek), I. S. Chong, M. Karczewicz (Qualcomm), T. Yamakage, T. Watanabe, T. Chujoh (Toshiba)]

This contribution reports results of CE8.d.1. In HM-4.0, snowflake5x5 and cross11x5 filter shapes have nine and eight multiplications, respectively, and are used for both luma and chroma in ALF. In this proposal, snowflake5x5 and cross9x9 are used, and they both have nine multiplications to better utilize multipliers without increasing the number of multipliers in hardware. Simulation results reportedly show

0.1%, 0.4%, 0.6% and 0.3% coding efficiency gains for HE-AI, HE-RA, HE-LDB, and HE-LDP, respectively, with roughly the same encoding time and 1%–2% decoding time increase. Apparently cross9x9 needs more line buffers than cross11x5, so it is suggested to combine this proposal with ALF line buffer removal techniques.

JCTVC-G133 CE8: Crosscheck of JCTVC-G208 - Snowflake5x5 and cross9x9 for luma and chroma ALF shapes [M. Budagavi (TI)] [late]

JCTVC-G648 CE8 Subtest d, Tool 2: ALF filters with 9 coefficients and up to vertical-size 7 [P. Lai, F. C. A. Fernandes (Samsung), H. Guermazi, F. Kossentini, M.Horowitz (eBrisk)]

This contribution presents ALF method using two filter shapes both having 9 coefficients: star-5x5 and cross-11x7. Compared to the previously adopted proposal JCTVC-F303, one coefficient has been added to construct cross-11x7, and extended its vertical-size to 7. The proposed method reports gains of 0.1/0.2/0.3/0.2 BD-rate for AI/RA/LDB/LDP structures as compared to HM4.0, with average of 2% / 1% enc / dec time increases on Linux cluster server.

JCTVC-G613 CE8 Subset d.2: Cross-Verification of Samsung's Filter Shapes and Coefficients constraints [I. S. Chong, M. Karczewicz (Qualcomm)]

JCTVC-G130 CE8 Subtest d - Chroma ALF with reduced vertical filter size [M. Budagavi, V. Sze, M. Zhou (TI)]

This contribution presents results for Nx3 chroma ALF filters when integrated into HM 4.0. Nx3 chroma ALF filters have a vertical size of 3 when compared to filters in HM 4.0 which have vertical size of 5. The filter set of 7x3 diamond + 11x3 cross with 3x3 center is reported to have following BD-Rate results (Y, U, V): AI-HE: 0.0%, 0.4%, 0.5%; RA-HE: 0.0%, 0.8%, 0.5%; LB-HE: 0.0%, 0.7%, 0.5%;LP-HE: 0.0%, 0.7%, 0.4%. The worst case number of multiplications for this filter set is reported to be the same as for HM-4.0 filter set. Results for other Nx3 filter sets that have vertical size of 3 are also presented. Filters with reduced vertical size are asserted to be useful from the point of view of reducing number of line buffers required and/or external memory bandwidth. Nx3 filters are claimed to result in a 50% reduction in line buffer/external memory bandwidth requirements compared to HM-4.0 chroma ALF filters.

JCTVC-G652 CE8 Subtest d: Cross-check of Tool 3 (JCTVC-G130): Chroma ALF with reduced vertical filter size, proposed by TI [P. Lai, F. C. A. Fernandes (Samsung)]

Subtest E

JCTVC-G665 CE8.e.3: ALF coefficient prediction [K. Andersson (Ericsson)]

This contribution is a core experiment report on JCTVC-F076 which exploits that adaptive loop filter coefficients typically are largest towards the middle of the filter. The BDR can be improved by 0.1% compared to HM-4.1 for random access and low delay for the common conditions at similar encoding and decoding time.

JCTVC-G928 CE8.e.3: Cross-check of Ericsson's ALF coefficient prediction JCTVC-G665 [T. Yamakage, T. Watanabe (Toshiba)] [late]

Subtest F

(original proposal withdrawn)

JCTVC-G060 CE8 Subtest F: Verification results of Panasonic's Proposal [F. Kossentini, H. Guermazi (eBrisk Video Inc.)]

Subtest G

JCTVC-G056 CE8 Subtest G: Adaptive Loop Filtering of Chrominance Samples Using Luma Map [F. Kossentini, H. Guermazi, N. Mahdi, M. Horowitz (eBrisk Video Inc.)]

This contribution presents a technique for the Adaptive Loop Filtering (ALF) of chrominance samples that employs the map used in ALF of the luminance samples. The proposed technique reduces the average decoding time (~1%) while also achieving better U/V BD-Rate (0.21%–0.19%) performance than those of HM4.0.

JCTVC-G480 CE8.g.1: Crosscheck for eBrisk's adaptive loop filtering of chrominance samples using luma map in JCTVC-G056 [C.-Y. Tsai, Y.-W. Huang (MediaTek)]

Subtest H

JCTVC-G235 CE8.h: CU-based ALF with non-local means filter [M. Matsumura, S. Takamura, H. Jozawa (NTT)]

This contribution reports the performance of a technique that utilizes a denoising filter as the in-loop filter of HM codec. In the proposed method, a denoising filter called non-local means filter is unified into CU-based adaptive loop filter of HM4.0.

Compared to the anchor of HM4.0, the average BD-rate differences were –0.1, –0.2, –0.3, and –0.5% for Intra, Random Access, Low Delay B, and Low Delay P, respectively. The average decoding time increased 2 to 5%. The maximum gain was –1.4% in Low Delay P for the sequence “BasketballDrive”.

JCTVC-G299 CE8 Subtest h: Cross verification of NTT’s CU-based ALF with NLM filter (JCTVC-G235) by Intel [Y. Chiu, L. Xu (Intel)]

JCTVC-G482 CE8.h.1: Crosscheck for NTT's CU-based ALF with non-local means filter in JCTVC-G235 [C.-Y. Tsai, Y.-W. Huang (MediaTek)]

4.9 CE9: MV coding and skip/merge operation

4.9.1 Summary and general discussion

JCTVC-G039 CE9: Summary Report of Core Experiment on MV Coding and Skip/Merge Operations [B. Bross, J. Jung, W.-J. Chien, I.-K. Kim, M. Zhou (CE coordinators)]

In this CE report test results for the five different categories: Simplification, Modification of the AMVP candidate selection, Parallel merge/skip, Additional merge mod.e and Merge/Skip operations for identical motion are reported.

For SP01..04 there was no need to discuss (according to proponents).

Tentative recommendations (as from report)

- Discuss in BoG what is simplified by AMVP_SEL01/02 compared to HM4.0 and what causes the high losses in AMVP_SEL03/04 for some sequences. (During discussion in track A, SEL03/04 is said to include a bug which should be further investigated. There was doubt that SEL01/02 is really a simplification.)
- Recommend MRG_PAR pending on a clarification. Clarification was not confirmed at the time, this report was uploaded. (See discussion on JCTVC-G085 below.)
- Recommended to further study the proposed additional merge mode technique in MRG_MVD tests. MRG_MVD01 is simplest version (encoder complexity increased by checking the additional mode), whereas the other extensions add some more encoder complexity with some additional gain. No support was expressed by other companies.

Discussion on JCTVC-G085 (MRG_PAR): Some concern was expressed regarding which would be the correct reference of comparison. Comparison is made versus a modified HM anchor where parallel motion estimation is enabled such that RD optimization decisions cannot be correctly performed. Compared to actual HM anchor, the bitrate increase is roughly 0.7% for LCU 16x16 and 1.5% for LCU 32x32, even more for 64x64.

Note: JCTVC-G164, JCTVC-G387, JCTVC-G416 are related but are said to provide less penalty by the parallel approach. See conclusions recorded in notes relating to JCTVC-G164.

4.9.2 Contributions

JCTVC-G052 CE9: Results of MRG_MVD series [S. Fukushima, M. Ueda, K. Arakage, S. Sakazume (JVC Kenwood)]

The CE9 was established to evaluate the performance of motion vector coding and skip/merge operations at 6th JCT-VC meeting. Merge base MVD transmission was proposed at the meeting. This contribution reports the results of merge base MVD transmission under HM4.0 common test conditions.

The simulation results report that merge base MVD transmission provides 0.5% BD-rate gain for random access settings and 0.8% gain for low delay B settings under HM4.0 common test conditions.

JCTVC-G179 CE9: Cross-check report of MRG_PAR03 and 04 on Parallel ME [S. Park, B. Jeon (LGE)]

JCTVC-G190 CE9: Cross-verification result of MRG_MVD01 [K.Kazui (Fujitsu)]

JCTVC-G536 CE9: Cross-check report of MRG_MVD02 by Panasonic [T. Sugio, T. Nishi(Panasonic)]

JCTVC-G688 CE09: Crosscheck report of JCTVC-G52 test MRG_MVD03 [Y. Zheng, X. Wang (Qualcomm)]

JCTVC-G053 CE9: Results of AMVP_SEL01 and AMVP _SEL02 [H. Nakamura, S. Fukushima, M. Nishitani, H. Takehara (JVC Kenwood)]

This contribution reports the test results of CE9 AMVP_SEL01 and AMVP_SEL02. The simulation results reportedly show that AMVP_SEL01 and AMVP_SEL02 provide no coding loss for both random access settings and low delay B settings.

Was presented in the plenary Sat morning.

The claim is that it simplifies the memory access and allows parallel processing.

Several experts expressed the opinion that there is no advantage compared to the current design of HM4.0, where neither memory access nor parallel processing are an issue in this specific context.

JCTVC-G084 CE9: Test results on SP01, SP02, SP03 and SP04 [M. Zhou (TI)]

This document reports CE9 test results on SP01, SP02, SP03 and SP04 which are related to temporal MVP. Test results reportedly show that disabling the centre TMVP position from both the merge/skip and AMVP MVP list derivation process leads to a loss of 0.1% in all configurations(SP01); removing TMVP from the AMVP list derivation process causes an average reported loss of 0.3% in RA-HE, 0.4% (0.3%) in RA-LC, 0.6% in LB-HE and 0.7% in LB-LC (SP03, SP04); and disabling TMVP from both the merge/skip and AMVP MVP list derivation process leads to an average reported loss of 2.4% in RA-HE, 2.6% in RA-LC, 3.4% in LB-HE and 4.0% in LB-LC (SP04).

JCTVC-G261 CE9: cross-check of experiment SP01 – Remove TMVP center position (JCTVC-G084) [J. Jung (Orange Labs)]

JCTVC-G706 CE9: Cross-check report for TI's JCTVC-F083 by Motorola Mobility [Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)]

JCTVC-G689 CE09: Crosscheck report of JCTVC-G084 test SP04 [Y. Zheng, X. Wang (Qualcomm)]

JCTVC-G085 CE9: Test results on parallelized merge/skip mode [M. Zhou (TI)]

This document reports CE9 test results on parallel merge/skip mode. The current HEVC merge/skip mode design is highly sequential and introduces dependency among neighboring PUs, which can lead to significant quality loss if motion estimation (ME) is performed in parallel for throughput or

implementation cost reasons. For typical parallel ME level of 32x32, the reported measured average loss is 5.0% in RA-HE, 5.3% in RA-LC, 6.7% in LB-HE and 7.8% in LB-LC. The loss is caused by fact that the merge/skip mode cannot be tested for those PUs inside the 32x32 block whose neighboring motion data are still unavailable during the parallel processing process. It is proposed to add a high-level syntax element to signal the parallel level of merge/skip mode, divide a LCU into parallel motion estimation regions (MERs) and allow only those neighboring PUs which belong to different MERs from the current PU to be included in the merge/skip MVP list construction process. Simulation results reportedly show that an average gain of 3.4% in RA-HE, 3.5% in RA-LC, 4.4% in LB-HE and 5.0% in LB-LC can be achieved for 32x32 block level parallel ME when compared to a modified use of the current HEVC design, and for parallel level 16x16, the average gain from a similar comparison is reportedly 1.9% in RA-HE, 1.8% in RA-LC, 2.6% in LB-HE and 2.5% in LB-LC. The proposed design was asserted to be backward compatible to the current design but to offer flexibility for high throughput and high quality encoder designs.

JCTVC-G404 CE9: Cross-check of parallelized merge/skip mode (JCTVC-G085) [B. Li (USTC), J. Xu (Microsoft)]

JCTVC-G439 CE9 subtest 2.6: Results of MRG_ID01 in Merge/Skip operations for identical motion [A. Tanizawa, T. Shiodera, T. Chujoh, T. Yamakage (Toshiba)]

This contribution reports results of MRG_ID01 described in JCTVC-F325 in CE9 subtest 2.6 (Merge/Skip operations for identical motion). MRG_ID01 modified derivation process of temporal merge/skip mode in B-slice and has two kinds of variations. The variation A means that the collocated picture for L1 motion vector is changed from RefPicList1[0] to RefPicList1[1], if the two reference frames for the collocated MV candidates are identical. The variation B means that the same derivation process as the above is performed if both reference frames and MVs of the collocated merge candidates are identical.

Experimental results reportedly show that BD-bitrate of the variation A is 0.0%, 0.0%, 0.3% and 0.3% for RA-HE, RA-LC, LB-HE and LB-LC, respectively. The positive value means loss. Average decoding times are 100%, 100%, 99% and 99% for RA-HE, RA-LC, LB-HE and LB-LC, respectively. BD-bitrate differences of the variation B are 0.0%, 0.0%, 0.1% and 0.1% for RA-HE, RA-LC, LB-HE and LB-LC, respectively. Average decoding times are 99%, 100%, 99% and 100% for RA-HE, RA-LC, LB-HE and LB-LC, respectively.

JCTVC-G422 CE9: Cross-check for MRG_ID01 (JCTVC-G439) [H. Y. Kim (ETRI), K. Y. Kim, S. M. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee (ETRI)]

JCTVC-G421 CE9: Results of Experiments MRG_ID02, MRG_ID03, and MRG_ID04 [H. Y. Kim (ETRI), K. Y. Kim, S. M. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee (ETRI)]

This contribution reports the results of CE9 experiment MRG_ID02, MRG_ID03, and MRG_ID04. Experimental results showed that an average loss of 0.1–0.2% for Low Delay test condition is observed.

JCTVC-G745 CE9: Cross-check report on MRG_ID02 A and B (JCTVC-G421) [I.-K. Kim (Samsung)]

JCTVC-G161 CE9: cross-verification of ETRI proposal on merge/skip operations for identical motion (MRG_ID03 A, MRG_ID03 B) [Y. Jeon, B. Jeon (LG)]

JCTVC-G437 CE9 subtest 2.6: Cross-checking reports of MRG_ID04 (ETRI/KHU's proposal) [A. Tanizawa, T. Shiodera (Toshiba)]

JCTVC-G702 CE9: Simplification of MVP Design for HEVC [Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)]

This document reports the results of a proposed simplification of MVP design for HEVC. They are AMVP_SEL03 and AMVP_SEL04 tests specified in the CE9. Simulation results reportedly show that there is a no loss for low delay and 0.2% loss for random access conditions compared to original AMVP while the complexity of the proposed method is reduced by half as compared to the MVP selection procedure of AMVP.

JCTVC-G513 CE9: Cross-check result of Sel01&02 [K. Sato (Sony)]

JCTVC-G101 CE9 subset 2.3: cross-verification of MMI's proposal on AMVP simplification Sel03 & Sel04 [M. Zhou (TI)]

4.10 CE10: Core transforms

4.10.1 Summary and general discussion

JCTVC-G040 CE10: Summary Report of Core Experiment on Core Spatial Transforms [P. Topiwala, M. Budagavi, R. Joshi, E. Alshina (CE coordinators)]

This CE investigated the design of core spatial transforms, to study the tradeoff between coding efficiency and complexity. The anchor for comparison was the transforms in the HM.

Current proposals:

- FastVDO/Samsung (JCTVC-G266): full factorization (FF) only, invertibility for 4, 8, 16 length (same as JCTVC-G737 for 32 length).
- Qualcomm (JCTVC-G579): FF only
- Cisco/TI (JCTVC-G495): matrix multiply (MM) or partial butterfly (PB) implementations possible, with some asserted property for sharing forward and inverse transform processing
- Samsung/FastVDO (JCTVC-G737): MM, PB or FF implementations reportedly possible

All but JCTVC-G266 were actually reported to be the same for the 4x4 case.

JCTVC-G266 is not (exactly) invertible for 32x32, but is for other block sizes.

At low QP (1) the coding efficiency differences between the proposals are up to 1% on average. In the usual common settings, there were reportedly no remarkable differences (0.1%).

None of the transforms, for the case of matrix multiply implementation, has the transpose as the exact inverse transform (i.e. giving identity matrix when multiplied by transpose), but they have different amounts of deviation from that characteristic (which is equivalent of being more or less orthogonal).

Visual quality was not checked, but is assumed to be irrelevant, as the proposals are assumed to be roughly the same in that regard.

The difference between full factorization and partial butterfly of inverse transform becomes low when many zero coefficients are present.

It was asked whether having only a full factorization design is not desirable. It was then commented that matrix multiplication is good for SIMD and should also be supported. It was agreed to remove JCTVC-G266 and JCTVC-G579 from consideration as they do not have this flexibility.

Power consumption was noted to be especially important for hardware.

Pruning properties can also be important (see JCTVC-G628).

In PB operation, JCTVC-G495 uses 8 b coefficients, JCTVC-G737 uses 14 b coefficients.

In the CE, the software and hardware implementation complexity were studied.

JCTVC-G495 uses 8 bit coefficients in partial butterfly implementation, while JCTVC-G737 uses 14 bit coefficients. 8 bit gives an advantage both for hardware and software.

Regarding Tables 1 & 2 of the CE10 report (FPGA implementation by Altera): For length-4, the HM transform (JCTVC-G495) and JCTVC-G737 should be the same, but they get different numbers. It was asked whether mult/add engines (that are usually available on FPGAs) were used? The response was No, that only add/shift implementation was checked (the particular FPGA used did only have 56 SP blocks).

Regarding Tables 3 & 4 of the CE10 report (gate count based on automatic generation from C code to RTL): Is it useful to look at different latency? Usually a latency would be selected that gives smallest design, i.e. smallest gate count (it is confirmed by STM who provided this analysis that in this case looking at higher latency values is irrelevant). The numbers show an advantage of JCTVC-G737 in gate count. There is however some debate about the amount of optimization that could still be done in the translation of C to RTL. It is confirmed by D Alfonso that usually further manual optimization is necessary to get optimum results.

Regarding the reported analysis from Altera, it was noted that the 4 point comparison in Tables 1 and 2 of the reported analysis does not seem to make objective sense, because identical transforms seem to not have identical reported complexity. This was reportedly due to the analysis being based on particular implementations of the 4-point transform that differed in implementation details, resulting in substantially different complexity measures. It was also remarked that an FPGA implementation would likely use MAC operations that were assumed not to be used in the reported results. The person who performed the analysis said this was because the number of available MACs on some devices is limited, so this analysis was done in a way that avoided them.

A reported hardware analysis was reported from ST Micro (JCTVC-G887) based on automatic RTL generator. A proponent suggested to emphasize lower area implemenatation, and noted that the data actually showed lower latencies with lower areas; that it would not make sense to increase latency if that increases the area.

Additional hardware information was provided from TI.

The submitted hardware implementation information seemed to favor JCTVC-G737. However, there was some (non-proponent) questioning of the validity of the reported results – e.g. due to dependency on the particular implementation of what was tested (as noted above), and it was acknowledged that there is some dependency on this.

JCTVC-G628 (from Cisco/TI) described some aspects that were asserted to favour JCTVC-G495 over JCTVC-G737, in regard to:

- 8 b versus 14 b coefficients

- a symmetry property relative to the main diagonal that makes sharing of processing elements feasible for the forward and inverse transform
- a pruning advantage for software implementations
- comments about a reduced number of unique coefficient values
- saying that JCTVC-G737 would sometimes exceed a 32-bit range (encoder and decoder)

It was remarked that there is an input document from MIT, discussing the implications of having a reduced number of unique coefficients – estimating a 25% reduction in codec complexity being feasible from that. This property was not used in some of the hardware implementation analysis.

A proponent of JCTVC-G737 questioned some of this reported information – e.g. regarding the number of unique coefficient values. The proponent of JCTVC-G495 indicated that this could be addressed by clipping. However, this would affect the ability to represent some valid input values for the 32x32 transform.

It seemed to be indicated that for hardware implementation, the FF approach is the only one that really makes the most sense for JCTVC-G737 – the PB approach would not make sense. In the FF case, the number of unique coefficient values was suggested to be similar.

The proponent of JCTVC-G737 said that with the FF approach, the sharing of processing elements should also be feasible with that approach. However, the information available about this seemed limited.

Some SIMD information was presented by the proponent of JCTVC-G737. However, for the PB part, it was remarked that some additional information is in JCTVC-G757 describing a real-time decoder that seemed to indicate better performance for the PB approach for JCTVC-G495.

JCTVC-G495 has a “symmetry property” with the same coefficients in different basis functions and with nesting of smaller transforms within larger ones – such as 4x4 being subset of 8x8 (also in 8 bit/14 bit integer approximation of the matrix) which is also advantageous for partial butterfly implementation. The number of unique multiplier coefficients is 29 and 171 for 8 bit and 14 bit cases, respectively.

JCTVC-G737, in the partial butterfly form, would not be useful for hardware (whereas full factorization can be implemented in 8 bit video operation). It was asked whether the same transform can then be used for the inversion.

Regarding 32 bit precision, it was indicated that theoretically, overflow could happen if the input of inverse transform does not come from the forward transform.

JCTVC-G737 has the number of unique multipliers for the 32x32 block size being 30, but that relates to full factorization and is higher in the matrix multiply form.

4.10.2 Contributions

JCTVC-G266 CE10: Lossless Core Transforms for HEVC [W. Dai, M. Krishnan, J. Topiwala, P. Topiwala (FastVDO), E. Alshina (Samsung)]

JCTVC-G694 CE10: Cross-check report for FastVDO/Samsung's core Transform by Motorola Mobility (JCTVC-G266) [J. Lou, L. Wang (Motorola Mobility)]

JCTVC-G737 CE10: Full Factorization Core Transforms for HEVC [E. Alshina, A. Alshin, W. Lee, J. Park, K. Pachauri (Samsung), P. Topiwala (FastVDO)]

JCTVC-G863 **CE10: Crosscheck of FastVideo/Samsung core transforms for high and low QP range [Rajan Joshi] [late]**

JCTVC-G495 **CE10: Core transform design for HEVC [A. Fuldseth, G. Bjøntegaard (Cisco), M. Budagavi (TI)]**

JCTVC-G579 **CE10: Scaled integer transforms supporting recursive factorization structure [R. Joshi, J. Sole, M. Karczewicz (Qualcomm)]**

JCTVC-G953 **CE10: Cross-check of JCTVC-G579 core transform - low and high QP range [M. Budagavi (TI)] [late]**

JCTVC-G819 **CE10: Cross check for core transform proposed by Qualcomm by Samsung [E. Alshina, J.H. Park] [late]**

JCTVC-G887 **CE 10: hardware test of inverse transform proposals [Sumit Johar, Daniele Alfonso (STM)] [late]**

4.11 CE11: Coefficient scanning and coding

4.11.1 Summary and general discsussion

JCTVC-G041 **CE11: Summary report of Core Experiment on coefficient scanning and coding [V. Sze, J. Chen, T. Nguyen, K. Panusopone, J. Sole (CE coordinators)]**

This contribution is a summary of core experiment 11, Coefficient scanning and coding. Fourteen companies have been registered in CE11, and eight tools from seven proposals have been evaluated on the condition defined in document by the Software Ad Hoc Group. An eighth proposal was withdrawn; a ninth proposal (JCTVC-G301) released software for cross-check more than 6 weeks after deadline and it was agreed that it would be tested outside of CE.

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

- Context modeling/selection for syntax elements related to transform coefficients in HE configuration
- Transform coefficient scanning order methods for CAVLC and/or CABAC.

JCTVC-G121 Change c1 and c2 thresholds in context selection of coeff_abs_level_greater1_flag & coeff_abs_level_greater2_flag

Reduces the number of contexts by 36. No change of logic.

Deferred previously from concern regarding low QP and RDOQ off. That aspect was checked and no problem was found. 0.07% degradation in AI, 0.0 in others.

Aside from a desire to consider competing proposals, this seemed generally supported. Was later discussed again in relationship to other non-CE inputs and was adopted, as noted elsewhere.

JCTVC-G321 Change context selection of significant_coeff_flag to depend on scan position rather than block position

Change last_significant_coeff_x and last_significant_coeff_y to always assume diagonal scan

Removes a dependency on determining the intra prediction mode. A loss of 0.2% for AI, 0.1% for RA, and 0.1%. It was asked whether the complexity savings is substantial, and it did not seem very substantial.

JCTVC-G320 Change ordering/grouping of significant_coeff_flag and coefficient level information.

Alternatives: “Group by 16” or “group by TU”. No quality difference was measured.

In the current design, there doesn’t seem like a strong argument here for changing the current design to operate this way.

JCTVC-G703 Additional scans for intra coded 16x16/32x32 TU

Adds more scans – bit rate savings 0.1 for AI HE, 0.0 for other cases. Gain doesn’t seem sufficient to justify the change.

JCTVC-G284 Additional scans for intra coded 16x16/32x32 TU

Adds more scans – bit rate savings 0.2 for AI HE, other cases not tested. Gain doesn’t seem sufficient to justify the change.

JCTVC-G679 Use horizontal and vertical scans on intra coded 16x16 and 32x32 TU

CAVLC specific – thus, not reviewed

JCTVC-G269 Add horizontal and vertical scans to inter coded TU for NSQT

CAVLC specific – thus, not reviewed

4.11.2 Contributions

JCTVC-G121 CE11: Reduction in contexts used for coefficient level [V. Sze (TI)]

JCTVC-G327 CE11: Cross-check of TI’s reduction in contexts used for coefficient level (JCTVC-G121) [J. Sole (Qualcomm)]

JCTVC-G269 CE11 Report on Prediction Unit Dependent Coefficient Scanning For Inter Frame [J. Song, X. Zheng, H. Yang, H. Yu (Huawei)]

JCTVC-G708 CE11:Cross-check report for Huawei's JCTVC-F501 by Motorola Mobility [Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)]

JCTVC-G792 **Cross-check for Huawei's proposal on PU dependent coefficient scan for inter block (JCTVC-G269) [Y. Piao, J. Chen, J. Min, J.H. Park (Samsung)]**

JCTVC-G284 **CE11: Extended Mode Dependent Coefficient Scanning [X. Zhao, X. Guo, S. Lei (MediaTek), S. Ma, W. Gao (PKU)]**

JCTVC-G364 **CE11: Crosscheck of JCTVC-F124 on Extended Mode-Dependent Coefficient Scanning from MediaTek [C. Auyeung (Sony)]**

JCTVC-G320 **CE11: Scanning of Residual Data in HE [J. Sole, R. Joshi, M. Karczewicz (Qualcomm)]**

JCTVC-G412 **CE11: Cross-check result of Significance Map interleaving part of Qualcomm proposal on Parallel Processing of Residual data in HE (JCTVC-G320) [C. Rosewarne, M. Maeda (Canon)]**

JCTVC-G321 **CE11: Removal of the parsing dependency of residual coding on intra mode [J. Sole, Y. Zheng, W.-J. Chien, R. Joshi, X. Wang, M. Karczewicz (Qualcomm)]**

JCTVC-G124 **CE11: Cross-check of proposal on Removal of the parsing dependency of residual coding on intra mode JCTVC-G321 (F550) [V. Sze (TI)]**

JCTVC-G302 **CE11: Cross-check report for CE11 B2 Qualcomm's proposal on Removal of the parsing dependency of residual coding on intra mode [H. Sasai, T. Nishi (Panasonic)]**

JCTVC-G679 **CE11: Extending horizontal and vertical scan to big block for CAVLC [M. Karczewicz, Y. Zheng, L. Guo, X. Wang (Qualcomm)]**

JCTVC-G703 **CE11: Adaptive Scan for Large Blocks for HEVC [Y. Yu, K. Panusopone, J. Lou, L. Wang (Motorola Mobility)]**

JCTVC-G077 CE11: Cross-check of CE.B1 - Scans for large blocks in CAVLC [C. Yeo (I2R)]

JCTVC-G975 CE11: Crosscheck - Adaptive Scan for Large Blocks for HEVC (JCTVC-G703) [T. Nguyen (Fraunhofer HHI)] [late]

4.12 CE12: Deblocking filter

4.12.1 Summary and general discsussion

JCTVC-G042 CE12: Summary report of Core Experiment on deblocking filtering [A. Norkin, X. Guo, B. Jeon, M. Narroschke (CE coordinators)]

This contribution is a summary report of Core Experiment 12 on deblocking filtering. The goal of the proposals is to enhance deblocking filtering techniques in the HEVC Test Model. This is not limited to improving coding efficiency and subjective quality but also reducing complexity and harmonization of the various schemes that are technically feasible. The CE comprises five subtests. All the proposals are based on HM4.0 and experiments are performed according to the common test conditions provided in JCTVC-F900. Additionally, proposals from subtest 5 provide results for higher QPs. All results are verified by cross-checkers.

Subtest 1: Subjective and objective quality improvements

JCTVC-G286 / JCTVC-G287: Adding filters for chroma, the first using separate decisions, the other re-using luma decision

JCTVC-G409: Using stronger (longer) filters

JCTVC-G590: Taking separate decisions for each half (4 lines/columns) of a length-8 block boundaries, decision is not taken per line/column, but rather based on two lines/columns (first/fourth) for the entire half. (in total, complexity reduction is claimed)

JCTVC-G383: specific filtering (weaker) for AMP blocks 4x16/16x4. Basically, same filter as HM.

JCTVC-G087: Uses delta calculation of HM3, done same way for luma and chroma.

Visual tests to be performed on JCTVC-G287, JCTVC-G409, JCTVC-G590 and JCTVC-G383. As JCTVC-G287, JCTVC-G409 and JCTVC-G383 increase complexity (JCTVC-G383 is at least less regular), it would be expected that visual improvement is shown. JCTVC-G590 is reducing complexity, which should not be bought by additional artifacts. Was discussed again after tests had been performed, which unveiled no subjective quality difference for any proposal.

Note: Proposal JCTVC-G089 is similar to JCTVC-G590 but uses parallel decision.

Decision: Adopt JCTVC-G590

Subtest 2: Parallel deblocking decision solutions

JCTVC-G255: Horizontal and vertical filtering can be done in parallel, additional buffers required; may have disadvantage in lowering throughput for sequential operation.

JCTVC-G256: No additional buffers needed. On/off decision made on 2 center lines/columns out of 8 (instead of HM which uses the outer lines/columns. (256 includes additional modifications that were not in the original plan: modified decision for vertical edge re-modified as in JM.)

JCTVC-G088: Changes back to HM3 (or AVC style) where horizontal decision would not depend on vertical filtering, as it is argued that this reduces throughput.

Would JCTVC-G256 solve this problem?

Presentation of JCTVC-G256:

Has two aspects: change on/off decision (samples 3+4 instead of 2+5 at the vertical edge) and strong/weak filter decision.

Both could be tested differently.

Doing things different horizontally/vertically is inconsistent.

Decision: Adopt JCTVC-G088 (i.e. remove parallel decision part, i.e. in that aspect go back to HM3).

No visual tests need to be performed on subtest 2.

Subtest 3: Line memory reduction

JCTVC-G257 and JCTVC-G228 would be in conflict with CE8 subtest c (reduced line buffer in ALF)

JCTVC-G229 was tested visually – did not have worse quality. Decision: Adopt JCTVC-G229.

Note: JCTVC-G230 is somehow a combination of JCTVC-G257 and JCTVC-G228 with new elements

Subtest 4: Reduction of computational complexity of deblocking filter

JCTVC-G086: Seems to be a minor decrease in complexity as this case may not occur too frequently

No support of other companies – no need for visual testing

Subtest 5: Controlling strength of deblocking filter at slice level

JCTVC-G466: BS intra offset for luma and chroma

JCTVC-G174: tc_offset and beta offset

JCTVC-G574: Parameter on/off flag (for presence of parameters) and 5 weights (quantized to 6 bits) for delta values of luma filters (3 for strong, 2 for weak)

JCTVC-G574 also includes a new method of adapting (more subjective targeted) which was not in the original proposal but is non-normative

JCTVC-G466 and JCTVC-G174 keep the filter unchanged. JCTVC-G574 requires one more multiplication by the weight factor per decision (after tc clipping)

Test all 3 (both old and new method for 574) in subjective tests to see whether it gives benefit

Note: JCTVC-G291 extends JCTVC-G174 in defining a reasonable syntax – BoG on this later in the week.

It was agreed to establish a BoG (coordinated by A. Norkin, G. v.d. Auwera, M. Narroschke, T. Yamakage etc.) to discuss about cleaning up the de-blocking description and propose a set of adaptation parameters as from CE12 subtest 5, JCTVC-G291, JCTVC-G619, …, as well as an appropriate place of such signalling (e.g. slice, APS …), and prepare for a CE.

4.12.2 Contributions

Subtest 1

JCTVC-G286 CE12 Subtest 1: Chroma Deblocking Filter [Q. Huang, J. An, X. Guo, S. Lei (MediaTek), A. Norkin, K. Andersson, R. Sjöberg (Ericsson)]

This contribution presents experimental results for the chroma deblocking filter in CE12 Subtest 2. In specific, chroma deblocking filter with independent filtering decision and 8x8 filtering unit is tested and proposed. It is reported that, average BD-Rate reduction of 0.6% can be achieved for chroma. The runtime is reported to be similar to HM4.0. It is also reported that the subjective quality is almost the same as that of HM4.0.

JCTVC-G410 CE12, Subset 1: Cross-verification report for MediaTek and Ericsson's proposal (JCTVC-G286) [Z. Shi (USTC), J. Xu (Microsoft)]

JCTVC-G287 CE12 Subtest 1: Simplified Chroma Deblocking Filter in JCTVC-G286 [Q. Huang, J. An, X. Guo, S. Lei (MediaTek), A. Norkin, K. Andersson, R. Sjöberg (Ericsson)]

This contribution presents the results of chroma deblocking filter in CE 12 Subtest 1. In specific, chroma deblocking filter with dependent filtering decision on luma and 8x8 filtering unit is tested and proposed. It is reported that an average BD-Rate reduction of 1.0% can be achieved for chroma. For low delay cases, an average BD-Rate reduction of 0.1% can also be achieved for luma. The runtime is reported to be similar to HM4.0. It is also reported that the subjective quality is almost the same as that of HM4.0.

JCTVC-G411 CE12, Subset 1: Cross-verification report for MediaTek and Ericsson's proposal (JCTVC-G287) [Z. Shi (USTC), J. Xu (Microsoft)]

JCTVC-G383 CE12 Subtest1: Deblocking of New Non-Square Blocks: Edge Shift for AMP [G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm)]

This proposal addresses the adaptation of the deblocking filter in case of AMP partitions of size 16x4 or 4x16. Instead of deblocking the central edge on the 8x8 deblocking grid inside the 16x16 CU of the AMP type, the relevant internal AMP partition edge is deblocked, which keeps the number of filtering operations unchanged. The deblocking filter width is adapted to avoid filtering dependencies between nearby edges. The BD-rates and execution times are very similar to the HM4 anchor.

JCTVC-G485 CE12.1.5: Crosscheck for Qualcomm's AMP deblocking with edge shift in JCTVC-G383 [T.-D. Chuang, Y.-W. Huang (MediaTek)]

JCTVC-G409 CE12, Subset 1: Report of Deblocking for Large Size Blocks [Z. Shi (USTC), X. Sun, J. Xu (Microsoft)]

This document presents a deblocking scheme for large size blocks to improve the visual quality of HEVC decoded video. For large smooth regions with small variation, an extra smoothing deblocking mode is introduced to suppress the visually severe blocking artifacts. It was asserted that the proposed method can reduce blocking artifacts in smooth regions, which are usually more visible to human eyes.

JCTVC-G673 CE12 Subtest 1: Crosscheck for Microsoft's Deblocking for Larger Blocks in JCTVC-G409 [Q. Huang, X. Guo (MediaTek)]

JCTVC-G590 CE12 Subtest 1: Results for modified decisions for deblocking [M. Narroschke, S. Esenlik, T. Wedi (Panasonic)]

This contribution is part of CE12. It presents the results for modified decisions for deblocking which is based on JCTVC-E251 and JCTVC-F191. In HM4.0, a first decision for enabling the deblocking is performed for edge segments of eight lines. In the case of enabled deblocking, a subsequent second decision is performed for each individual line by which either a strong or a weak filter is selected. In this proposal, two modifications are introduced. The first decisions are performed for edge segments of four lines instead of 8 lines. The second decisions are also performed for edge segments of four lines instead of for each individual line. At the same quality, the following average bit rate reductions are reported relative to HM4.0: I-HE: 0.0%, I-LC: 0.0%, RA-HE: 0.0%, RA-LC: 0.0%, LD(B)-HE: 0.2%, LD(B)-LC: 0.1%, LD(P)-HE: 0.2%, LD(P)-LC: 0.0%. The modifications reduce the number of operations required for these two decisions by around 20%. In addition, the size of line buffers is reduced. They allow parallel deblocking of all 8x8 blocks.

JCTVC-G238 CE12 Subtest1: Cross-verification of Panasonic's proposal JCTVC-G590 [M. Ikeda, T. Suzuki (Sony)]

JCTVC-G621 CE12: Cross-verification of F191 from Panasonic [A. Norkin (Ericsson)] [late]

Subtest 2

JCTVC-G255 CE12 Subtest2: Parallel deblocking improvement based on JCTVC-F214 tool1 [M. Ikeda, J. Tanaka, T. Suzuki (Sony)]

This contribution proposes one approach to improve and develop the parallel deblocking filter (JCTVC-E181 and JCTVC-E224). This approach is both horizontal (H) and vertical (V) filtering process applied to reconstructed samples. This proposal makes the dependency between H and V filter reduced, and then both H and V filtering process can be performed in parallel. In addition it is expected that the necessary memory to store for H filtered samples in AVC is made redundant. Sony has two proposals, and one is basic proposal based on JCTVC-F214 tool1 and the other one is improved one based on the basic proposal. The experimental results reportedly show 0.0 to 0.2% in BD-rate impact regarding basic proposal, −0.1 to −0.2 in BD-rate regarding modified one, and the subjective quality is asserted to be similar to HM-4.0.

JCTVC-G585 CE12 Subtest 2: Cross-check results of the parallel deblocking tool 1 of Sony (JCTVC-G255) [Matthias Narroschke, Semih Esenlik (Panasonic)]

JCTVC-G256 CE12 Subtest2: Parallel decision improvement and reduction based on JCTVC-F214 tool2 [M. Ikeda, J. Tanaka, T. Suzuki (Sony)]

This contribution proposes to improve the parallel deblocking filter (JCTVC-E181 and JCTVC-E224). This approach is decision by using the central non-deblocked samples in block boundary. The decision with the central non-deblocked samples means the decision for reconstructed samples because the decision regarding “on/off decision” and “strong/weak filter selection” is performed by the central non-

deblocked samples. Sony has two proposals, and one is basic proposal based on JCTVC-F214 tool2 and the other one is improved one based on the basic proposal. The experimental results show 0.0–0.3% increases in BD-rate and 0–2% decreases in decoding time regarding basic proposal and 0.0–0.2% increases in BD-rate and 0–2% decreases in decoding time regarding improved one. Therefore it is expected that the necessary memory to store for the results of the decision is made redundant with keeping the similar performance to HM-4.0 and that it is possible to save the computation in the decision process, and the subjective quality is similar to HM-4.0.

JCTVC-G587 CE12 Subtest 2: Cross-check results of the parallel deblocking tool 2 of Sony (JCTVC-G256) [Matthias Narroschke, Semih Esenlik (Panasonic)]

JCTVC-G103 CE12 subset 2: cross-verification of SONY's parallel de-blocking filtering proposals JCTVC-G255 and JCTVC-G256 [M. Zhou, V. Sze (TI)]

JCTVC-G622 CE12: Cross-verification of parallel deblocking from Sony F14 tool 2 [Andrey Norkin (Ericsson)] [late]

Subtest 3

JCTVC-G228 CE12.3.2: Reducing pixel line buffers by modifying DF for horizontal LCU edges [C.-W. Hsu, Y.-W. Huang, S. Lei (MediaTek)]

This contribution reports results of CE12.3.2, which is based on JCTVC-F053 method2 to modify deblocking filter (DF) only for horizontal LCU boundaries and to keep DF unchanged for rest edges. Pixels above the first row of the upper side of the horizontal LCU boundary are not used in filtering decisions. Moreover, filtering operations are also modified without changing pixels above the first row of the upper side of the horizontal LCU boundary. In comparison with HM-4.0, the proposed method can remove all pixel line buffers dedicated for DF and reportedly causes 0.0–0.2% coding efficiency loss with roughly unchanged run time and similar visual quality in most cases.

JCTVC-G253 CE12 Subtest3: Cross-verification of MediaTek's proposal JCTVC-G228 [M. Ikeda, T. Suzuki (Sony)]

JCTVC-G229 CE12.3.3: Reducing motion data line buffers [T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)]

This contribution reports results of CE12.3.3, which is based on the motion data compression method in JCTVC-F060. Simulation results reportedly show that the proposed method can reduce motion data line buffer size by 50% with the same coding efficiency, encoding time, and decoding time in comparison with HM-4.0. No undesirable visual artifact is observed due to the modified motion data for calculating boundary strengths in deblocking filter.

JCTVC-G292 CE12 Subtest3: Cross Check of Mediatek's Motion Data Line Buffer Reduction Proposal JCTVC-G229 [G. Van der Auwera (Qualcomm)]

JCTVC-G257 CE12 Subtest3: Deblocking vertical tap reduction for line buffer based on JCTVC-F215 [M. Ikeda, T. Suzuki (Sony)]

This contribution proposes to reduce the line buffers required in deblocking filter base on JCTVC-F215. A lot of line buffers are required in deblocking filter, SAO (Sample Adaptive Offset) and ALF (Adaptive Loop Filter) in HM-4.0. Especially, deblocking filter is included in both high efficiency and low complexity and it is considered that deblocking filter is used in many cases, and so it is asserted to be significant that the line buffers in deblocking filter are reduced alone. It was proposed to reduce one line buffer with keeping BD-Rate and subjective quality by reducing upper one pixel to read in vertical filtering. The experimental results reportedly show 0.0–0.1 increases for luma in BD-rate and similar run-time; and with subjective quality similar to HM-4.0.

JCTVC-G486 CE12.3.1: Crosscheck for Sony's deblocking vertical tap reduction for line buffer in JCTVC-G257 [C.-W. Hsu, Y.-W. Huang (MediaTek)] [late]

JCTVC-G180 CE12: Cross-check report of subtest 3 on Deblock filter line memory reduction [S. Park, B. Jeon (LGE)]

Subtest 4

JCTVC-G087 CE12 subset 4.10: Test results on unification of luma and chroma filtering [M. Zhou, O. Sezer, V. Sze (TI)]

This contribution reports test results on CE12 subset 4.10 “unification of luma and chroma filtering”. In the proposed algorithm the unification of luma and chroma filtering is achieved by increasing filter coefficient precision for chroma filter by 2-bit and restoring HM3.0 delta calculation for luma weak filter. Simulation results were asserted to show that the proposed unification improved the coding efficiency in luma by 0.2% in AI-HE and AI-LC, and 0.1% in RA-HE, RA-LC, LB-HE and LB-LC, and up to 0.3% gain for chroma components. However, unified luma weak and chroma filtering reportedly led to visual quality loss in vidyo3 (LB-HE, QP=37) sequence.

JCTVC-G249 CE12 Subtest1: Cross-verification of TI's proposal JCTVC-G087 [M. Ikeda, T. Suzuki (Sony)]

Subtest 5

JCTVC-G088 CE12 subset 5.6: Test results and architectural study on de-blocking filter without parallel on/off filter decision [M. Zhou, O. Sezer, V. Sze (TI)]

This contribution reports test results on CE12 subset 5.6 “removal of parallel on/off filter decision”. Architectural study reportedly shows that the parallel on/off decision actually restricts architecture choices, increases implementation costs in terms of memory reads and buffer size without intended throughput benefits. The contributor recommended to restore the AVC fashion of on/off filter decision, that is to use the un-filtered samples for the on/off filter decision of vertical edges, and the intermediate filtered samples (i.e. filtered samples after vertical edge filtering) for the on/off decision of horizontal edges. Test results were asserted to show that this change leads to 0.0% BD-rate difference, and subjective viewing reportedly verifies that there is no visual difference for all the CE12 selected subjective testing sequences when compared to the HM4.0 anchor.

JCTVC-G588 **CE12 Subtest 2: Cross-check results of the deblocking proposal of Texas Instruments (JCTVC-G088) [Matthias Narroschke, Semih Esenlik (Panasonic)]**

JCTVC-G746 **CE12 subset 5.6: Cross-check report on parallel deblocking decision (JCTVC-G088) [I.-K. Kim, J. Chen (Samsung)]**

JCTVC-G574 **CE12 Subtest 5: Deblocking filter using adaptive weighting factors [Matthias Narroschke, Ann-Kathrin Seifert (Panasonic)]**

This contribution presents the results for a Deblocking filter using adaptive weighting factors which is based on JCTVC-F405. Five adaptive weighting factors are introduced into the deblocking filter of the luminance signal. Each weighting factor weights the value, by which the HM4.0 deblocking filter would modify a sample. The weighting can be interpreted as an adjustment of the frequency responses of the deblocking filter. In this contribution, the weighting factors are estimated by two methods at the encoder side. Both methods minimize the mean squared error between the deblocked signal and the original input signal. The difference between both methods is that the second one considers the subjective importance of the samples during the estimation. However, any other estimation method is also possible since the encoded weighting factors are coded and transmitted to the receiver side. It is also possible to use default weighting factors, which lead to deblocking filter operations equivalent to HM4.0. For the first estimation method, average BD-bit rate reductions of I-HE: 0.4%, I-LC: 0.2%, RA-HE: 0.3%, RA-LC: 0.2%, LD-HE(B): 0.5%, LD-LC(B): 0.2%, LD-HE(P): 0.3%, LD-LC(P): 0.1% are reportedly achieved compared to HM4.0 with approximately no encoder/decoder run time increases. For the second estimation method, slightly lower average BD-bit rate reductions are reportedly achieved at no encoder/decoder run time increases. However, visible blocking artifacts are reportedly removed, especially for high QP coder configurations.

JCTVC-G237 **CE12 Subtest5: Cross-verification of Panasonic's proposal relating to JCTVC-F405 [S. Lu, M. Ikeda, T. Suzuki (Sony)]**

Subtest 6

JCTVC-G174 **CE12: Deblocking filter parameter adjustment in slice level [T. Yamakage, S. Asaka, T. Chujoh (Toshiba), M. Karczewicz, I.S. Chong (Qualcomm)]**

Parameters for deblocking filter to improve coding efficiency for CE12 are presented. Offsets to Qp to derive beta and tc in slice level syntax are introduced in order to adjust subjective and/or objective picture quality. The purpose of this contribution is to provide a "placeholder" to adjust the picture quality.

When Qp offsets to derive beta and tc offsets are −2 and −5, BD-rate reduction were reported as 0.0% (HE) and 0.4% loss (LC) on average under the common test conditions, with maximum BD-rate reduction of 0.7% (HE) and 0.3% (LC). When higher Qp (32, 37, 42 and 47) is used, BD-rate reduction is 0.4% loss (HE) and 0.6% loss (LC) on average, with maximum BD-rate reduction of 0.6% (HE) and 0.3% (LC).

JCTVC-G465 **CE12: crosscheck of deblocking filter parameter adjustment in slice level [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]**

JCTVC-G466 CE12: results on signaling of boundary filtering strength [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]

This contribution reports verification results on CE12 Subtest 5 that evaluates signaling of boundary filtering strength at slice header. The verification work was performed using the software implemented the proposed technique on top of HM-4.0. Reported performance results were obtained by building and running the software on 64bit Linux platform.

JCTVC-G388 CE12: Cross-check of Mitsubishi's deblocking filter JCTVC-F175 / JCTVC-Gxxx [T. Yamakage, S. Asaka (Toshiba)]

Subtest 7

JCTVC-G086 CE12 subset 7.4: Test results on decreasing worst case complexity of deblocking filter [M. Zhou, O. Sezer, V. Sze (TI)]

This contribution reports test results on CE12 subset 7.4 "decreasing worst case complexity of deblocking filter". By removing the motion vectors from the boundary strength (BS) calculation of the deblocking filter, the worst case number of operations, and memory access are reduced from (8, 10) to (1, 4), and from (39, 20) to (7, 4) for the BS calculation of a de-blocking edge in P-frame and B-frame, respectively. Subjective tests at TI observed visual quality improvement in BQMall + (random access-high efficiency) + QP 37 (ringing artifact around diagonal edge has been reduced), and no subjective difference in other CE12 selected sequences when compared to the HM4.0 anchor. The proposed simplification leads to an average BD-rate increase of 0.2% in RA-HE, RA-LC, LB-HE and LB-LC configuration.

JCTVC-G251 CE12 Subtest4: Cross-verification of TI's proposal JCTVC-G086 [M. Ikeda, T. Suzuki (Sony)]

JCTVC-G623 CE12 : Cross-verification of deblocking simplification from TI F484 [Andrey Norkin (Ericsson)] [late]

4.13 CE13: Motion data parsing robustness and throughput

4.13.1 Summary and general discsussion

JCTVC-G043 CE13: Summary report of Core Experiment 13 on motion data parsing robustness and throughput [J. Jung, B. Bross, J. Chen, P. Onno (CE coordinators)]

This Core Experiment relates to motion data parsing robustness and throughput. During the 6th JCT-VC meeting, a simplified version of JCTVC-F470 has been adopted in HM4.0. The goal of this CE is to evaluate various configurations or simplifications of different methods proposed for HM3.0, and evaluate them in the context of HM4.0.

- Decision (SW): Agree on ENC_MRG_FIX (bug fix from experiment S0 from JCTVC-G776)
- Signaling number of candidates in slice header (T1…T4 vs. T5…T8): Gives a small benefit (0.3% BR reduction for case of 3 candidates) compared to the case where the coder restricts the number of candidates without changing syntax. Goal: Tradeoff encoding time vs. complexity, no

impact on decoder. It is also shown that another option is adaptation to sequence characteristics, where it give a small benefit in case of LD P.

There was support by several companies: Discussion: Better in APS? No – slice header is better place. Decision: Adopt T1…T4 from JCTVC-G091, S1 from JCTVC-G776.

- Pruning number of MVP candidates T9/T10 and C1..C4:

We should target here for proposals that simplify (preferably without loss), and not those which remove something and put in something else with little gain.

Note: An initial decision to adopt T10 later became obsolete due to the adoption of JCTVC-G397+JCTVC-G542simp3.

A process was suggested by CE coordinators: Identify adoptions from CE9 & 13, integrate software, and only after that consider inclusion of other related proposals.

4.13.2 Contributions

JCTVC-G091 CE13: Test results on maxNumMergeCand signaling and simplification of merge MVP list pruning process [M. Zhou (TI)]

This document reports CE13 test results on the following two tools: signalling the maximum number of merge/skip MVP candidates (maxNumMergeCand) in slice header (signaling method), and simplification of the second pruning process of the merge/skip MVP list derivation process. (simplification method). The signaling method enables the truncated unary table of accurate length to be used for merge_idx coding, while the simplification method reduces the complexity of the second pruning process by 2x, thanks to the reduction of the total number of combined, non-scaled and zero MVP candidates from 8 to 5. Experimental results reveal that the proposed signaling method provides e.g. an average of gain of 0.1% in RA-HE, 0.3% in RA-LC, 0.2% in LB-HE and 0.7% in LB-LC when maxNumMergeCand equal to 3 when compared to the HM4.0 encoder only method, which uses a fixed truncated unary table of maximum length 5 for merge_idx coding regardless of number of merge candidates supported by the encoder. The gain is significantly larger in LC configurations. Results also reportedly showed that the proposed simplification method and adding it on the top of the signaling method does not cause coding loss.

JCTVC-G231 CE13: Results of section 3.1 tests 1, 3d, and 3e on replacing redundant MVPs and its combination with adaptive MVP list size [J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)]

This contribution reports the results of CE13 section 3.1 tests 1, 3d, and 3e, which are based on JCTVC-F052. In test 1, redundant or empty MVPs are replaced by truncating the first available MVP to integer precision or by adding a constant value to the first available MVP. In test 3d, test 1 is combined with adaptive MVP list size by neighboring Merge indices. In test 3e, test 1 is combined with adaptive MVP list size by current CU size. In comparison with HM-4.0 under JCTVC-F900 common test conditions, it is reported that test 1 together with a bug-fix achieves 0.2–0.5% coding efficiency gain with 100–103% encoding time and 98–100% decoding time, test 3d together with a bug-fix achieves 0.0–0.4% coding efficiency gain with 98–103% encoding time and 99–102% decoding time, and test 3e together with a bug-fix achieves 0.1–0.5% coding efficiency gain with 100–102% encoding time and 100–101% decoding time, where the bug-fix alone achieves 0.1% coding efficiency gain and no run time difference.

JCTVC-G236 CE13: Cross-check of Mediatek results section 3.1 [G. Laroche, P. Onno (Canon)] [late]

JCTVC-G686 CE13: Crosscheck report of JCTVC-G231 Test 1 [Y. Zheng, X. Wang (Qualcomm)]

JCTVC-G845 CE13 Section 3.1: Cross-verification of MediaTek's test 3d (JCTVC-G231) [T. Lee, J. Chen, J. H. Park (Samsung)]

JCTVC-G232 CE13: Results of section 3.1 tests 2d and 2e on adaptive MVP list size [J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)]

This contribution reports the results of CE13 section 3.1 tests 2d and 2e. Based on JCTVC-F052, two proposed tools to determine the MVP list size adaptively are evaluated. In tool 1, the MVP list size of each PU is adaptively determined by merge indices of neighboring PUs. In tool 2, MVP list size is determined by the current CU size. In comparison with HM-4.0 under JCTVC-F900 common test conditions, it is reported that tool 1 achieves 0.0–0.1% coding efficiency loss with 98–100% encoding time, and tool 2 achieves 0.0–0.1% coding efficiency loss with 99–100% encoding time.

JCTVC-G240 CE13: Experiment regarding section 3.5 [G. Laroche, T. Poirier, P. Onno (Canon)]

This contribution reports the results of experiments for section 3.5 of CE13 as described in JCTVC-F913. 6 experiments have been proposed in the field of parsing robustness for both AMVP and Merge modes. The four first proposed experiments replace some of the additional candidates of the current HM4.0 motion vector derivation by non-redundant candidates as proposed in JCTVC-F474. These four experiments correspond to different compromises between the coding efficiency and the complexity reductions in terms of number of operations for the Merge mode MVP derivation process compared to the HM4.0. The 2 other experiments deal with the modification of the motion vector predictor index parsing for AMVP. The best experiment in term of coding efficiency reportedly shows an average gain for 4 Inter coding configurations of 0.3% coding compared to the HM4.0 anchors without any increase number of operations. Moreover, some configurations divide by 3 the worst case complexity in terms of number of predictors and number of comparisons with a BDR gain of 0.1%.

JCTVC-G424 CE13: Cross-check report of JCTVC-G240 (section 3.5 test 1 and test 4) [S.-C. Lim, J. Lee, H. Y. Kim (ETRI)]

JCTVC-G489 CE13: Crosscheck for Canon's section 3.5 tests 5 and 6 on additional MVP candidates in JCTVC-G240 [J.-L. Lin, Y.-W. Huang (MediaTek)]

JCTVC-G842 CE13 Section 3.5: Cross-verification of Canon's test 3 (JCTVC-G240) [T. Lee, J. Chen, J. H. Park (Samsung)]

JCTVC-G776 CE13: Merge candidates list construction [T. Lee, J. Chen, J. H. Park (Samsung)]

This document reports the results of "merge candidates list construction" method proposed in document JCTVC-F402 within the context of CE13. Three tests were done in this contribution: a) encoder modification of HM4.0; b) Optimal merge list size derived in encoder side and signal it in slice head; c)

inserting additional merge candidates. Experiments reportedly show that the encoder side fix achieves average −0.11% BD rate saving for six inter configurations without enc/dec time change. Merge list size signaling in slice header shows average 0.08% BD rate loss with 96.9% encoding time. Inserting additional merge candidates shows average −0.17% BD rate saving for six inter configurations based on encoder fix version with 102.8% encoding time.

JCTVC-G487 CE13: Crosscheck for Samsung's section 3.4 test 5' on adaptive list size and additional MVP candidates in JCTVC-G776 [J.-L. Lin, Y.-W. Huang (MediaTek)]

JCTVC-G191 CE13: Cross-verification result of JCTVC-F402 Test3 [K. Kazui (Fujitsu)]

JCTVC-G275 CE13: cross-check of experiments T1 (TI - JCTVC-G091), S1 (Samsung – JCTVC-G776) and C2 (Canon - JCTVC-G240) [J. Jung (Orange Labs)] [late]

JCTVC-G514 CE13: Cross-Check Result of Test3b&4b [K. Sato (Sony)]

JCTVC-G539 CE13: Cross-check report of subset 3.3 (test2a, 3a, 4a) by Panasonic [T. Sugio, T. Nishi (Panasonic)]

JCTVC-G540 CE13: Cross-check report of subset 3.2 series by Panasonic [T. Sugio, T. Nishi (Panasonic)]

5 Non-CE Technical Contributions

5.1 Clarification and Bug Fix Issues

JCTVC-G116 On PCM memory usage reduction in HM software [K. Chono, H. Aoki (NEC)]

Just an implementation change – delegated to software coordinator.

5.2 HM settings and common test conditions

JCTVC-G111 Common test conditions to specify 8-bit internal bit depth for all 8-bit source material [T. Hellman, Y. Yu, W. Wan (Broadcom)]

This proposal recommends changing the common test conditions to specify an internal bit depth (IBD) of 8 bits for all 8-bit source material. It presents results that show a coding loss from this change relative to the current 10-bit IBD configuration, but claims that the cost of 10-bit IBD cannot be justified. A cost increase of 20–23% is reported for a sample hardware codec implementation as well as additional

memory and bandwidth costs. It also recommends keeping 10-bit IBD for 10-bit source material, in preparation for a future 10-bit encoding profile.

In some cases, the benefit of 10 bit vs. 8 bit is high for chroma (extreme more than 100% chroma bit rate increase for steam locomotive). It is said that this is particularly observed for sequences when chroma PSNR is high. Typical loss in chroma around 6%.

Loss of 8 bit relative to 10 bit for HE is bigger in chroma (10% for RA & LB, including Class F) than luma (2.2% for RA & LB), and is focused in particular sequences (removing one sequence drops the chroma average gain to about 6%).

Class F is included in the results.

Excluding class F, there is more gain, as there is essentially no observed gain on class F.

It was mentioned in the discussion that 10 vs. 8 bit most likely would be a profiling issue. Several experts anticipate that an 8-bit 4:2:0 profile with high coding efficiency will be defined (confirmed by Broadcom, Docomo, Cisco and TI).

Would a 10-bit (or higher) profile be in the first version of the standard? (Several experts said that this could be deferred to a later version, and is at least not as high a priority.)

For common test conditions (that will need to be re-defined as there is only one entropy coder now):

- Only 8-bit test settings in common conditions
- The capability of higher bit depth should be retained in the software and the spec
- Keep a mode to test with higher bit depth to verify that any tools are in principle extensible (10? 12?)
- Also include parameter settings for tool combinations that are not currently checked in common conditions
- The latter two points could be done for a largely reduced test set (as it is not about compression performance but rather sanity check)

There was a suggestion to define one test point with ALF on and one off. Some experts argued that also SAO should be on/off at these points – and this was agreed. It would also be beneficial to test interpolation filters with SAO off.

Decision (SW): It was agreed that we need a high coding efficiency profile that has only 8 bit decoding capability. And we should have a set of common test conditions that corresponds to that.

It was commented that it may be that we may not define a profile with greater than 8 bit capability in the first version of the standard (e.g. so that we could later define a single profile that covers both greater than 8 bit capability and higher-resolution chroma formats).

It was commented that the current 10 bit sequences are rather noisy, so if we don't have 10 bit encoding in the common conditions, we may no longer need those sequences.

We definitely want to retain higher bit depth capability in the design and software. So we should still include higher bit depth capability in the common conditions.

This was agreed.

It was suggested to develop a supplemental set of tests for other aspects as well that differ from the main common conditions (e.g. in QP and CU size as well as bit depth). This idea was supported.

It was suggested that perhaps our LC common conditions should no longer include SAO.

It was suggested that the MC interpolation filter should perhaps be different if SAO is not going to be used.

A BoG (coordinated by Frank Bossen) was asked to discuss and propose future test conditions. And also todiscuss whether Steam Locomotive and Nebuta (10 bits) will still be used, or stripped down to 8 bit.

There was further discussion on Nov. 29:

There was a desire to create a set of alternate configurations for the purpose of testing robustness and make sure new integration do not break other tools typically not used in common test conditions. It was agreed to add a mandate to AHG3 to do this.

Suggestions for differences between HE and LC configs included the following:

- ALF
- SAO
- NSQT
- AMP
- 32x32 LCU vs 64x64 LCU
- 32x32 T vs 16x16 T

There was no consensus on whether to use 1 or 2 configurations at the time of that discussion.

JCTVC-G136 Suggestion on picture quality hierarchy for Low Delay configurations [S. Liu, X. Zhang, S. Lei (MediaTek)]

This contribution proposes a modification to the picture quality hierarchy for Low Delay settings in the current HM. It is proposed to replace the current multi-level hierarchical picture quality structure by a two-level scheme. Average 0.2–0.3% BD-rate reduction is reported for Luma and average 1.8% BD-rate reduction is reported for Chroma. No impact on encoding or decoding time is reported.

Would this affect the visual quality (as quality fluctuations are at lower frame rate)?

Gain is relatively small. Subjective characteristics were discussed.

Changes may tend to make historical comparisons more tricky – gain seems not so large as to justify a change at this time.

JCTVC-G634 Cross check of MediaTek's JCTVC-G136: Suggestion on picture quality hierarchy for Low Delay configurations [E. S. Ryu, Y.Ye (InterDigital)] [late]

JCTVC-G150 Proposed Error Pattern Files for JCT-VC [S. Wenger (Vidyo)]

Adopted as the current preferred method for testing robustness characteristics and proposals. See also notes on JCTVC-G014.

JCTVC-G399 Comparison of Compression Performance of HEVC Working Draft 4 with AVC High Profile [B. Li (USTC), G. J. Sullivan, J. Xu (Microsoft)]

This contribution presents the results of compression comparison tests between the current state of the HEVC draft standard and the AVC High Profile as an anchor reference. The conditions used for the comparison tests were 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. The testing was indicated to be generally configured in favour of using a relatively strong AVC anchor reference. Several of the encoder optimizations currently found in the HEVC software were tested and reportedly shown to be helpful to improve the AVC anchor performance. When compared to the improved anchor encoder configurations, the HEVC WD 4 design reportedly provides a bit rate

savings for equal PSNR of about 39% for random access applications, 44% for low-delay use, and 25% for all-intra use.

The contribution uses “combined YUV PSNR” measurements (weighted superposition of luma and chroma) for simplification of reporting of results – see also JCTVC-G401.

Abetter AVC anchor was used than in the HEVC CfP (8% better for RA-HE).

Average gains are reported as 39% for RA, 44% for LD, 25% for AI (all for HE).

It was noted that subjective quality is our primary goal, and this contribution does not test subjective quality. The combined PSNR metric was noted and is further discussed in JCTVC-G401.

JCTVC-G678 A tool for rate-constrained performance test [S. Campbell, J. Wang, X. Yu (RIM)]

This document describes a set of tools that can be used to run the encoder multiple times to obtain a given set of bit rates. This is achieved by adding a new set of parameters, the Lambda-factors, to the encoder. These Lambda-factors provide control over the encoded bit rates. The shell script, targetBitrates.sh, will run the encoder many times while adjusting the Lambda-factors until the desired bitrates are obtained.

The tool controls the bit rate allocation for each temporal layer.

The tool was used in CE4 subtest 2.b.

The actual files used as this tool were not included in the contribution, but will be added in a new version.

Some change to the reference software was needed to work with this.

It was asked whether this should become part of our reference software. Decision (SW): This was supported and agreed. (It was offered to be provided with our regular licensing header.)

JCTVC-G855 Performance evaluation of full search mode decision for Intra of HM4.0 [C. Lai, Y. Lin, L. Liu, J. Zheng (HiSilicon)] [late]

Late information document (not presented in detail, no action expected) – available for study.

JCTVC-G910 Non-CE6: Cross-check of HiSilicon’s performance evaluation of full search mode decision for intra of HM4.0 (JCTVC-G855) by Panasonic [S. M. T. Naing, V. Wahadaniah, C. S. Lim (Panasonic)] [late]

5.3 Source video test material

JCTVC-G732 Study on test materials in common test condition [T. Suzuki (Sony)] [late]

In JCTVC-E011, a problem of the class E test materials in the common test condition was reported. This contribution investigates the reason why this is happened and proposes to reconsider to replace the class E test materials.

It was reported to seem likely that the material was produced by interlaced camera with compression & de-interlacing.

It was reported that the pixel values are changed frame by frame, even in still areas. This phenomenon could impact the evaluation of video coding tools. For example, tools to use this line by line change could improve coding efficiency in the current design.

In discussion, it was indicated by the sequence contributor that the sequences were captured by a Sony camera that is switchable between 1080i and 720p.

The company (Vidyo) that contributed the Class E sequences indicated that they should be able to provide new material with similar scene content that does not exhibit this phenomenon. The group indicated that such a contribution is requested and would be appreciated. This can be collected and made available in an AHG activity in advance of the next meeting (chair T. Suzuki).

5.4 Functionalities

5.4.1 Scalable coding

JCTVC-G078 Information for HEVC scalability extension [J. Boyce, D. Hong, W. Jang, A. Abbas (Vidyo)]

For information to JCT-VC. Out of scope of current phase of work.

JCTVC-G248 Low Complexity scalable extension of HEVC intra pictures [S. Lasserre, F. Le Léannec, E. Nassor (Canon)]

This contribution presents a new approach for scalable extension of HEVC intra pictures. This scalable intra codec design targets coding efficiency together with very low complexity. Spatial random access and a high degree of parallelism are two additional targeted features. The proposed scalable intra codec employs only one coding mode, which is inter-layer intra prediction, which is asserted to provide low complexity. Coding efficiency is obtained through statistical modeling of DCT channels to encode rate distortion optimal quantifiers that are pre-computed off-line, coupled with a distortion allocation process between DCT channels. Overall, a bit rate increase of 12.8% is reported relative to HEVC single layer coding on tested sequences in dyadic spatial scalability operation. Finally, non-contextual, non-adaptive entropy coding provides the spatial random access feature.

This was presented Tue. 29th afternoon in track A.

For information to JCT-VC. Out of scope of current phase of work.

JCTVC-G948 Draft requirements and discussion on the scalable enhancement of HEVC [A. Luthra] [late]

For information to JCT-VC. Out of scope of current phase of work.

JCTVC-G949 Draft requirements for the scalable enhancement of HEVC [A. Luthra] [late]

For information to JCT-VC. Out of scope of current phase of work.

JCTVC-G950 Draft use cases for the scalable enhancement of HEVC [A. Luthra] [late]

For information to JCT-VC. Out of scope of current phase of work.

JCTVC-G951 Draft Call for Proposals on the Scalable Video Coding Extensions of HEVC [A. Luthra (Motorola)] [late]

For information to JCT-VC. Out of scope of current phase of work.

5.4.2 Stereo/Multi-view

JCTVC-G582 Multiview HEVC – experimental results [M. Domanski, T. Grajek, D. Karwowski, K. Klimaszewski, J. Konieczny, M. Kurz, A. Luczak, R. Ratajczak, J. Siast, O. Stankiewicz, J. Stankowski, K. Wegner]

This document presents an approach of providing multiview compression capability in HEVC in a similar way to AVC Annex H. The results for experimental implementation of HEVC-based multiview codec and prospective performance of multiview prediction in HEVC-based multiview codecs are described. Codec has been implemented using HEVC reference software (HM 3.0), by application the compression scheme similar to Multiview Video Coding technology (MVC). Coding efficiency of HEVC-based multiview coder was evaluated and compared to the efficiency of simulcast HEVC. Performance of the proposed encoder was tested with the sequences provided in Call for Proposals (CfP) on 3D Video Coding (3DVC). The average compression gain of using multiview prediction in video encoder is 22.7% in the 2-view cases and 30.5% in 3-view cases, relative to simulcast scenario.

For information – contribution noted.

For information to JCT-VC. Out of scope of current phase of work.

5.4.3 Interlace

JCTVC-G170 On issues for interlaced format support in HEVC standard [K. Chono, H. Aoki (NEC)]

JCTVC-G196 Modification of derivation process of motion vector information for interlace format [J. Koyama, A. Yamori, K. Kazui, S. Shimada, A. Nakagawa (Fujitsu)]

JCTVC-G296 Picture-adaptive Field/Frame Coding: support for legacy video [O. Bar-Nir (Harmonic)]

JCTVC-G450 High level syntax to support interlace format [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]

JCTVC-G667 HEVC field coded sequences vs. deinterlaced progressive coding [C. Fogg] [late]

JCTVC-G877 Interlaced and 4:2:2 color format support in HEVC standard [J. Vieron] [late]

JCTVC-G912 On interlaced format [K. Chono, H. Aoki (NEC)] [late]

This contribution was an eleven-company submission. It suggested to specify some form of interlaced video support for HEVC, and suggested to create a BoG to create "starting point text" toward that end.

JCTVC-G962 Interlace profiling in HEVC [D. Singer] [late]

This contribution emphasized the desire to avoid potential needs to include interlace-handling display adaption in decoding systems, and requested to retain HEVC as progressive only with no mention of interlace or fields, or as lesser acceptable alternative, to put any such aspects into a separate profile for that purpose.

JCTVC-G967 4:2:2 support in HEVC [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)] [late]

General

Remarks mad in the discussion of interlace-related subjects included the following:

- Will interlaced displays still exist in the future?
- Interlaced content still exist and continues to exist (interlaced cameras)
- Could this be de-interlaced?
- If done, it should be simple
- De-interlacing at encoder end would double necessary throughput
- Can this be solved with an SEI message like approach? (SEI would not allow frame/field adaptivity, as it is not possible to have two different picture sizes in one sequence.)
- Anything that involves a mode decision is undesirable. Picture adaptive frame/field switching is undesirable.
- Would it be useful to invoke an interlace SEI message per profile/level? Some experts think this is desirable. (H.263 has such an option for another SEI message.)
- It was suggested to work on specifying candidate text for an SEI message on field coding in an AHG.

Noting that there are basically no interlaced displays anymore (and the availability of source deinterlacing technology), it was asked why we would bother with this.

Legacy content and legacy camera equipment were cited as a rationale, and it was noted that new cameras are still being manufactured that generate new such content. It was suggested that the fact that prior standards include interlace-oriented features might create a need for persistence of support of prior technologies in addition to support of HEVC.

Regarding deinterlacing at the source, a doubling of codec throughput requirements was suggested to be unacceptable.

As a reference example, H.263 Annex W (subclause W.6.3.11) was mentioned.

It seems more than likely that if we do not do something, at least as an SEI message, others will do so in a less interoperable fashion. The associated indicator (as shown by H.263 Annex W) seems simple to specify.

Suggestion: "Have an enable flag at the VUI level with a top/bottom flag SEI on each picture".

Is it possible to profile an SEI message? It was noted that H.263 Annex X has such a thing.

The following plan was agreed: to establish an AHG with the mandate to develop candidate text for an SEI message signaling an interlaced format indicator. The suggestion quoted above was agreed as a starting point for that work.

5.5 Loop Filtering

5.5.1 Deblocking filter

Pre-review of related contributions took place in a BoG (JCTVC-G1005). Decisions were made in the track A sessions. The proposals are sorted into categories (although some proposals can belong to more than 1 category) as follows:

1. Parallel deblocking
2. Modifications to deblocking filter description
3. Modifications to Bs calculation process
4. Line buffer reduction
5. Deblocking filter simplifications
6. Signaling deblocking filter parameters in slice header
7. Varying QP deblocking and deblocking for IPCM blocks

1. Parallel deblocking

JCTVC-G089 Non-CE12: Enable low-complexity and fully parallelized de-blocking filter with minor changes [M. Zhou, O. Sezer, V. Sze (TI)]

This contribution advocates the following two changes to the current HM4.0 de-blocking filter design: 1) compute the on/off decision on 4 lines/columns segment instead of 8 lines/columns segment, and 2) remove the parallel on/off filter decision to speed up vertical edge filtering. The proposed changes reportedly lead to a low-complexity, fully parallelized de-blocking filter design with enhanced architecture flexibility. Compared to the current HM4.0 design, the buffer size is reportedly reduced from 12x12 to 8x8, and number of memory access is reportedly reduced from 8x12 to 8x8, and from segment to segment the de-blocking filter is reportedly fully independent and parallelized. Experimental results reportedly revealed that the proposed algorithm led to 0.1% BD-rate reduction in LB-HE and LB-LC, and 0.0% BD-rate difference in other configurations when compared to HM4.0. Subjective tests reportedly showed that the proposed algorithm led to visible visual gain in BQMall (RA-HE, QP=37) sequence, and had no visual difference for other CE12 selected subjective testing sequences.

Results: 0.0/0.0, 0.0/0.0, −0.1/−0.1 for HE-AI/LC-AI, HE-RA / LC-RA, HE-LD / LC-LD.

Similar to JCTVC-G590 in spirit (however, does not change the strong filtering).

Recommendation: Depending on adoption of JCTVC-G590. If JCTVC-G590 is adopted this would not be further investigated, otherwise possibly CE.

JCTVC-G624 Non-CE12: Cross-verification of parallel deblocking proposal JCTVC-G089 from TI Andrey Norkin [late]

JCTVC-G171 Parallel deblocking filter [J. Yu, S. Yang, J. Byun, Y. Kim, J. Kim (Yonsei Univ.)]

A parallel deblocking filter for HEVC is proposed. The proposed technique includes the parallelization of the filtering process and decisions. The proposed algorithm is based on a parallel deblocking filter decision scheme presented in JCTVC-D214. For the deblocking of a current coding unit, all required decisions and filtering are performed on the basis of the unfiltered pixels of the current coding unit. This method can reportedly eliminate the dependencies present in the current coding unit and between neighboring coding units. Therefore, the proposed deblocking filter can be implemented in parallel processing structures, making it applicable to variable structures. Experiments following the common conditions reportedly show that the BD-bit rate change is −0.1% in the case of All Intra high efficiency and 0.1% in the case of Random Access HE and Low delay HE. The BD-bit rate reportedly stays approximately unchanged for the luminance signal and chrominance signal.

Similar to JCTVC-G255 which was not considered

Slight increase in dec runtime.

No action.

2. Modifications to deblocking filter description

The proposals presented in this section do not modify HM4.0 behavior but modify the working draft text.

JCTVC-G175 BS decision tree simplification [S. Park, N. Park, B. Jeon (LGE), X. Guo, J. An, C. Hsu, Y. Huang, S. Lei (MediaTek)]

This contribution reports the simplification of the BS (boundary strength) decision tree in the deblocking filter. The proposed simplification removes redundant BS values with related conditions. The number of BS values is changed from 5 to 3 and this modification provides the same BD rate and visual quality as HM4.0.

The check for the CU boundary (Bs = 4) is removed. The proposed BS values are 0, 1, 2.

Recommendation: Makes sense, is related to contributions JCTVC-G620 part 1 and JCTVC-G638, parts 1 and 2.

Subjective test: not needed, identical to HM4.0

JCTVC-G959 Cross check of Non-CE12: BS Decision Tree Simplification - JCTVC-G175 [A. Kotra, M. Narroschke, T. Wedi (Panasonic)] [late]

JCTVC-G620 Clean-up of deblocking filter description [A. Norkin (Ericsson)] [late]

The document proposes certain simplifications to the deblocking filter description and HM 4.0 reference software. In particular, it is proposed to remove clipping operations from strong filtering and to reduce the number of Bs values.

Part 1: Removing clipping operations from the deblocking strong filter. Clipping is unnecessary since the output values cannot get outside the input range. (6 different places)

e.g. replace $p_1' = Clip1_Y((p_2 + p_1 + p_0 + q_0 + 2) >> 2)$ with $p_1' = (p_2 + p_1 + p_0 + q_0 + 2) >> 2$.

Editorial change & cleanup of software without changing operation. Decision (SW): Adopt; Check with software coordinators and WD editors.

Part 2: Check for the CU boundary (Bs = 4) is removed. Decreasing the number of Bs values to 0, 1, 2. This part of the proposal is identical to JCTVC-G175.

Subjective test: Not needed, proposal is identical to HM4.0

JCTVC-G638 Deblocking boundary strength and filtering process simplifications [A. Kotra, M. Narroschke, T. Wedi (Panasonic)]

This contribution presents three simplifications in boundary strength (bS) derivation and filtering process for deblocking in HM-4.0. The first simplification removes the "coding unit edge" check for Intra blocks in bS derivation. In the second simplification, the output boundary strength values of the boundary strength derivation are adjusted such that the bS value can be directly used in tc (threshold) value derivation. After this modification, the extra tcoffset (derived based on bS) used in HM-4.0 for tc derivation is not necessary anymore. The third simplification performs the calculation of thresholds tc and ß only when bS>0. These simplifications reduce the number of instructions in the deblocking operations.

Part 1. Remove the Bs = 4 and the check for CU boundary. Same as in JCTVC-G620 and JCTVC-G175.

Part 2. Set Bs values to 0, 1 and 3. Remove the tc_offset from the WD text and replace tc_table [Clip3(0, 55, qP_L + tc_offset] with tc_table[Clip3(0, 55, qP_L + bS−1)]. One participant supports this proposal, one was against it.

Part 3. If Bs = 0, do not calculate Tc and Beta when Bs = 0. Suggests this change to the working draft text. Two participants support the proposal. Adopting Part 3 to WD was recommended.

Subjective test: not needed, results are identical to HM4.0

Recommendations on Bs calcuation (JCTVC-G175, JCTVC-G620, JCTVC-G638):

Suggestion: Remove the check for the CU boundary (Bs = 4) and having 3 values for Bs.

Possibilities:

1. Bs = 0, 1, 2 (JCTVC-G175, JCTVC-G620) or
2. Bs = 0, 1, 3 and removing tc_offset (JCTVC-G638).

(Note: tc_offset can have values of 0 and 2 and is redundant with Bs as it is derived from that.)

Crosscheck JCTVC-G385 (See under JCTVC-G639).

3. Modifications to Bs calculation process

JCTVC-G176 Simplified BS calculation process [S. Park, B. Jeon (LGE)]

This contribution reports that there is an inconsistency in the minimum unit size between BS (boundary strength) calculation and boundary filtering in the current HEVC, which makes a redundant BS calculation and additional BS unification process. The proposed method changes the minimum unit size of BS calculation unit from 4x4 to 8x8 and removes the additional BS unification process. This contribution claims that there is no subjective and objective performance degradation (avg. 0% loss) with a reduced complexity compared with HM4.0.

Currently in HM4.0, Bs decision process for an 8-pel edge consists of finding BS decision for every 4-pel edge and then a maximum of two 4-pel Bs is found, because the minimum unit of BS and filtering is different.

The proposal suggests using the Bs of the first 4-pixel part as the Bs for the whole 8-pel edge to reduce Bs decision operation and remove BS merging process.

The proposal suggests using the Bs of the first 4-pixel part to determine Bs for the whole 8-pel edge. The average BD-rate change is 0.0% for all configurations.

Results: 0.0/0.0, 0.0/0.0, 0.0/0.0 for HE-AI/LC-AI, HE-RA / LC-RA, HE-LD / LC-LD.

One participant supports the proposal.

Recommendation: CE investigation.

JCTVC-G675 Non-CE12: Crosscheck for LGE's Simplified Bs Calculation in JCTVC-G176 [J. An, X. Guo (MediaTek)]

JCTVC-G616 On parallel deblocking [A. Norkin (Ericsson)]

The proposal discusses parallel deblocking. The proposed solution is based on a parallel deblocking proposal JCTVC-G089 from Texas Instruments and includes some modifications to it. The proposal also addresses implementation of parallel deblocking in case of deblocking in CU order.

The proposal suggests using separate Bs for two 4-pixel parts of the 8-pixel block boundary in order to align Bs calculation with transform size. The other modification is to use lines 0 and 4 for the deblocking filtering decision.

The proposal also addresses implementation of parallel deblocking in the case of deblocking in CU order. The average BD-rate gains are between 0.0% (AI) to 0.2% (LDB HE).

Results: 0.0/0.0, 0.0/0.0, −0.2/−0.1 for HE-AI / LC-AI, HE-RA / LC-RA, HE-LD / LC-LD.

Recommendation: CE, depending on what happens to JCTVC-G590 / JCTVC-G089.

JCTVC-G973 Non-CE12: Crosscheck for Ericsson's Parallel Deblocking in JCTVC-G616 [J. An, X. Guo (MediaTek)] [late]

4. Line buffer reduction

JCTVC-G230 Non-CE12.3: Reducing pixel line buffers by modifying DF to R3W2 for horizontal LCU edges [C.-W. Hsu, Y.-W. Huang, S. Lei (MediaTek), M. Ikeda, T. Suzuki (Sony), S. Park, B. Jeon (LG)]

In this contribution, modified vertical filtering with reading 3 pixels and writing 2 pixels (R3W2) for deblocking filter (DF) is proposed for horizontal LCU boundaries to reduce pixel line buffers required by DF, while the DF in HM-4.0 is still used for rest edges. The proposed method can save one pixel line buffer for DF compared with the current HM-4.0. It uses fewer pre-DF pixels above the horizontal LCU boundary for the filtering decisions, and filtering operations are also modified. Simulation results reportedly show 0% bit rate increase with unchanged run time and similar subjective quality in comparison with HM-4.0.

Modification points: in strong filtering decision use p2 instead of p3. Strong filter is modified. Only the upper side of deblocking filter is modified, the bottom side is the same as in HM4.0.

One proponent suggested discussing trade-off between having one more loop filter and removing one line from line buffer after the subjective test.

Results: 0.0/0.0, 0.0/0.0, 0.0/0.0 for HE-AI / LC-AI, HE-RA / LC-RA, HE-LD / LC-LD.

Recommendations: There was some interest, but proponents indicated that they may not be willing to join a CE investigation.

JCTVC-G844 Cross-verification of MediaTek and Sony's reducing pixel line buffers by modifying DF to R3W2 for horizontal LCU edges (JCTVC-G230) [T. Lee, J. Chen, J. H. Park (Samsung)]

5. Deblocking filter simplifications

JCTVC-G290 Deblocking Filter Simplifications [G. Van der Auwera, M. Karczewicz (Qualcomm)]

This contribution addresses simplification of the deblocking filter. It is proposed to modify the weak filter delta and the strong/weak filter decision. Modifying the weak filter delta reportedly results in BD-rate impacts of −0.2% for all-intra, −0.1% for random access, and −0.2% for low delay B. The number of strong/weak filter decisions for an edge segment is reduced from eight to two.

Part 1. It is proposed to modify the weak filter delta. Modifying the weak filter delta results in BD-rate savings of −0.2% for AI, −0.1% for RA, and −0.2% for LD B. The delta calculation for the first pixel from the block boundary is modified from (9*(q0-p0)−3*(q1-p1))/16) to (3*(q0-p0)-(q1-p1))/8 therefore reducing number of operation and resulting in weaker deblocking. E.g., in the absence of clipping, the blocking artifact 0 0 0 | 16 16 16 will be smoothed by the proposed deblocking to 0 2 4 | 12 14 16, whereas current HM4.0 deblocking results in 0 3 6 | 10 13 16.

Results: −0.2/−0.2, −0.1/−0.1, −0.2/−0.1 for HE-AI / LC-AI, HE-RA / LC-RA, HE-LD / LC-LD.

Part 2. It is proposed to modify strong/weak filter decision by performing the decision for the 4-pel edge based on one line. The number of strong/weak filter decisions for an edge segment is reduced from eight to two.

It was claimed by one participant that complexity in hardware does not decrease when comparing to testing two lines like in JCTVC-G590. The complexity in software probably decreases.

Results: 0.0/0.0, 0.1/0.0, 0.1/0.1 for HE-AI / LC-AI, HE-RA / LC-RA, HE-LD / LC-LD.

Recommendations: CE

JCTVC-G929 Cross check of Qualcomm‘s deblocking filter simplifications (JCTVC-G290 [A. Kotra, M. Narroschke, T. Wedi (Panasonic)] [late]

JCTVC-G090 Non-CE12: Testing results on using HM3.0 delta calculation for luma weak filter [M. Zhou, O.Sezer, V. Sze (TI)]

This contribution proposes to modify delta calculation for luma weak filter which has higher precision when compared to HM4.0 one. Simulation results revealed that the proposed modification improved coding efficiency by 0.2% in AI-HE and AI-LC, and 0.1% in RA-HE, RA-LC, LB-HE and LB-LC. The proposed change reportedly led to visible visual gain in BQMall (RA-HE, QP=37) sequence and no visual difference in the other CE12 selected subjective testing sequences.

Results: −0.2/−0.2, −0.1/−0.1, −0.1/−0.1 for HE-AI / LC-AI, HE-RA / LC-RA, HE-LD / LC-LD.

The proponent does not think it is necessary to participate in subjective viewing (since the proposal is similar to JCTVC-G290). Only one of JCTVC-G290 or JCTVC-G090 was expected to be studied in further CE work.

JCTVC-G162 Non-CE12: cross-verification of JCTVC-G090 on testing results on using HM3.0 delta calculation for luma weak filter by TI [Y. Jeon, S. Park, B. Jeon (LG)]

JCTVC-G639 Deblocking simplification and rounding optimization [A. Kotra, M. Narroschke, T. Wedi (Panasonic)]

Part 1: Replace deblocking for the second pixel from the block boundary by smoothing operation that does not take into account pixels on the other side of the block boundary. The motivation is simplification of the delta calculation. The BDR results are: AI HE −0.3%, AI LC −0.1%, small BD-rate increase (0.1%) on LDP configurations, other configurations 0.0%.

Results: −0.3/−0.1, 0.0/0.0, 0.0/0.0 for HE-AI / LC-AI, HE-RA / LC-RA, HE-LD / LC-LD.

One participant liked the idea, while one participant was concerned.

One participant states it is not a real simplification in terms of number of operations; however the contributors state that they break off various dependencies.

Part 2: Modification to deblocking rounding control. It is claimed that the current rounding in deblocking is not completely symmetric (according to collected statistics) and it is proposed to introduce another clipping function Clip4() with two adjustment parameters. These adjustment parameters were determined based on statistics of the current test set. The objective difference in BD bit rate is −0.1 on LC configurations and 0.0 on HE configurations.

Results: 0.0/−0.1, 0.0/−0.1, 0.0/−0.1 for HE-AI / LC-AI, HE-RA / LC-RA, HE-LD / LC-LD.

Recommendation: CE (parts 1 and 2 separate)

JCTVC-G385 Cross check of Panasonic's JCTVC-G638 and JCTVC-G639 on Deblocking [G. Van der Auwera (Qualcomm)] [late]

6. Signaling deblocking filter parameters in slice header

JCTVC-G291 Transform Dependent Deblocking Filter Parameter Adjustment in Slice Level [G. Van der Auwera, M. Karczewicz (Qualcomm)]

This contribution proposes to adjust the Tc and Beta parameters of the deblocking filter by enabling signalling of control data in the slice header. It is proposed to adjust Tc depending on the transform size and on intra or inter type of the blocks. The deblocking_filter_control_present_flag is proposed in the SPS to control the presence of the deblocking filter adjustment parameters in the slice header. There are BD-rate gains of −0.3% for all-intra HE and −0.1% for random access HE test conditions, other configurations similar to the anchor. The proponent advocates that these parameters are important for subjective visual quality.

Different tc offsets are sent for blocks of different size. The control parameters are signalled in the slice header. Similar to proposal JCTVC-G174 but with sending additional parameters.

Results: −0.3/−0.1, −0.1/0.0, 0.1/0.1 for HE-AI / LC-AI, HE-RA / LC-RA, HE-LD / LC-LD.

Recommendation: Participate in subjective viewing.

JCTVC-G982 Non-CE12 Subtest 5: Cross-check of Qualcomm's transform dependent deblocking filter parameter adjustment in slice level JCTVC-G291 [T. Yamakage, S. Asaka (Toshiba)] [late]

JCTVC-G619 Non-CE12: deblocking parameters signalling in slice header [A. Norkin, R. Sjöberg, K. Andersson, J. Enhorn (Ericsson)]

The document is a proposal for signaling deblocking filter parameters in the slice header. It is proposed to signal three deblocking parameters that control which pixels are being filtered, and one clipping parameter that determines the largest possible modification of the pixels in the weak filtering mode.

The proposal sends a flag and four parameters in the slice header:

- slice_tc_offset_div2
- slice_beta_offset
- slice_side_beta_offset_div4
- slice_nat_edge_offset_div2

The encoder makes a rough estimation of the parameters frame-wise on SSD has been implemented. BD-rate results are: −0.1% on AI, −0.4% on LDB HE and −0.3% on the rest of standard configurations.

The proposal can possibly participate in subjective viewing

Results: −0.1/−0.1, −0.3/−0.3, −0.4/−0.3 for HE-AI / LC-AI, HE-RA / LC-RA, HE-LD / LC-LD.

Recommendation: CE.

JCTVC-G1010 Cross Check of Ericsson's Proposal JCTVC-G619 [G. Van der Auwera (Qualcomm)] [late]

Recommendation for proposals on deblocking filtering parameters in CE12

A BoG was created (see under CE12.5) to discuss what tests to perform and how to evaluate proposals.

7. Varying QP deblocking and deblocking for IPCM blocks

JCTVC-G384 Varying QP Deblocking [G. Van der Auwera, M. Karczewicz (Qualcomm)]

This contribution proposes changes to the deblocking filter to support the varying QP capability enabled by delta-QP signaling. It is proposed to use the maximum of the QP values on both sides of the edge to lookup for Beta and tC threshold parameters. In case of weak filter decision for modifying one or two samples, it is proposed to use the QP value of the respective edge side to lookup a Beta parameter.

Related to proposal JCTVC-G640 part 1.

Recommendation: See below.

JCTVC-G987 Cross-check of Varying QP Deblocking (JCTVC-G384) Kenneth Andersson [late]

JCTVC-G640 Deblocking bug fix for CU-Varying QP's and IPCM blocks [A. Kotra, M. Narroschke, T. Wedi (Panasonic)]

The contribution presents modifications to deblocking operations when CU-based multi-QP optimization is enabled (Part 1) and IPCM blocks (Part 2).

Part 1:

Five modifications are proposed related to varying QP deblocking.

Individual tc and ß thresholds are derived for the blocks corresponding to an edge on which weak filtering is performed.

Separate tc values are used in deriving the delta offsets for innermost samples in weak filtering

Separate ß values are used in decision for filtering of outermost samples in weak filtering.

It was proposed to use an average of the QP's for deriving tc and ß values in filter decision process and strong filtering.

Experimental results were provided for a QP adaptation control that randomly assigns QP to coding units and to CE4 testing conditions.

Part 2:

It is suggested to use a separate QP (QP_PCM) which is associated to IPCM blocks whenever deblocking filtering is desired to be performed over IPCM blocks. QP_PCM parameter is transmitted in the slice header.

Recommendation: See below.

JCTVC-G1013 Cross Check of Panasonic's Proposal JCTVC-G640 On Varying QP Deblocking [G. Van der Auwera (Qualcomm)] [late]

JCTVC-G138 Deblocking of IPCM Blocks Containing Reconstructed Samples [G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm)]

This contribution proposes a modification to the HM4.0 deblocking loop filter in case of IPCM blocks containing reconstructed samples. HM4.0 deblocking filter always assigns quantization parameter value zero to the IPCM blocks, therefore deblocking filtering is disabled for the left and top edges of the IPCM blocks.

The proposal is to assign a quantization parameter value to the IPCM block, which is predicted from the neighboring quantization group.

Recommendation: See below.

JCTVC-G883 Cross-check report of Qualcomm's Deblocking of IPCM Blocks Containing Reconstructed Samples (JCTVC-G138) [K. Chono, H. Aoki (NEC)] [late]

JCTVC-G793 Non-CE12: Cross check of deblocking of IPCM blocks containing reconstructed samples (JCTVC-G138) [S. M. T. Naing, V. Wahadaniah, C. S. Lim (Panasonic)] [late]

Summary on JCTVC-G640, JCTVC-G384 and JCTVC-G138.

JCTVC-G384 uses maximum of the neighbouring blocks QPs, JCTVC-G640 part 1 uses average of QPs.

It is not possible currently to compare JCTVC-G383 and JCTVC-G640 subjectively or objectively since they are using different anchors (different varying QP settings).

There are certain similarities between two proposals (e.g. using separate QP values on the side of block boundaries).

Conclusion on varying QP:

- There was a suggestion to use the average of QPs on both sides of the edge (as in AVC) and align to decide the weak filter within one or two samples at each side of the edge.
- It was requested to develop proposed WD text on this and software in side activity (see JCTVC-G1031).

JCTVC-G1031 Support of varying QP in deblocking [G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm), M. Narroschke, A. Kotra, T. Wedi (Panasonic)] [late]

This contribution provides working draft changes and the corresponding software to support varying QP capabilities in the deblocking filter, which were recommended to have during the discussions in Track A. All changes are based on JCTVC-G640 and JVTVC-G384.

Was tested with the CE4 software (+/−12 QP variations)

Two changes are suggested:

- Average QP from both sides of the block boundary (as in AVC)
- In case of the luma weak filter, decisions on each side of the edge for modifying one or two samples, the QP that is associated to the CU of the respective edge side is used to derive the value β.

Decision: Adopt aspect 1 (averaging). Average value would be used also for deriving same beta value at both sides of the edge.

Note: Further study may be necessary on cases where one side of the edge is an IPCM block.

JCTVC-G138 proposes deriving QP for IPCM from neighbouring blocks, JCTVC-G640 proposes sending QP in the slice header for the all IPCM blocks in the slice.

Regarding IPCM deblocking, further study was recommended.

JCTVC-G1033 Crosscheck Report for JCTVC-G1031 by Qualcomm and Panasonic [S. Park, B. Jeon (LG)] [late]

5.5.2 Adaptive loop filter

Pre-Review of contributions on ALF, SAO and combined approaches took place in a BoG (JCTVC-G1020). Decisions were made in the track A sessions.

JCTVC-G146 Non-CE8: Information on ALF coefficient re-designing process [J. Lim, S. Park, B. Jeon (LG)]

This document presents an investigation report on complexity reduction for ALF. The purpose of the investigation is to reduce the ALF complexity by reducing the loop number of CU-based ALF control redesign process. The simulation result reportedly shows that the proposed method achieves 26%/7%/5% encoding time decrease with 0.0%/0.2%/0.4% bit rate increase for all intra HE, random access HE and low delay B HE configurations respectively.

(This is a non-normative encoder optimization.)

Investigation of the number of re-designs (3, 2, 1 and 0) vs. coding performance was conducted. If set to 1, 1 re-design will be required for each depth which results in 6 times scan of frame memory at encoder. In comparison with Qualcomm's 1/2-pass code that requires less frame memory scan, 2-pass requires 1 additional scan.

No action was taken on this.

JCTVC-G339 Crosscheck of LG's ALF (JCTVC-G146) [T. Ikai (Sharp)] [late]

JCTVC-G919 Non-CE8: Cross-check of JCTVC-G146 [P. Lai, F. C. A. Fernandes (Samsung)] [late]

JCTVC-G214 Non-CE8: Constrained ALF coefficients [C.-Y. Chen, C.-Y. Tsai, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek)]

In HM-4.0, ALF coefficients are unconstrained, which makes it difficult to decide the bit width of multipliers in hardware implementations. In this contribution, center coefficients are clipped within [0, 2), non-center coefficients are constrained within [−1, 1), and offsets are clipped within $[-2^D, 2^D)$, where D is the pixel bit depth. It is reported that the constrained coefficient ranges do not cause any coding efficiency loss or run time change.

The proposal limits the range of the integer part of ALF coefficients. Center: [0,2), other:[−1,1), DC:$[-2^D, 2^D)$. This is to specify multiplier's bit range. No need for syntax change was indicated. However, it would be necessary to add a restriction on the encoder/bitstream. No detailed statistical analysis was available, but it was indicated that more than 99% of coefficients would not be hit by this restriction, and the proposal was indicated to reduce complexity/runtime.

Recommendation from BoG: Adoption.

Decision: Adopt.

JCTVC-G853 Crosscheck of JCTVC-G214 on constrained ALF coefficients from MediaTek [S. Park, B. Jeon (LG)] [late]

JCTVC-G215 Non-CE8: Limited number of filters per picture for ALF [C.-Y. Chen, C.-Y. Tsai, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek)]

In ALF of HM-4.0, up to 16 filters per picture are used for luma, and it was asserted that 16 filters may be too many for low resolution applications. In this contribution, a maximum number of filters per picture can be given on the encoder side, and the ALF encoder will merge regions or classes accordingly. Simulation results reportedly show that when the maximum number of filters per picture is 10, no coding efficiency loss is observed. When the maximum number of filters per picture is six, 0.1% bit rate increase was reported in LDP. It was suggested that proper values for the maximum number of filters can be discussed when common test conditions are defined and that allowed values can be decided when profiles and levels are defined.

Two options: Make it switchable by syntax element, or just define the number by profile/level. (It was discussed elsewhere that there may be dependency of the required number of filters on picture size, but nobody is sure about that.)

Decision (SW): (Track A) Have the number of filters as a parameter in the encoder configuration file, with a default of 16.

JCTVC-G147 Non-CE8: Cross-check of MediaTek's limited number of ALF filter by LG (JCTVC-G215) [J. Lim, S. Park, B. Jeon (LG)]

JCTVC-G216 Non-CE8: Removing the 15th merge flag for BA mode in ALF [C.-Y. Chen, C.-Y. Tsai, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek)]

The block-based adaptation (BA) mode of ALF in HM-4.0 classifies blocks into 15 classes. Classes can be merged, and one filter is used for each class after merging. For class merging, only 14 merge flags are needed. Therefore, it is proposed to remove the 15th merge flag for BA mode, as a bug-fix.

In BA mode, 15 merge flags exist in HM4/WD4. But only 14 merge flags are necessary to merge 15 filters. The same conclusion is reported in JCTVC-G610.

Decision: Adoption (as a syntax bug fix).

JCTVC-G218 Non-CE8: One-stage non-deblocking loop filtering [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)]

In this contribution, SAO and ALF are combined into one stage by dividing one picture into filter units (FUs) and switching FUs among {ALF, SAO, OFF}, where FUs are LCU-aligned blocks coded in raster scan in APS and the FU-based syntax is also asserted to be friendly for low latency. It is reported that the proposed method achieves 0.1%, 0.1%, 0.0%, and 0.0% bit rate reductions for HE-AI, HE-RA, HE-LDB, and HE-LDP, respectively, with a picture-based 2-pass encoding algorithm. The proponents requested to adopt this proposal in the next CE8 for studying LCU-based syntax and corresponding low latency encoding algorithms.

The proposal integrates ALF and SAO in a single processing step (also keeps the options SAO only or ALF only). Number of filters: up to 16 for the experiment. Gain 0.1/0.1/0.0/0.0, chroma loss (2%). Runtime Enc: 108/102/102/103, Dec: 104/105/105/107. The software is not mature; therefore runtime increase is observed. Further study in a CE was recommended.

JCTVC-G846 Cross-Check for JCTVC-G218 [C. Kim, Y. Park(Samsung)] [late]

JCTVC-G351 Modification of ALF classification [E. Maani, M. Ikeda (Sony)]

The classification of ALF is modified to make the process more hardware friendly. More specifically, with the proposed modification, the classification of the 4x4 block and filtering operations of the first pixel can be done at the same time. The classification only uses the top left 3x3 subblock which is also used for filtering of the first pixel.

A single read is used for classification and filtering for hardware friendly design.

Bit rate reductions are: Common: 0.1/0.1/0.1/0.1 BA reduced: 0.1/0.1/0.1/0.1 (BA classification and calculation with inner two pixels.)

Runtimes Enc Common: 100/100/100/100 BA reduced: 100/100/100/100 Dec 98/98/100/99 96/99/99/99.

Relationship with JCTVC-G609 which only does BA classification with inner two pixels (partially adopted from CE8). Further study in a CE was recommended.

JCTVC-G803 Non-CE8: Cross-check for Simplification of ALF Classification [T. Yamamoto, T. Ikai (Sharp)] [late]

JCTVC-G1045 Cross-check of JCTVC-G382 (Quantization with Adaptive Reconstruction Levels) set-2 modifications David Flynn (BBC) [late]

JCTVC-G380 Non-CE8: Coding tree level signalling of alf_cu_flag [T. Nishi, K. Uchibayashi (Panasonic)]

In this contribution, a coding tree level signalling of alf_cu_flag was proposed instead of the signalling using the adaptive loop filter coding unit control parameter syntax in the slice header. In the current HEVC WD, ALF process requires a buffer memory to store the flags in a decoder implementation. In the proposed method, in order not to require the buffer memory, alf_cu_flag is coded in the coding tree syntax, and thus the flag can be discarded right after the relevant block level processing. The proposed method was evaluated on the top of HMv4.0, and the difference in the objective performance was reportedly negligible.

Signal alf_cu_flag at each cu. This eliminates a buffer to store alf_cu_flag (16kBytes for 4K2K). Coding results were obtained by an encoder with the current frame-based design of ALF coefficients. This approach is claimed to be friendly with low latency coding.

Coding gain and runtime were unchanged.

Comments by experts included the following: The flags can be stored in external memory, where the memory bandwidth increase is negligible. If this proposal claims friendliness with low latency encoding, the encoder should use sub-optimal filter coefficients that were designed from the previous frames. A question was raised whether the transmission of the bitstream can be started right after an LCU is coded, or needs to wait for a slice to be fully coded. The approach may not be friendly for some parallel processing schemes (wavefront, slice boundary filtering).

There was no consensus about this, one non-proponent company supports it, but there were several statements against it. The subject was left as-is; no action was taken.

JCTVC-G938 Cross-check of JCTVC-G380, "Non-CE8: Coding tree level signaling of alf_cu_flag" [A. Fuldseth (Cisco)] [late]

JCTVC-G499 Improved ALF with low latency and reduced complexity [A. Fuldseth, G. Bjøntegaard (Cisco)]

The contribution proposed a low complexity ALF technique with support for sub-frame encoder delay. One single set of ALF filter coefficients are transmitted for each LCU using single-pass estimation. This supports low encoder-side delay by allowing for estimation and signaling of the ALF coefficients on the LCU level without aggregating pixel date of the whole frame. The proposed ALF uses either 5x5 diamond shape or 9x3 cross shape and does not require decoder-side variance calculations. The absence of decoder-side variance calculations reportedly represents a significant reduction in decoder complexity. When applied to low complexity configurations, BD-rate gains between 1.6% and 4.0% are reported. When applied to high efficiency configurations, BD-rate impacts between −0.2% and 0.4% are reported. For high efficiency configurations, encoding times varied between 67% and 94%, while decoding times varied between 91% and 94%.

This was a proposed improvement of a CE8 proposal, JCTVC-G498. At each LCU, a filter is designed (or previously designed filter is used). A flag to indicate control of filtering is signalled. The scheme is intended to be suitable for single-pass encoders. It was proposed to adopt this in both HE and LC. Two filter shapes were proposed (snowflake as is, and cross-shape with 3 pel vertical height). Up to 16 coefs. were stored for a slice (as a kind of dynamic codebook); one of which is selected for a LCU, or a new one is designed.

The software was uploaded to the JCT-VC site on Nov. 22.

Luma Bitrate: HE: 0.2/0.4/0.0/−0.2 LC: 1.6/2.5/2.3/4.0 (AI/RA/LBLP)

Runtime: Enc HE: 67/91/94/90 LC: 106/102/101/101 Dec HE: 91/92/94/94 LC: 114/113/111/113

A non-proponent preferred this. Comment: There seems to be higher loss in higher resolutions. Runtime reduction may come from not applying ALF to chroma. The same discussion as with JCTVC-G380 seemed to apply regarding transmission timing.

The syntax and estimation process were LCU based, with no pixel based classification, and no chroma filter.

Largest loss for RA was in class A (1.1%, a little more on steam locomotive)

The combination with wavefront processing needs to be investigated.

This seemed to be a very interesting proposal. Investigation in a CE was requested. The CE should also investigate a more drastic simplification of current ALF, e.g. removal of pixel-based classification.

There was some discussion regarding whether low latency testing criteria should be established.

(The group decided that no special software branch should be created for this study.)

JCTVC-G651 Crosscheck of JCTVC-G499 - Improved ALF with low latency and reduced complexity [M. Budagavi (TI)] [late]

JCTVC-G445 Removing DC component of ALF filter coefficients [A. Minezawa, K. Sugimoto, K. Miyazawa, S. Sekiguchi (Mitsubishi)]

In this contribution, a modification to adaptive loop filtering is proposed. In the proposed scheme, DC offset coefficient for adaptive loop filtering is removed. This modification is implemented onto HM-4.0 software, and simulations are conducted using common test configurations to evaluate the performance of the scheme. It is reported that the proposed scheme shows 0.1% BD-rate achievement on average with reduction of encoding run-time.

Remove DC offset of ALF. SAO and ALF DC offset may have overlapping effect. This comes with a loss for class E (0.4% luma, more for V channel).

JCTVC-G918 Non-CE8: Cross-check of JCTVC-G445 on removing DC component of ALF filter coefficients [P. Lai, F. C. A. Fernandes (Samsung)] [late]

JCTVC-G615 Non-CE8: Cross check of Mitsubishi's removing DC component of ALF filter coefficients [I. S. Chong, M. Karczewicz (Qualcomm)]

JCTVC-G774 Non-CE8: Modified ALF DC coefficients [T. Yamakage, T. Watanabe, T. Chujoh (Toshiba), C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), M. Karczewicz, I. S. Chong (Qualcomm)]

This evaluates modified ALF DC coefficients. This technique uses less bit-depth for ALF DC coefficients. Coding efficiency gain for luma is 0.0%, 0.1%, 0.1% and 0.1% in HE-AI, RA, LB, and LP, without encoding/decoding time increase on average.

Use lower precision to signal DC coefficient (2 bits instead of the current 9 bits).

JCTVC-G892 Non-CE8: Cross-check of JCTVC-G774 on modified ALF DC coefficients P. Lai, F. C. A. Fernandes (Samsung) [late]

JCTVC-G610 Improvements to ALF [J. Zhao, A. Segall (Sharp)]

This contribution proposes three simplifications and improvements for signalling Adaptive Loop Filter coefficients.

First, a switchable option of not sending the DC coefficient is proposed. It is asserted that this reduces the complexity of the ALF process and improves coding efficiency. Using common conditions, the average bit rate difference is −0.1%, −0.4%, −0.4% for Y, U, and V components, respectively for AI, −0.1%, −0.4%, −0.5% for RA configuration, and 0.0%, 0.1%, 0.0% for LD.

Second, it is proposed to predict the luma center coefficient from other coefficients when inter filter prediction is not used. This harmonizes the coding of the center coefficient between the luma and chroma filters. It is reported that the method provides an average −0.1% rate change for luma for RA and LD configurations.

Third, it is proposed to use fixed k tables for the Golomb code for sending luma filter coefficients. In HM4.0, the k value to decode luma filter coefficients is adapted on a slice-by-slice level. Using a fixed set of k values removes the need for the adaptation, and the need for transmitting/extracting the k values from the bitstraem. Results reportedly show that there is no coding efficiency loss by using fixed k tables.

Item 3 not discussed in the relevant BoG, as there is some understanding that this is preliminary work.

Lower precision is proposed to be used to signal DC coefficient (2 bits instead of the current 9 bits).

This proposal also includes reports of two bug fixes:

1. Suggests to remove the k values from entries 0 to 4 in alf_golomb_index_bit, which are not used any more in the case of the cross-shaped filter – Decision: Agreed.
2. The second aspect is identical as suggested by JCTVC-G216, and was agreed there.

JCTVC-G952 Non-CE8: Cross-check of JCTVC-G610 on improvements to ALF [P. Lai, F. C. A. Fernandes (Samsung)] [late]

JCTVC-G998 Combined Result of JCTVC-G610 and JCTVC-G774 [J. Zhao, A. Segall (Sharp), M. Karczewicz, I. S. Chong (Qualcomm)] [late]

JCTVC-G610 proposes modifications to the ALF process consisting of (i) selectively sending DC coefficients, (ii) harmonization of center coefficient signalling between luma and chroma, and (iii) reduced signalling of the k values used to transmit ALF coefficients. It is asserted that these modifications simplify ALF and also provide coding efficiency improvement. JCTVC-G774 also proposes modifications to the ALF process consisting of reducing the bit-depth of DC coefficient values. It is also asserted that this modification simplifies ALF and provides coding efficiency improvement.

In this proposal, the combination of JCTVC-G610 and JCTVC-G774 is reported. The proposal reports that the combined solution provides additional coding efficiency gains. Moreover, it is asserted that the simplifications of each proposal are maintained and additive.

Conclusion of BoG from JCTVC-G445, JCTVC-G774, JCTVC-G610, JCTVC-G998:

Regarding the necessity of the DC offset. In some cases (in particular, high quality coding cases), the DC offset will work (at least 0.4% gain); however it does not always work. Therefore, it is suggested to create a switch to enable/disable the DC offset.

Suggestions: a) removal (JCTVC-G445) b) Make DC offset switchable and use predictive coding of center luma coefficient (JCTVC-G610), or c) Reduce the precision of the offset value (from spatial neighbors, JCTVC-G774).

Decision: Adopt JCTVC-G445 (remove DC offset). No CE on the other aspects was planned.

The prediction of the center coefficients from JCTVC-G610 is a variant of a subset of JCTVC-G665, which was adopted.

JCTVC-G615 Non-CE8: Cross check of Mitsubishi's removing DC component of ALF filter coefficients [I. S. Chong, M. Karczewicz (Qualcomm)]

JCTVC-G446 Reduction of the number of pixels used in Adaptive Loop Filter [K. Miyazawa, K. Sugimoto, A. Minezawa, S. Sekiguchi, T. Murakami (Mitsubishi)]

This contribution proposes a method for reducing the number of pixels used in the Adaptive Loop Filter (ALF). Prior to applying ALF, the proposed technique calculates a score predicting the effectiveness of ALF for each pixel, then, skips all ALF processes (e.g. pixel classification, filter design, filter apply) for the pixels whose scores are less than a threshold. This threshold is adaptively determined for each frame in the encoding process, and is transmitted to the decoder. The simulation results reportedly show that the proposed method achieves 2–9% encoding time reductions and 1–2% decoding time reductions, with 0.1–0.2% BD-rate loss for AI-HE, RA-HE, and LD-HE structures.

Complexity reduction of ALF by skipping area of ALF pixels by pre-analyzing a cost for 4x4 block.

ALF-skipped pixels is 40%, loss 0.1/0.2/0.2/xx

Comment: alf_cu_flag may do similar thing with more burden.

Helps on average complexity, but hurts worst case (unless we would limit percentage of ALF use which might incur additional problems). No action taken.

JCTVC-G920 Cross-check of Mitsubishi's reduction of the number of pixels used in Adaptive Loop Filter JCTVC-G446 [T. Yamakage, T. Itoh (Toshiba)] [late]

JCTVC-G463 Block-based filter adaptation with intra prediction mode and CU depth information [S. Wang, S. Ma, J. Jia (LG)]

This contribution presents a simplification of block-based filter adaptation (BA) scheme for intra slice. For each 4x4 block, features are obtained from intra picture prediction mode and CU depth. So that filter adaptation is free from calculation of direction and Laplacian features. The proposed method reportedly shows an average 2% decoding time reduction, with 0.1% BD-rate loss for AI structures in comparison with the HM 4.0.

Simplification of filter adaptation in BA-ALF for intra slices. Intra prediction modes, CU depth information and PU sizes are used instead of calculating directional and Laplacian features. Only for intra slices? Yes. 0.1% loss is reported for intra.

It may become complicated to implement a different adaptation process just for intra (additional functions or circuitry are necessary), whereas the worst case run time must be supported anyway, so saving computation for intra only may not be so helpful. No action taken.

JCTVC-G835 Cross verification of LG's Block-based filter adaptation with intra prediction mode and CU depth information (JCTVC-G463) [Y. Chiu, L. Xu (Intel)] [late]

JCTVC-G656 Non-CE8 Subtest a: Harmonization of CE8a Tool 2 Shape-dependent BA (SDBA) and Tool 3 Block-based filter adaptation with up to 8 filters (HV8) [P. Lai, F. C. A. Fernandes, I.-K. Kim (Samsung)]

This contribution presents a filter adaptation method which harmonizes CE8a Tool 2 "Shape-dependent Block-based Filter Adaptation (SDBA)" and CE8a Tool 3 "Block-based filter adaptation with 8 initial filter classes (HV8)". For BA, computation of features along diagonal directions or horizontal/vertical directions is coupled with the filter shape (snowflake or cross), such that there are the same numbers of "classification + shape combinations" to be evaluated at encoder, as compared to HM4.0. For classification, unified and reduced number of initial filter classes to 8 for both BA and RA is achieved by: For BA, directly comparing BA directional features to produce 2 directional classes, each with 4 magnitude levels. For RA, a frame is partitioned into 8 regions corresponding to 8 initial filter classes.

The harmonized method reportedly shows 0.1% BD-rate gain for AI, RA, LDB; and 0.2% BD-rate gain for LDP.

Reviewed in context of CE8a.

JCTVC-G338 Non-CE8.a: Crosscheck of Non-CE8 Subtest a: Harmonization of CE8a Tool 2(SDBA) and Tool 3(HV8) (JCTVC-G656) [T. Ikai (Sharp)]

JCTVC-G666 1D- DCT based frequency domain adaptive loop filter (FD-ALF) [Jeongyoen Lim, Ju Ock Lee, Hae-Kwang Kim, Joo-Hee Moon]

A frequency-domain adaptive loop filtering (FD-ALF) method on the basis of 1D DCT is proposed in this document. The purpose of this contribution is reducing computational complexity of ALF while minimizing coding efficiency loss. The basic scheme of FD-ALF follows the current ALF in HM4.0 except that the filtering is applied in 1D DCT frequency domain. FD-ALF is adaptively applied on RA or BA classification mode and can be controlled on CU unit basis just as same way as the existing ALF. DCT domain filtering is processed by multiplication operation of DCT domain filter to the DCT transformed reconstructed picture after SAO rather than the convolution operation of current pixel based ALF filter. Different 1D DCT filters are characterized by its tap size (8 tap, 16 tap), its direction (horizontal or vertical) and the coefficients of each of 1D DCT filters. The coefficients of 1D DCT filters are obtained by MSE (Mean Square Error) optimization between the original picture and the reconstructed picture.

Using common conditions, the average bit rate change is +1.2% for Y components for high efficiency AI, +2.2% for Y components for high efficiency RA, +1.8% for Y components for high efficiency LDB, and +2.8% for Y components for high efficiency LDP. Encoder Time is 83% for high efficiency AI, 97% for high efficiency RA, 98% for high efficiency LDB, and 96% for high efficiency LDP. Decoder Time is 94% for high efficiency AI, 91% for high efficiency RA, 94% for high efficiency LDB, and 92% for high efficiency LDP.

Presented Friday afternoon. No bit rate reduction (loss).

No action taken.

JCTVC-G691 Non-CE8: Combination of CE8.a.1 and CE8.a.2 [T. Yamakage, T. Watanabe, T. Chujoh (Toshiba), C. Y. Chen, C. M. Fu, C. Y. Tsai, Y. W. Huang, S. Lei (MediaTek), M. Karczewicz, I. S. Chong (Qualcomm), T. Ikai, A. Segall, T. Yamamoto (Sharp)]

This evaluates a combination of CE8.a.1 and CE8.a.2. The coding efficiency is reportedly improved by 0.2%, 0.3%, 0.3% and 0.4% in HE-AI, RA, LB, and LP.

Reviewed in context of CE8a.

JCTVC-G653 Non-CE8: Cross-check of JCTVC-G691 Combination of CE8.a Tool 1 and Tool 2 [P. Lai, F. C. A. Fernandes (Samsung)]

JCTVC-G813 ALF with single filter type [M. Budagavi (TI)]

In HM-4.0, two types of ALF filters are used – with cross and star support shapes. This contribution presents BD-Rate results when only one of the two filters is used. It is asserted that using only the cross results in a BD-Rate loss of: AI-HE: 0.08%, RA-HE: 0.32%, LB-HE: 0.40%; using only the star results in a BD-Rate loss of: AI-HE: 0.16%, RA-HE: 0.41%, LB-HE: 0.58%. It is asserted that from an encoder complexity reduction perspective a single filter type that can provide most of the gains of two filter types is desirable since it reduces the number of encoder passes. A single filter type of a cross filter with rectangular center was reported in JCTVC-G130 to capture most of the gains of chroma ALF with two filter types. This contribution proposes that a similar filter be evaluated for luma.

Results (negative means losses): No ALF: −1.9/−3.7/−3.1/xx; Only Star: −0.2/−0.4/−0.6/−0.3; Only Cross: −0.1/−0.3/−0.4/−0.7.

Comments:

If a single filter is adopted, is it possible to use more coefficients?

Slice boundary processing becomes simpler. Gain/loss highly depends on the sequence.

Study in CE part on simplification of ALF design.

JCTVC-G1012 Non-CE8: Supplementary results to JCTVC-G813 regarding ALF using one filter type (Luma only) [P. Lai (Samsung), H. Guermazi (eBrisk Video)] [late]

Not considered (late/missing when the topic was discussed).

JCTVC-G923 ALF decoding time reduction by adopting a simple SIMD code (Informative) [T. Yamakage, T. Itoh (Toshiba)] [late]

This contribution informs about decoding time reduction of ALF by implementing with SIMD code.

By implementing ALF (BADIR classification and ALF filtering) with a simple SIMD code, the decoding time is reportedly reduced by 9% on average. This SIMD code can be compiled with Microsoft (R) Visual Studio (R) 2010, and uses Intel (R) SSE4.1. Results were cross-checked by JCTVC-G954.

Process 8 pixels in parallel.

10% less decoding time by SIMD code (i.e., ALF time became 1/3).

Just for information – no action.

JCTVC-G954 Non-CE8: Cross check of ALF decoding time reduction by adopting a simple SIMD code (JCTVC-G923) [I. S. Chong, M. Karczewicz] [late]

5.5.3 Sample adaptive offset

JCTVC-G222 Non-CE8: Offset coding in SAO [C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek), I. S. Chong, M. Karczewicz (Qualcomm)]

The offset coding in SAO of HM-4.0 reportedly does not fit the offset distribution. In this contribution, a new codeword design was proposed and asserted to better fit the offset distribution, or an offset prediction technique can be used to reduce offset information. Simulation results reportedly show that the luma bit rate and the chroma bit rate are reduced by 0–0.1%, and 0.1−0.5%, respectively, with unchanged run time.

Bitrate reduction HE: 0.0/0.0/0./0.0 LC: 0.0/0.1/0.1/0.1 (little more for chroma).

Comment: Predictor seems to depend on Qp.

JCTVC-G818 Cross-check for Offset coding in SAO from MediaTek and Qualcomm by Samsung [E. Alshina, J.H. Park] [late]

JCTVC-G490 Modified SAO edge offsets [K. Andersson, P. Wennersten, R. Sjöberg (Ericsson)]

In this contribution, SAO edge offsets in HM4.0 are modified to be more specific to edge characteristics. The result reportedly indicates that edges are enhanced both subjectively and objectively. The average BDR gain versus HM4.0 is reported as 0.2% for luma and 1% for chroma for the common conditions. With YUV BDR (6Y+U+V)/8, the average YUV BDR gain is reportedly 0.4%. The best results are obtained for the optional condition of low delay P at low complexity, where average luma BDR is

reportedly improved by 1.1%. The encoding time is similar to HM4.0. The average decoding time on a single machine is increased by 1.8% compared to HM4.0.

By adding the possibility to use more specific edge offsets when needed, both the subjective and the objective quality can reportedly be improved. The contribution proposes selection of either the current 4 constrained edge offset or a new 10 unconstrained edge offset.

Bit rate reduction HE: 0.0/0.0/0.1/0.1 LC: 0.0/0.2/0.5/1.1 (more for chroma).

Comments:

- Small complexity increase.
- Potential increase of offset values. Encoder needs to be a little bit more complicated.
- Most of the gain comes from adding 10 offsets.
- There was a concern about extra cost / switching.

JCTVC-G827 Non-CE8: Crosscheck for Ericsson's modified SAO edge offsets in JCTVC-G490 [C.-M. Fu, Y.-W. Huang (MediaTek)] [late]

JCTVC-G680 Non-CE8: Method of visual coding artifact removal for SAO [W.-S. Kim, D.-K. Kwon (TI)]

Sample adaptive offset (SAO) is reported to usually improve overall subjective quality. However, it can reportedly cause visual artifacts occasionally by adding offset value determined globally in the given region to pixels having statistics that are very different from that of global ones. For example, in the class E sequence Vidyo 1, a “pepper and salt” type of coding artifact has reportedly been observed. In this contribution the cause of such a coding artifact is analysed, and a method to remove this artifact is proposed. In the proposed method, the sign value of the edge offset is restricted according to edge category, so that the contrast between the current and neighboring pixels is not increased after adding the offset. Subjective tests reportedly show that the SAO visual artifact is removed by employing the proposed method. Experimental results also reportedly show that the proposed change does not compromise overall subjective quality and coding efficiency (Average BD-rate increase of 0.0% for luma and 0.2% for chroma).

Proposes an asserted subjective picture quality improvement on SAO.

The sign value of edge offset is restricted according to edge category, so that the contrast between the current and neighboring pixels is not increased after adding the offset. (Basically, only low-pass non-linear filtering is applied.)

Still images were shown during presentation, and the improvement was recognized by participants.

BR reduction HE: 0.0/0.0/0.0/0.0; LC: 0.0/0.0/−0.1/0.0.

Comments from BoG discussion:

The rationale of having the sign for the offset was debated. It was suggested that there should be a non-normative way to do the same thing. The proposal was supported by several participants, while the original SAO proponent expressed some concern about the immediate change of the specification. It is suggested to conduct subjective viewing of moving pictures.

Can be done encoder-only, but then the sign would be useless.

The BoG recommended adopting the encoder-only action in principle, but no one had yet tested or implemented it. Further investigation in context of CE (both normative and non-normative solution) was recommended.

JCTVC-G808 Cross-check for TI's proposal (JCTVC-G680) [T.Matsunobu, T.Sugio, T.Nishi (Panasonic)] [late]

JCTVC-G915 Coding and selection of SAO parameters [D. Baylon, K. Minoo (Motorola Mobility)] [late]

In HM4.0, the determination of the SAO offset value is based upon only distortion considerations. This contribution proposes to determine the offset based on RD considerations. In addition, this contribution proposes to increase the number of EO classes to eight. Simulations over 30 frames reportedly show no significant loss in luma coding for HE and LC, with a bit rate savings of up to 1.2% for chroma HE, and 1.1% for chroma LC.

The contribution proposes to determine the offset based on RD considerations. In addition, this contribution proposes to increase the number of EO classes from four to eight. Also a change in coding of BO type. (HE case)

Short-length results: HE: 0.0/0.0/0.0/0.0 luma LC: 0.0/0.0/0.0/−0.1 luma Chroma: 0.5 to 1.1% gain

Encoder optimization: supported by a participant, but wait for cross-check results.

There was a recommendation from breakout discussion to adopt the encoder optimization part, but conditional on receiving cross-check analysis.

A CE is suggested on various proposals of SAO offset adaptation which slightly reduces the rate but also appears to slightly increase complexity – it was discussed whether that was 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 the next meeting (note: this could apply to some other CEs as well and would just mean to apply rules that were already set up previously).

JCTVC-G1014 Non-CE8: Crosscheck for Motorola's coding and selection of SAO parameters in JCTVC-G915 [C.-M. Fu, Y.-W. Huang (MediaTek)] [late]

It was reportedly confirmed that the non-normative part provides the intended fix in the RD optimization and achieves the expected BD rate gain (0.3–0.4% for chroma).

Decision (SW): Adopt the non-normative element of JCTVC-G915.

JCTVC-G246 On additional SAO Band Offset classifications [G. Laroche(Canon), T. Poirier, P. Onno (Canon)]

This contribution presents a modification of sample adaptive band offsets. The proposed modification consists of adding 8 classifications of band offsets. The additional classifications are based on the first group of sample adaptive band offsets. These additional classifications are the combination of 3 interval sizes and 3 sizes of class. Moreover, the center of the proposed intervals in the intensity range is coded. In the experimental results, two configurations are presented with respectively 6 and 8 additional classes. The proposed modification reportedly gives an average BDR of −0.4% for $PSNR_{AV}$, −0.1% for Luma component, −1.7% for Chroma U and −2.0% for Chroma V with a small impact on the encoding runtime and with complexity reduction of the decoding runtime.

Adds 8 Band Offset classifications to the 2 current HM4.0 BO groups. In particular, 3 additional intensity subdivision ranges are added. Worst case complexity does not increase since it comes from EO. Decrease of decoding time was achieved by selecting BO more frequently. A new RDO selection applied for all SAO classification.

Another test was to add 6 Band Offset classification.

Main proposal: HE: 0.0/0.0/0.1/0.1 luma LC: 0.0/0.1/0.2/0.1 luma Chroma: 0.7 to 2.7% gain (average 1.7U, 2.0V).

Additional test: HE: 0.0/0.0/0.1/0.1 luma LC: 0.0/0.1/0.2/0.1 luma Chroma: 0.5 to 2.2% gain (average not recorded).

Comments: Chroma only change? No, both luma and chroma for consistency. It was suggested to signal the center band for every region.

JCTVC-G828 Non-CE8: Crosscheck for Canon's additional SAO band offset classifications in JCTVC-G246 [C.-M. Fu, Y.-W. Huang (MediaTek)] [late]

JCTVC-G682 Non-CE8: Reduced number of band offsets in SAO [W.-S. Kim, D.-K. Kwon (TI)]

In the current HM-4.0 design, SAO parameters are encoded in the adaptation parameter set (APS), and need to be stored in a buffer until the SAO process is completed for each picture. The buffer size is proportional to the number of SAO partitions and the size of SAO parameters for each partition. In this contribution the number of band offsets is reduced from 16 to 8, and number of bands is increased from 2 to 4. With this scheme, the number of band offsets that a decoder needs to buffer can effectively be reduced from 16 to 8. The experimental results and subjective viewing reportedly show that the proposed scheme reduces the SAO parameter buffer size on the decoder side by half without degrading subjective and objective quality. The measured BD-rate reduction is 0.1% in LB-LC, and 0.0% in all the other configurations.

The number of band offsets is reduced from 16 to 8, and number of bands is increased from 2 to 4. The purpose is to reduce the memory to store offsets.

Proposal 1: 4 band, 8 offsets

Proposal 2: The coverage of offsets of the first and the last sub-band are extended to the pixels outside the band.

Main proposal: HE: 0.0/0.0/0.0/0.0 luma LC: 0.0/0.0/0.1/0.0 luma Chroma: 0.1 to 0.5% gain

Extended proposal: HE: 0.0/0.0/0.0/0.0 LC: 0.0/0.0/0.1/0.0

Comments:

- It is suggested that number of offsets could also be imposed by level constraints.
- Encoder must perform more depth analysis.
- Note: JCTVC-G218 (unified ALF/SAO) might also solve this problem

Conclusion: Conduct CE on JCTVC-G246, JCTVC-G682 (SAO simplifications)

JCTVC-G748 Non-CE8: Crosscheck of TI's Reduced number of band offsets in SAO [T. Ikai (Sharp)] [late]

JCTVC-G309 Modifications of offset classifications in SAO [Y. Yasugi, T. Ikai (Sharp)]

This contribution describes modifications of offset classification in SAO (Sample Adaptive Offset). In this proposal, offset classification tables are modified for both offset types: Edge Offset (EO) and Band Offset (BO). For EO types, the fifth offset is employed on pixels which edgeIdx is 2. For BO types, a new band-classification table is introduced for chroma values. It is reported that the proposed method improves coding efficiency of chroma channels by averages of 0.3%, 0.4% and 0.5% for IO_HE, RA_HE and LB_HE condition respectively.

For EO types, the fifth offset is employed on pixels which edgeIdx is 2. For BO types, a new band-classification table is introduced for chroma values.

HE: 0.0/0.0/0.0/xx luma LC: 0.0/0.0/0.0/xx luma Chroma: 0.3 to 0.5% gain in chroma (HE cases).

No action.

JCTVC-G483 Non-CE8: Crosscheck for SHARP's modifications of offset classifications in SAO in JCTVC-G309 [C.-M. Fu, Y.-W. Huang (MediaTek)] [late]

JCTVC-G831 Non-CE8: Sample Adaptive Offset with LCU-based Syntax [C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), M. Karczewicz, I. S. Chong (Qualcomm)]

In HM-4.0, sample adaptive offset (SAO) parameters are coded for each region in a picture. In order to support localization of SAO parameters with higher flexibility, this contribution proposed a new syntax that allowed SAO parameters to be adaptively changed at any largest coding unit (LCU). Simulation results reportedly showed that the proposed syntax caused 0.0%, 0.1%, 0.1%, 0.1%, 0.0%, 0.1%, 0.2% and 0.2% bit rate increases for HE-AI, HE-RA, HE-LB, HE-LP, LC-AI, LC-RA, LC-LB, and LC-LP, respectively, with almost the same encoding and decoding times when the algorithm of deriving localized SAO parameters was unchanged.

Motivation: It is desirable to develop a simple syntax that can support many different picture partitioning algorithms for SAO optimization.

Allow SAO parameters to be adaptively changed at any largest coding unit (LCU). SAOP can be signalled LCU by LCU or can be copied from left or above LCU or above LCU line. Prediction of offset is also applied.

Loss: HE: xx/−0.1/−0.1/−0.1 LC: xx/−0.1/−0.2/−0.2

Encoder implementation can be (1) same design as HM4 with the LCU-based syntax, or (2) LCU by LCU level encoder that may lose some coding gain.

Note: JCTVC-G218 also would enable LCU-based adaptation. However, it may be implementation specific whether combined SAO and ALF is desirable, as some implementations may rather combine de-blocking and SAO. Therefore, include this in the same CE part as JCTVC-G218.

JCTVC-G935 Cross-check for LCU based SAO from MediaTek and Qualcomm (JCTVC-G831) by Samsung [E.Alshina, J.H.Park (Samsung)] [late]

5.5.4 Combined approaches

JCTVC-G211 Non-CE8.c.6: Multi-source SAO and ALF virtual boundary processing with cross9x9 [C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), S. Esenlik, M. Narroschke, T. Wedi (Panasonic), I. S. Chong, M. Karczewicz (Qualcomm)]

In HM-4.0, SAO requires 0.2 luma pixel line buffer (PLB) and 0.2 chroma PLB, and ALF requires 4.1 luma PLBs and four chroma PLBs. In JCTVC-F054 and JCTVC-F055, virtual boundary (VB) processing was proposed to remove all line buffers for ALF and SAO, respectively. In JCTVC-F272, multi-source SAO and ALF were proposed to reduce line buffers. In JCTVC-G206, the three prior proposals and using snowflake5x5 and cross9x9 ALF shapes are combined as CE8.c.4-2 to remove all SAO and ALF line buffers, and this contribution further improves the visual quality of CE8.c.4-2 without increasing any line

buffer. Due to the DF in HM-4.0, the luma VB and the chroma VB are set as three pixels and one pixel above the horizontal LCU boundary, respectively, and processing each pixel on one side of a VB avoids any data access from the other side of the VB unless the data can become available in time without using any additional line buffer. When compared with the JCTVC-F900 anchor, this proposal reportedly improves coding efficiency and achieves 0.0%, −0.2%, −0.5%, and −0.2% BD-rate differences for HE-AI, HE-RA, HE-LDB, and HE-LDP, respectively, and has the same visual quality. No VB artifact is observed.

Already discussed in context of CE8.c

JCTVC-G477 Non-CE8.c.6: Cross-check of MediaTek/Panasonic/Qualcomm's multi-source SAO and ALF virtual boundary processing with cross9x9 JCTVC-G211 [T. Yamakage, T. Watanabe (Toshiba)]

JCTVC-G212 Non-CE8.c.7: Single-source SAO and ALF virtual boundary processing with cross9x9 [C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), S. Esenlik, M. Narroschke, T. Wedi (Panasonic), I. S. Chong, M. Karczewicz (Qualcomm)]

In HM-4.0, SAO requires 0.2 luma pixel line buffer (PLB) and 0.2 chroma PLB, and ALF requires 4.1 luma PLBs and four chroma PLBs. In JCTVC-F054 and JCTVC-F055, virtual boundary (VB) processing was proposed to remove all line buffers for ALF and SAO, respectively. In JCTVC-G206, the two prior proposals and using snowflake5x5 and cross9x9 ALF shapes are first combined as CE8.c.4-1 to remove all SAO and ALF line buffers, and this contribution provides two solutions to improve the visual quality of CE8.c.4-1. Due to the DF in HM-4.0, the luma VB and the chroma VB are set as four pixels and two pixels above the horizontal LCU boundary, respectively, and processing each pixel on one side of a VB avoids any data access from the other side of the VB. Non-CE8.c.7-1 gives up SAO VB processing and has SAO line buffers, while non-CE8.c.7-2 applies SAO VB processing method that can reduce 50% SAO line buffers. Both solutions apply ALF VB processing that can remove all ALF line buffers. When compared with the JCTVC-F900 anchor, both solutions reportedly improve coding efficiency and achieve 0.0%, −0.1%, −0.3%, and −0.0% BD-rate differences for HE-AI, HE-RA, HE-LDB, and HE-LDP, respectively, and has the same visual quality. No VB artifact is observed.

Already discussed in context of CE8.c.

JCTVC-G337 Non-CE8.c.7: Crosscheck of Single-source SAO and ALF virtual boundary processing (JCTVC-G212) [T. Ikai (Sharp)]

JCTVC-G654 Non-CE8: Cross-check of CE8.c Tool 7-1 (JCTVC-G212) on single-source SAO and ALF virtual boundary processing with cross9x9 [P. Lai, F. C. A. Fernandes (Samsung)]

JCTVC-G220 Non-CE8: Pure VLC for SAO and ALF [C.-Y. Tsai, C.-M. Fu, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S. Lei (MediaTek)]

In the HM-4.0-dev-miscs software, SAO and ALF parameters in APS and CU-level ALF-on/off flags in the slice header can be coded by CABAC. No other syntax elements in the APS and slice header can be coded by CABAC. In this contribution, it is proposed to use VLC coding for SAO and ALF and to remove the byte alignment bits for CABAC in the APS. Simulation results reportedly show 0%, 0.1%, 0.2% and 0.2% coding efficiency gains for HE-AI, HE-RA, HE-LDB, and HE-LDP, respectively, when

the APS coding is changed from CABAC to VLC. Simulation results also show no coding efficiency impact when the slice header coding is changed from CABAC to VLC.

Use pure VLC for SAO and ALF and to remove byte alignment bits for CABAC in APS.

Use pure VLC for APS 0.0/0.1/0.2/0.2 Use pure VLC for slice header 0.0/0.0/0.0/0.0

From BoG: Many participants support this.

Decision: Adopt.

JCTVC-G617 Non-CE8: Cross check of MediaTek's pure VLC for SAO and ALF [I. S. Chong, M. Karczewicz (Qualcomm)]

JCTVC-G978 Cross check of syntax refinements for SAO and ALF in JCTVC-G566 [J. Tanaka, T. Suzuki (Sony)] [late]

JCTVC-G608 Unified Deblocking and SAO [A. Segall, J. Zhao (Sharp)]

In current HEVC test model HM4.0, there are three in-loop filtering processes — deblocking filter, Sample Adaptive Offset (SAO) and Adaptive Loop filter (ALF). They are processed sequentially. SAO is applied to the debocked pictures. Due to dependency on future deblocked pixels, SAO cannot be done immediately after a pixel is fully deblocked. This reportedly makes it hard to integrate SAO into parallel deblocking process.

This contribution proposes a simple modification to SAO classification process — use horizontal deblocked pixels instead of fully deblocked pixels for EO type SAO classification. This eliminates the dependency of SAO of a pixel on future deblocked pixels, and makes it possible to integrate SAO into parallel deblocking process. On average, there is about 0.1% rate increase on coding performance.

If an SAO offset is known, SAO process is simply an add operation, it would be desirable to be added to a pixel while the pixel is deblocked.

Use horizontal deblocked pixels instead of fully deblocked pixels for EO type SAO classification. For the offset adding step, the offset is still added to the fully deblocked pixels. For BO type, no modification needed.

Bitrates (losses) HE: −0.1/−0.1/0.0/xx LC: −0.1/−0.1/−0.1/xx

Runtime Enc HE: 99/99/100/xx LC: 100/100/99/xx Dec HE: 100/102/104/xx LC: 101/101/102/xx

It was asked whether this can also be implemented as one pass at the encoder – this must be studied.

There was some concern that this may complicate the encoder, whereas the benefit seems to be unclear. No action taken.

JCTVC-G1011 Cross-check results of the Unified Deblocking and SAO of Sharp (JCTVC-G608) [M. Narroschke, S. Esenlik (Panasonic)] [late]

JCTVC-G684 Subjective Tests on ALF and SAO Using HM-4.0 [W.-S. Kim, O. G. Sezer, M. Budagavi (TI)]

This contribution presents results of informal subjective tests conducted on two loop filtering operations in HM-4.0: SAO and ALF. Test video sequences were presented at their actual frame rates to the viewers. Three configurations were tested using low delay B high efficiency (LB-HE) condition: HM-4.0 Anchor vs. SAO-off+ALF-off, HM-4.0 Anchor vs. SAO-off+ALF-on, and HM-4.0 Anchor vs. SAO-on+ALF-off. In HM-4.0 Anchor, both SAO and ALF are activated (SAO-on+ALF-on). Among these three configurations, SAO-on+ALF-off reportedly gives subjective quality results better than or comparable to the HM-4.0 Anchor. This contribution requests that JCT-VC conducts subjective quality test of SAO and ALF in a core experiment setting to evaluate the subjective quality gains provided by the aforementioned tools, and decide on the minimal set of configurations that provide the best subjective quality improvements, so that the optimal performance can be achieved in the final standard in terms of implementation cost and visual quality.

Request subjective viewing on SAO and/or ALF. This was reported also in previous meeting.

Consider the possibility to conduct some formal subjective viewing in CE8 prior to the next meeting (Minhua Zhou indicated a willingness to take the lead on this). It is reported that at least 5 companies in the San Jose area would be able to offer viewing facilities for that. It was suggested that Vittorio Baroncini should get involved in the preparation of such a viewing. To be tested: ALF on/off with SAO on, possibly also both SAO/ALF on. This should be done with a reasonable number of viewers and test cases (i.e. sequences, bit rates).

5.6 Block structures and partitioning

5.6.1 NSQT (ref CE2)

JCTVC-G519 Non-CE2: Harmonization of implicit TU, AMP and NSQT [X. Zheng (HiSilicon), Y. Yuan, Y. He (Tsinghua)]

This contribution provides a harmonization proposal of implicit TU, AMP and NSQT. Experimental results show that the proposed change contributes average coding gain of 0.1% for RA, 0.1% for RA_LC, 0.2% for LD_B, 0.1% for LD_B_LC, 0.1% for LD_P and 0.1% for LD_P_LC. Both encoder and decoder complexity are reportedly the same as HM4.0.

Decision: It was agreed that this harmonization is desirable. WD and software were requested to be checked by WD editor and Motorola (K. Panusupone). (This was confirmed after the meeting. Interaction with JCTVC-E364 was noted, and the provided text was considered sufficient to address JCTVC-E364 as well.)

JCTVC-G852 Cross-check report on Harmonization of implicit TU, AMP and NSQT (JCTVC-G519) [I.-K. Kim (Samsung)] [late]

The cross-checker did not perform checking of whether the software and text matches, but the code change is confirmed to be minimum.

JCTVC-G521 Non-CE2: Non-square Hadamard transform for motion estimation and merge estimation [X. Zheng, L. Liu (HiSilicon), Y. Yuan, Y. He (Tsinghua)]

This contribution proposes a non-square Hadamard transform which is used for motion estimation and merge estimation processes. Different configurations of non-square Hadamard transform are also discussed in the contribution. Experimental results reportedly show that the non-square Hadamard can achieve the average gain of 0.2% for RA, 0.2% for RA_LC, 0.2% for LD_B, 0.3% for LD_B_LC, 0.2% for LD_P and 0.3% for LD_P_LC when inter 2x8 and 8x2 transform is used at residual coding.

Decision (SW): Adopt non-normative tools (but not the inclusion of 2x8/8x2 as also suggested in the document).

JCTVC-G599 Non-CE2: Cross-Check of Non-square Hadamard transform for motion estimation and merge estimation [S. Oudin, B. Bross(Fraunhofer HHI)] [late]

5.6.2 Partition mode/size coding

JCTVC-G151 Prediction and partition mode binarization for Low Delay P [X. Zhang, S. Liu, S. Lei (MediaTek)]

This contribution reports a bug fix and a method for binarizing prediction and partition modes for Low Delay P configuration. Firstly, a mismatch was reported between WD and HM with regard to the prediction and partition mode binarization for Low Delay P. With the bug fix in HM software, negligible (0.0%) impact is reported on both BD-rate and encoding and decoding runtime. Secondly, it is proposed to unify the prediction and partition mode binarization for Low Delay P and B, which simplifies both WD and HM. Again, experimental results reportedly showed negligible (0.0%) impact on both BD-rate and encoding and decoding runtime.

Partially already discussed - see under JCTVC-G785.

The deviation between WD and software is in binarization for Low Delay P operation.

JCTVC-G655 Cross-check of JCTVC-G151 on prediction and partition mode binarization for Low Delay P [P. Lai, F. C. A. Fernandes (Samsung)]

JCTVC-G283 Residue Quad Tree Depth for Chroma in Intra Coding [X. Zhao, X. Guo, X. Li, S. Lei (MediaTek), S. Ma, W. Gao (PKU)]

In HM4.0, luma and chroma components share the same maximum Residue Quad Tree (RQT) depth. This contribution proposes to use separate maximum RQT depth for luma and chroma components in intra coding. Specifically, a user-defined parameter is proposed to be added in the sequence parameter set (SPS) to allow independent RQT depth setting for chroma. It is reported that with setting the parameter as 0, average BD-Rate reductions of 0.04%, 1.67% and 1.70% are achieved for Y, U and V in AI-HE, respectively, and 0.20%, 2.43% and 2.53% are achieved for Y, U and V in AI-LC, respectively. It is also reported that the decoding time is slightly decreased.

In discussions, it was asked whether there is an implicit mode for chroma - currently there is not.

JCTVC-G798 Cross verification of MediaTek's proposed residue quad-tree depth for intra chroma coding (JCTVC-G283) [Y. Chiu, L. Xu (Intel)] [late]

JCTVC-G442 Improvement to chroma TU specification [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi), A. Ichigaya, S. Sakaida (NHK)]

This contribution proposes a change to the chroma TU structure of the current HM. The proposed method introduces up to 32x32 TU size for chroma when the LCU size is 64x64. In addition, it is proposed to apply fixed depth for chroma TU instead of using the same TU depth with luma component. The proposed method applies TU depth=0 for CU with 2Nx2N PU, and applies TU depth=1 for CU with rectangular PU and NxN PU while TU split for Luma is unchanged from HM-4. The proposed method achieves 2.0%, 2.1% and 1.0% chroma BD-rate gain for AI-HE, RA-HE and LD-HE, and 2.9%, 2.0% and

0.9% chroma BD-rate gain for AI-LC, RA-LC and LD-LC settings with 2–3% encoding time reduction. Luma BD-rate gain is on average 0.1% and 0.2% for HE and LC settings.

Difference compared to JCTVC-G283: Fixed RQT depth vs. variable RQT depth.

JCTVC-G378 Cross Check Report for Improvement to chroma TU specification (JCTVC-G442) [Y. Shibahara, T. Nishi (Panasonic)]

JCTVC-G605 Cross-check of Improvement to chroma TU specification (JCTVC-G442) [P. Helle, B. Bross (Fraunhofer HHI)] [late]

JCTVC-G980 Evaluation of Limiting Chroma Transform Depth in RQT on HM4.0 [L. Guo, X. Wang, M. Karczewicz (Qualcomm)] [late]

In previous Geneva meeting (March 2011), contribution JCTVC-E377 proposed that the maximum Chroma transform depth be limited relative to Luma component, so that Chroma component does not have to share the same transform depth as Luma. In this contribution, the method described in JCTVC-E377 has been implemented on top of HM 4.0. Simulation results reportedly show that by doing so an average BD-rate saving of 0.1%, 1.8% and 1.7% can be obtained for Y, U and V respectively in AI-HE condition.

Conclusion: Establish CE from JCTVC-G283, JCTVC-G442 and JCTVC-G980.

JCTVC-G417 Improved coding of CU-level information in CAVLC S. Y. Yi (KAU), H. Choi (Hanbat Univ.), S.-C. Lim (ETRI), J.-G. Kim (KAU), [H. Y. Kim, J. Lee, J. S. Choi (ETRI)]

It was indicated that this contribution did not need to be presented.

JCTVC-G881 Cross-check for Improved coding of CU-level information in CAVLC (JCTVC-G417) [T. Yamamoto (Sharp)] [late]

JCTVC-G709 On partition size information coding using CABAC [T. Yamamoto, K. Misra, A. Segall (Sharp)]

This document describes a technique for CABAC complexity reduction while coding partition size information in B slices. The document proposes the use of bypass coding engine of CABAC to code bins of syntax element pred_type used to distinguish between PartMode (2NxN, 2NxnU, 2NxnD) as well as bins used to distinguish between PartMode (Nx2N, nLx2N, nRx2N). This reduces the number of CABAC contexts in memory and eliminates the associated CABAC context update step. It is asserted that this has negligible impact on compression efficiency. For HM-4.0, high efficiency common test conditions the proposed change shows an average BD bitrate impact of –

(Without class F sequences)

RA_HE Y:0.00% U:0.02% V:0.02%; LB_HE Y:−0.02% U:0.07% V:0.00%.

(With class F sequences)

RA_HE Y:0.00% U:0.01% V:0.00%; LB_HE Y:−0.04% U:0.09% V:−0.04%.

Similar to JCTVC-G718 – further study in a CE was suggested.

5.7 Motion compensation operation and interpolation filters

5.7.1 Interpolation filters and MV precision (ref CE3)

JCTVC-G062 Non-CE3: 7-tap quarter-pel luma interpolation filter with accurate phase shift [Hongbo Zhu]

A 7-tap 1/4-pel luma interpolation filter is proposed in this document. The simulations were conducted under the common test condition using the HM4.0 r1354. When combined with the 6-tap DCT-IF 1/2-pel filter {2,−9,39,39,−9,2}, the performance impact of the proposed filter is reportedly 0.0% for he_ra, 0.0% for lc_ra, 0.0% for lb_he, −0.4% for lb_lc, 0.2% for lp_he and −0.3% for lp_lc in bdbitrate. Basically, the 6H7Q filter shows gain for the high resolution sequences and shows loss on the low resolution sequences (WVGA and WQVGA). When the half-pel filter is changed to DCT-IF 8-tap {−1,4,−10,39,39,−10,4,−1}, the performance is −0.1% for he_ra, −0.2% for lc_ra, −0.2% for lb_he, −0.7% for lb_lc, −0.1% for lp_he and −0.7% for lp_lc.

This seemed to be a major deviation from the current design. No cross-check was available when discussed.

JCTVC-G131 PU-size dependent motion compensation filtering order [M. Budagavi, R. R. Srinivasan (TI)]

This contribution presents a technique for reducing motion compensation (MC) cycles of rectangular PUs by modifying MC filtering order depending on PU size. For the case of PU width < PU height, vertical filtering is carried out first and then horizontal filtering instead of horizontal filtering followed by vertical filtering as in HM-4.0. The filtering order is not changed for square PUs and rectangular PUs with PU width > PU height. With the modified filtering order, it is claimed that MC computation cycles reduction is in the range from 5% for 64x32 block to 35% for 16x4 block for the case when motion vector is fractional in both x- and y-directions. The computation cycles for square PUs and rectangle PUs with PU width > PU height do not change. The proposed change is normative for bit depths > 8 and is asserted to reduce average number of MC cycles for both HE and LC settings. The BD-Rate for RA-HE, LB-HE, LP-HE are all 0%. It is further claimed that if HEVC does not support 4x4 PU, 8x4 PU becomes worst case block size from MC cycles point of view, and proposed technique will then reduce worst case MC cycles too.

Presented Mon 28th evening.

This seems less relevant as we are not primarily targeting 10 bit video at the moment (where the sequence H/V matters as intermediate rounding needs to be performed to fit 16 bits). For 8 bit it could likely be non-normative.

The 4x4 PU question remained open for discussion at the time of presentation of this contribution.

It was noted that this contribution is related to the memory bandwidth / PU restrictions issue that will be studied in AHG work.

JCTVC-G884 Verification of JCTVC-G131 on interpolation filter order [F. Bossen] [late]

JCTVC-G259 Modifications of LCU-based adaptive interpolation filter [S. Matsuo, S. Takamura, H. Jozawa (NTT)]

This document reports two modifications of an LCU-based adaptive interpolation filter described in JCTVC-G258. First modification is that the proposed filter is applied to chrominance components (Cb and Cr) as well as luminance component (Y). Second modification is a prediction method for luminance filter coefficients. The proposal was implemented in HM4.0 software to evaluate its performance.

Compared to the HM4.0 anchor, the overall average coding gain for Y, Cb and Cr were reportedly about 0.49%, 0.38% and 0.37%, respectively. The maximum coding gain of Y was about 10.2% for the sequence "Vidyo3" in the LP-LC case. The maximum coding gains of Cb and Cr were about 7.1% and 5.7% for the sequence "Nebuta" in RA-LC case, respectively. The computational complexity at the encoder and decoder were 101.42% and 102.51% on average, respectively.

Presented Mon 28th evening.

Adaptation at LCU level is used. A benefit over JCTVC-G258 (from CE3) was reported for chroma. Further study was suggested.

JCTVC-G347 Cross-check report of NTT's interpolation filter approach (JCTVC-G259) [T. Yoshino, S. Naito (KDDI)]

JCTVC-G392 Non-CE3: Report on a restriction for small block [K. Kondo, T. Suzuki (Sony)]

This contribution reports the results of a restriction for small blocks. To reduce worst case complexity, this contribution tested three restrictions relating to small PU size, without decoder change. The case-A is that PU size 8x4, 4x8 and 8x8 for bi-prediction are restricted. The case-B is that PU size 8x4 and 4x8 are restricted. The case-C is that 8x4 and 4x8 for bi-prediction are restricted. With the restriction, it is reported that the impact of coding efficiency is 2.2%, 1.4%, and 0.3% for case-A, B, and C.

Analysis shows that for large picture resolutions the loss by restricting the PU size is much less even for case A (e.g. class A only 1%). Case A allows bandwidth reduction of around 50%. This indicates it is very likely that small PU size restrictions for high resolutions could be meaningful.

Further study in AHG work (see under CE3) was suggested.

JCTVC-G429 Non-CE3: Cross-check report of Sony proposal on restriction for small block (JCTVC-G392) [T.Chujoh (Toshiba)]

JCTVC-G600 Non-CE3: Adaptive Motion Vector Resolution based on the PU Size [J. Jung, J. Heo, S. Yea (LG)]

This contribution proposes an adaptive mechanism for threshold selection at a PU level in the Progressive Motion Vector Resolution (PMVR) method proposed by MediaTek. The result was asserted to show that it improves the coding efficiency of the PMVR method due to its PU-level adaptation of threshold values. This contribution presents the result of the proposed scheme implemented on the PMVR method without 1/8 MV resolution. The Y BD-rate differences with respect to HM4.0 were −0.2% for RA HE, −0.2% for RA-LC, −0.1% for LB-HE, −0.2% for LB-LC, 0.0% for LP-HE, and 0.0% for LP-LC. The Y BD-rate differences with respect to the PMVR without 1/8-pel with Th=2 were 0.0% for RA HE, 0.0% for RA-LC, 0.0% for LB-HE, 0.0% for LB-LC, −0.1% for LP-HE, and −0.1% for LP-LC.

There was some expectation that finer resolution of MVs is rather for large PU sizes.

The statistics plot shown may not indicate that this assumption is justified.

Currently there was very small gain only for LD P. No action taken.

JCTVC-G698 On Chroma interpolation filter [J. Lou, K. Minoo, L. Wang, A. Luthra (Motorola Mobility)]

This contribution document proposes a 4-tap half-pel Chroma interpolation filter for HEVC. Compared to the current half-pel Chroma interpolation filter, better Rate-Distortion performance could reportedly be

achieved. When combined with the default HM Luma filters, it could reportedly achieve −0.01%/−0.77%/−0.94% bitrate differences on Y/U/V. When combined with the 8H7Q filters with 1/4 offset, it could achieve −0.03%/−0.67%/−0.80% bit rate differences on Y/U/V. When combined with the 8H7Q filters with 3/16 offset, it could achieve −0.03%/−0.62%/−0.77% bitrate differences on Y/U/V. The proponent indicated that a cross-check would be provided by Samsung.

The filters are more complex (multiplication by 7 instead of 4, 39 instead of 36), but this does not seem to be a big deal.

The filters preserve more high frequencies – but it was questioned whether this is this useful for chroma.

Definitely, the filters could have significant impact on visual quality, but no subjective assessment was performed by proponents, and could not be done during the meeting.

In the SAO off case, it was remarked that there are some color artifacts with current filters. Further study in CE work was suggested.

JCTVC-G699 Motion vector scaling for non-uniform interpolation offset [J. Lou, K. Minoo, L. Wang (Motorola Mobility)]

A non-uniform motion vector grid was proposed in the last Torino meeting. This contribution document addresses the problem of motion vector scaling for such a non-uniform motion vector grid, since reusing the motion vector scaling for a uniform motion vector grid might give slightly different motion vector predictors. The proponent indicated that a cross-check would be provided by Samsung.

The contribution was only informative – no action required.

JCTVC-G825 Cross-check for Motorola Mobility proposals on MV scaling by Samsung [E. Alshina, J.H. Park] [late]

JCTVC-G736 On luma/chroma interpolation precision [M. Coban, M. Karczewicz (Qualcomm)]

This contribution presents a 16-bit biprediction luma/chroma interpolation process with negligible impact on coding efficiency. In the current design, the intermediate values for calculating the biprediction sample values have 17-bit values that are converted to 16-bit values with the use of an offset. When all the intermediate values are reduced to 16-bit, there is reportedly no drop in performance. Simulation results reportedly show 0.0%, 0.0%, and 0.0% BD rate change for RA_HE, LB_HE and LP_HE cases, respectively.

No interest was expressed by experts in the room – no action was taken (also no cross-checker was available to confirm or support this).

JCTVC-G693 Cross-check of Qualcomm's proposal on interpolation precision (JCTVC-G736) [Y. H. Tan, C. Yeo (I2R)] [late]

JCTVC-G770 Non-CE3: A restriction of motion vector for small block size [T.Chujoh, T.Yamakage (Toshiba)]

An experimental result of restriction of motion vector for small block size is 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 luminance and chrominance of bi-prediction block. Therefore, in order to reduce the worst case of memory bandwidth, for example, two encoding methods that at least one motion vector of L0 or L1 is restricted to the integer position for both luma and chroma when the block size of bi-prediction is less

than 8x8 and 4x8 bi-prediction block is prohibited in the former case are introduced at this time. As experimental results, the gain coding efficiencies are lost an average of 0.33% and 0.38% respectively. The worst cases of memory bandwidth are reduced greater than 25% and 31% respectively compared to the anchor.

Similar to JCTVC-G392. In addition, restriction of fractional position for chroma is also introduced. Again, the loss due to restrictions becomes lower for the larger picture sizes (class A).

Study in AHG work was suggested.

JCTVC-G898 Non-CE3: Cross check for Toshiba's proposal (JCTVC-G770) [K. Kondo, T. Suzuki(Sony)] [late]

JCTVC-G931 Non CE3: Cross-check for memory band-width reduction from Toshiba (G770) by Samsung [E. Alshina, J.H. Park (Samsung)] [late]

JCTVC-G806 Non CE3: On the phase offset selection for motion compensation interpolation filters [K. Minoo, D. Baylon, J. Lou]

In this contribution 4 sets of filters are introduced and used to conduct motion compensation with quarter-pixel motion resolution (i.e. four level sub-pixel signaling and storing). The choice of filter set is decided based on the sub-pixel information of the motion vector predictor (stored at quarter-pel resolution). Overall 0.82% gain was observed for Luma. (0.2% gain was also observed for each of the Chroma components)

Various graph plots were shown that were not included in the contribution to motivate the idea, but seemed difficult to relate to the word file.

Selection of the phase offset for each sub-pixel position is somehow based on the conditional distribution of the MV for a given MVP (including such positions as e.g. 3/16), but it was not explicitly said how.

The number of filters was increased to 9. Main gain in LD P, in the other cases it is typically 0.3%.

Some interest was expressed by the cross-checker. No action was taken.

JCTVC-G993 Non-CE3: Cross-check of Motorola Mobility's motion compensation interpolation filter (JCTVC-G806) by Qualcomm [L. Guo (Qualcomm)] [late]

JCTVC-G807 Non CE3: On design of interpolation filters for Uni and Bi Predictive Motion Compensation [K. Minoo, D. Baylon, J. Lou] [late]

In this contribution, the authors proposed to perform motion compensation with a mix of filters currently proposed in JCTVC-G806 and JCTVC-G697. In essence, it is proposed to use the 6-tap filters proposed in JCTVC-G697 for Bi Prediction and 7&8-tap filters proposed in JCTVC-G806 for Uni-prediction motion compensation. On average a gain of 1.2% was reportedly observed for Luma (and 0.4% and 0.3% gain for U and V color components, respectively).

Some interest expressed by the cross-checker. No action was taken.

JCTVC-G994 Non-CE3: Cross-check of Motorola Mobility's Interpolation Filter for Uni and Bi Predictive Motion Compensation (JCTVC-G807) by Qualcomm [L. Guo (Qualcomm)] [late]

JCTVC-G824 Non CE3: Cross-check for Motorola Mobility proposals on Chroma interpolation filter by Samsung [E. Alshina, J.H. Park] [late]

5.7.2 Prediction methods

JCTVC-G065 Improved Weighted Prediction [Y. Ye, E. S. Ryu (InterDigital)]

This contribution presented a modified weighted prediction process for bi-prediction. The modified WP process improves accuracy by performing rounding operation only once for bi-prediction. Using the fading sequences provided by the weighted prediction AhG at the July meeting, it was reported that, in the RA_LC setting, on average 0.3 to 0.6% of BD rate reduction is achieved for luma, and 1.1% to 1.5% of BD rate reduction for chroma; in the LD_LC setting, on average 0.6 to 0.8% of BD rate reduction is achieved for luma, and 3.6 to 4.6% of BD rate reduction for chroma. The proposed modification does not affect the weighted prediction process for input signals with bit depth larger than 8 bits.

The proposal gets rid of one rounding, this is most likely where the gain comes from.

It showed the highest gain at higher rates.

The current WP (as well as this one) has 32 bit precision – it was asked whether this is really necessary – it may be desirable to reduce this.

Several experts expressed support for this. Decision: Adopt.

JCTVC-G524 On weighted prediction [A. Tanizawa, T. Chujoh, T. Yamakage (Toshiba)] [late]

Cross-check on JCTVC-G065 – confirms and supports.

JCTVC-G307 Bi-prediction restriction in small PU [T. Ikai (Sharp)]

This contribution presents a bi-prediction restriction to reduce motion compensation complexity. In the proposed method, bi-prediction of 4x8 and 8x4 PU is prohibited with changes of inter_pred_flag syntax and merge motion parameter derivation process. It is reported that BD-rate yields 0.0%, 0.1%, 0.0, and 0.0 impacts for RAHE, LBHE, RALC, LBLC condition respectively. Encoding time reduces about 5% and 7% compare to HM4.0 anchor in Hier-B case and B case respectively. Decoding time shows no impact. The proposal was cross-checked by TI (JCTVC-G289).

This would be a normative change by prohibiting a syntax element and changing the derivation process.

Compared to Sony's results, where a significant loss occurred by disabling the small PU sizes, it is surprising that we have no loss here – this should be further investigated.

Study in AHG was requested (the scope of the AHG is not restricted to "non-normative level only" changes).

JCTVC-G289 Cross-verification of Sharp's proposal JCTVC-G307 on Bi-prediction restriction in small PUs [M. Zhou (TI)]

JCTVC-G415 MC Complexity Reduction for Bi-prediction [H. Y. Kim (ETRI), K. Y. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee, J. S. Choi (ETRI)]

This contribution reports that roughly 27% and 6% area of forward B-Slices are observed to have identical motion information within each PU, under HM4 LD and RA configurations, respectively. It is proposed that when the L0 and L1 motion information is the same, the L1 interpolation process and the weighted averaging process in HM4 should be bypassed for complexity reduction. It was reported that average decoding time reduction of 4% was achieved for LD configurations without any change in coding results.

JCTVC-G874 Cross-check MC Complexity Reduction for Bi-prediction (JCTVC-G415) from ETRI [Patrice Onno (Canon)] [late]

JCTVC-G438 On complexity reduction of bi-prediction for identical motion [A. Tanizawa, T. Shiodera, T. Chujoh, T. Yamakage (Toshiba)]

This contribution reports results of complexity reduction of bi-prediction for identical motion described in JCTVC-F325. At the last JCT-VC Torino meeting, the implementation technique of complexity reduction by changing bi-prediction to uni-prediction in case of identical motion was proposed. This contribution reportedly provided a suitable source code and experimental results. Experimental results reportedly show that average decoding times are 99%, 99%, 95% and 95% for RA-HE, RA-LC, LB-HE and LB-LC, respectively. This scheme does not affect bitstreams, and the BD-bit rate is identical to the HM anchor.

Identical to JCTVC-G415.

Decision (SW): Adopt JCTVC-G415 and JCTVC-G438 tentatively. Leave it to the discretion of the software coordinator whether this non-normative change of decoder optimization is desirable in reference software. (Note: F356 was the same and with same conclusion.)

(After the Torino meeting, software was reportedly provided but no answer was received.)

HM description text shall also be provided.

JCTVC-G441 Redundancy removal of explicit weighted prediction syntax [A. Tanizawa, T. Chujoh, T. Yamakage (Toshiba)]

This document presents a redundancy removal of explicit weighted prediction syntax. This scheme has two proposals. First one (proposal 1) is to modify redundant pred_weight_table syntax for identical reference frames. Second one (proposal 2) is to introduce predictions for syntax elements in pred_weight_table syntax in order to reduce the redundant representation. The experimental results in HM software version 4.0 (HM-4.0-dev) with weighted prediction under common test conditions are reported. The results reportedly show that BD-rate impact of proposal 1 is 0.3% and 2.5% for RA-HE and LDB-HE on average, respectively. BD-rate impact of proposal 2 is reportedly 0.4%, 1.0% and 0.6% for RA-HE, LDB-HE and LDP-HE on average, respectively. BD-rate of combination with prop. 1 and prop. 2 is reportedly 0.7%, 3.0% and 0.6% for RA-HE, LDB-HE and LDP-HE on average. It is reported that these schemes do not affect the encoding and decoding time.

Several experts supported this.

Decision: Adopted into WD, conditional on availability of a confirmed statement about the alignment between software and WD text by the cross-checker (which is not in the current version of JCTVC-G525).

JCTVC-G525 Cross-check of JCTVC-G441: Redundancy removal of explicit weighted prediction syntax [P.Bordes, P.Salmon (Technicolor)] [late]

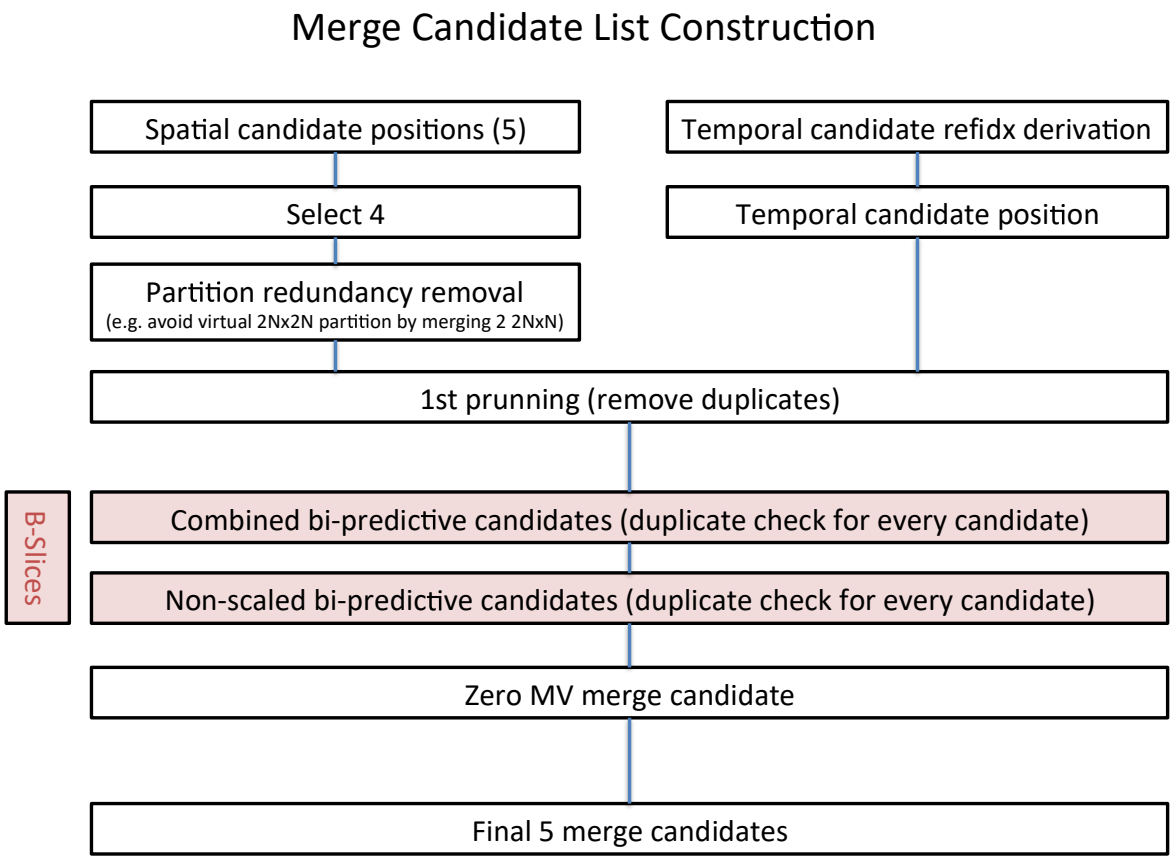
JCTVC-G858 Crosscheck of JCTVC-G549 proposed by Samsung [X. Zheng] [late]

5.8 Motion and mode coding

General remark: In AMVP, the WD text and software are already quite complex, such that there is a certain danger that mismatches occur (e.g. in candidate pruning process). For stability, we should be very careful in adding in more small changes unless they are well justified; however, simplifications are welcome (see also discussion under CE9/13).

5.8.1 AMVP/skip/merge (related to CE9/13)

The proposals in this category were first reviewed in a BoG (JCTVC-G1006), and decisions were taken in track A. The BoG recommended a classification as follows:



A) Simplifications

A.1 Merge spatial candidate positions

JCTVC-G416 CU-based Merge Candidate List Construction [H. Y. Kim (ETRI), K. Y. Kim, S. M. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee, J. S. Choi (ETRI)]

JCTVC-G516 On Spatial MV Prediction [K. Sato (Sony)] [late]

Conclusion: No action

A.2 Merge partition redundancy removal

JCTVC-G181 Non-CE9: Merging candidate reordering [H. Takehara, S. Fukushima (JVC Kenwood)]

JCTVC-G681 Non-CE9: Simplified Merge candidate derivation [Y. Zheng, X. Wang, W.-J. Chien, M. Karczewicz (Qualcomm)]

JCTVC-G593 Non-CE13: Simplification of merge mode [O. Bici, J. Lainema, K. Ugur (Nokia)]

JCTVC-G542 Non-CE9/Non-CE13: Simplification on AMVP/Merge [T. Sugio, T. Nishi(Panasonic)]

JCTVC-G416 CU-based Merge Candidate List Construction [H. Y. Kim (ETRI), K. Y. Kim, S. M. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee, J. S. Choi (ETRI)]

Decision:

1. Adopt the common part of all proposals (best expressed by removing void_merge_candidate function in HM software).
2. From JCTVC-G681, JCTVC-G593 and JCTVC-G542: For 2NxN and Nx2N (and likewise NxLN etc. in AMP) remove the 1st PU candidate for the 2nd PU. (e.g. refer to Fig. 1 in JCTVC-G681)

A.3 1st pruning

JCTVC-G593 Non-CE13: Simplification of merge mode [O. Bici, J. Lainema, K. Ugur (Nokia)]

JCTVC-G241 Non-CE9: On parallel derivation of the temporal predictor for Merge/Skip modes [G. Laroche, T. Poirier, P. Onno (Canon)]

JCTVC-G221 Non-CE13: The maximum number of merging candidates in P-slice [H. Nakamura, S. Fukushima, H. Takehara, M. Ueda (JVC Kenwood)]

Conclusion: See notes under individual docs.

A.4 Merge additional candidates (combined, non-scaled, zero mv,...)

JCTVC-G288 Non-CE13: Complexity Reduction of MVP List Construction [Y. Yu, T. Hellman (Broadcom)]

JCTVC-G593 Non-CE13: Simplification of merge mode [O. Bici, J. Lainema, K. Ugur (Nokia)]

JCTVC-G396 Non-CE9: swapping of merge candidate [C. Kim, Y. Jeon, B. Jeon (LG)]

JCTVC-G542 Non-CE9/Non-CE13: Simplification on AMVP/Merge [T. Sugio, T. Nishi(Panasonic)]

JCTVC-G397 Non-CE9/Non-CE13: Simplification of adding new merge candidates [B. Li (USTC), J. Xu (Microsoft), H. Li (USTC)]

JCTVC-G683 Non-CE13: Simplification and improvement of additional merge candidate [Y. Zheng, X. Wang, W.-J. Chien, M. Karczewicz (Qualcomm)]

JCTVC-G690 Non-CE9: Some possible motion vector coding related simplifications [Y. H. Tan, C. Yeo, Z. Li (I2R)]

Conclusion:

JCTVC-G397 suggests to remove non-scaled candidates. Several experts expressed the opinion that this is useful.

There were several proposals to avoid duplicate checking.

Side activity (coordinated by Minhua Zhou) was requested to try to identify the relation with T10, relation and commonalities of different methods, and come back with text and software and results of possible unified solution.

(The result of this activity is captured in a revision of JCTVC-G1006):

Overall combination (JCTVC-G397) reports 0.1% loss in LD B case (mainly by class E)

If combined with simplification 3 of 542 (removing the second pruning step entirely), there is no loss anymore.

Two experts expressed the view that for LD P the encoding time may increase (which could be resolved by restricting the number of candidates). One other expert reports that he has tested LD P, and found a 4% increase in encoding time, whereas the BR reduces by 0.2% (unofficial result).

The decoder would be simplified by omitting the pruning step. But this can increase the number of zero MV candidates, while the maximum (worst case) number of candidates is not changed. WD text is simplified by omitting limit and duplication checks.

Decision: Adopt JCTVC-G397 + JCTVC-G542 simplification 3.

(Note: JCTVC-G683 is similar as in removing 2nd pruning.)

A.5 Merge temporal candidate refidx derivation

JCTVC-G163 Non-CE9: simplification of merge/skip TMVP ref_idx derivation [Y. Jeon, S. Park, J. Park, B. Jeon (LG)]

JCTVC-G217 Non-CE9: Derivation process of reference indices for temporal merge candidates [H. Nakamura, S. Fukushima (JVC Kenwood)]

JCTVC-G552 Simplification of temporal motion vector (TMVP) candidate derivation for Merge and AMVP [I.-K. Kim, N. Shlyakhov, J. H. Park(Samsung)]

JCTVC-G592 Non-CE9: Removal of reference index derivation for TMVP in merge mode [O. Bici, J. Lainema, K. Ugur (Nokia)]

JCTVC-G690 Non-CE9: Some possible motion vector coding related simplifications [Y. H. Tan, C. Yeo, Z. Li (I2R)]

Conclusion: See under JCTVC-G163.

A.6 Temporal candidate position

JCTVC-G082 non-CE9: Modified H positions for memory bandwidth reduction in TMVP derivation [M. Zhou (TI)]

JCTVC-G552 Simplification of temporal motion vector (TMVP) candidate derivation for Merge and AMVP [I.-K. Kim, N. Shlyakhov, J. H. Park(Samsung)]

Conclusion: See under JCTVC-G082.

A.7 MV scaling

JCTVC-G223 Non-CE9: Division-free MV scaling [T.-D. Chuang, Y.-W. Chen, J.-L. Lin, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)]

JCTVC-G541 Non-CE9: Simplified scaling calculation method for temporal/spatial MVP of AMVP/Merge [T. Sugio, T. Nishi(Panasonic)]

JCTVC-G551 Restriction on motion vector scaling for Merge and AMVP [I.-K. Kim, Y. Park, N. Shlyakhov, J. H. Park (Samsung)]

Decision: Adopt the change of scaling factor clipping range to a value of 16 (one of the options suggested in JCTVC-G223).

A.8 AMVP

JCTVC-G182 Non-CE9: AMVP syntax for bi-prediction [H. Takehara, S. Fukushima (JVC Kenwood)]

JCTVC-G516 On Spatial MV Prediction [K. Sato (Sony)] [late]

JCTVC-G710 Non-CE9: The Parallel Friendly MVP Candidate Calculation for HEVC [Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)]

JCTVC-G712 Non-CE9: The Simplification of MVP for HEVC [Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)]

JCTVC-G219 Non-CE9: Construction of MVP list without using scaling [H. Nakamura, S. Fukushima (JVC Kenwood)]

JCTVC-G542 Non-CE9/Non-CE13: Simplification on AMVP/Merge [T. Sugio, T. Nishi(Panasonic)]

Decision: Adopt simplification 2 from JCTVC-G542, no action on JCTVC-G219.

A.9 Misc

JCTVC-G134 Motion Vector Predictor Candidate Clipping Removal [M. Coban, M. Karczewicz (Qualcomm)]

Conclusion: See under JCTVC-G134.

B) Parallel merge

JCTVC-G164 Non-CE9: improvement on parallelized merge/skip mode [Y. Jeon, S. Park, B. Jeon (LG)]

JCTVC-G387 Non-CE9 Parallel Merge/skip Mode for HEVC [X. Wen, O. Au, W. Dai, C. Pang, J. Dai, F. Zou, X. Zhan (HKUST)]

JCTVC-G416 CU-based Merge Candidate List Construction [H. Y. Kim (ETRI), K. Y. Kim, S. M. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee, J. S. Choi (ETRI)]

Conclusion: See under JCTVC-G164.

C) Coding efficiency improvements

JCTVC-G165 Non-CE9/Non-CE13: new MVP positions for merge/skip modes and its combination with replacing redundant MVPs [Y. Jeon, S. Park, B. Jeon (LG), J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)]

JCTVC-G195 Non-CE9/13: Averaged merge candidate [S. Shimada, K. Kazui, J. Koyama, A. Nakagawa (Fujitsu)]

JCTVC-G305 Non-CE9: Bi-prediction for low delay coding [Y. Suzuki, A. Fujibayashi (NTT DOCOMO)]

JCTVC-G343 Non-CE9: Improvement in temporal candidate of merge mode and AMVP [N. Zhang, X. Fan, S. Ma, D. Zhao (Harbin Inst. Tech.)]

JCTVC-G224 Non-CE13: Multiple-scaled merging candidates [H. Nakamura, S. Fukushima (JVC Kenwood)]

JCTVC-G787 Non-CE13: Additional merge candidates with MV dependent offsets [T. Lee, J. Chen, J. H. Park (Samsung), G. Laroche, P. Onno (Canon), J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)]

Conclusion: No action.

Further details and dispositions are recorded under the individual documents as follows (not per category).

JCTVC-G082 non-CE9: Modified H positions for memory bandwidth reduction in TMVP derivation [M. Zhou (TI)]

This contribution advocates modification of the H TMVP positions to avoid co-located motion data required for TMVP derivation of the current LCU going beyond the current LCU row. In the proposed design, the H TVMP positions around the bottom boundary of the current LCU are replaced with closest ones inside the current LCU row (configuration 1), or with C3 TMVP positions (configuration 2). The proposed algorithm enables LCU-aligned motion data compression, storage and fetch, and can reportedly reduce the memory bandwidth for the TMVP derivation by half. The reported BD-rate penalty is 0.1% in RA-HE and RA-LC, 0.2% in LB-HE and LB-LC for configuration 1, and 0.2% in RA-HE and RA-LC, 0.3% in LB-HE and LB-LC for configuration 2.

It was requested to discuss the need/trade-off of memory bandwidth reduction that may vary depending on the implementation.

This provided a simplification on the temporal candidate position.

Several experts expressed support for this. Decision: Adopt configuration 2, which is simpler and has less BD rate loss (only 0.05%) according to the cross-checker.

JCTVC-G274 Non-CE9: cross-check of contribution JCTVC-G082 (TI) on modified H TMVP position [J. Jung (Orange Labs)]

This verification contribution confirms the results obtained by TI in JCTVC-G082. According to the results obtained, it was recommended to adopt configuration 2, which provides similar results as configuration 1, allowing however cleaner WD text and software.

JCTVC-G134 Motion Vector Predictor Candidate Clipping Removal [M. Coban, M. Karczewicz (Qualcomm)]

This contribution presents a modification to the motion vector predictor (MVP) candidate derivation process that removes the final normative motion vector clipping operation. In the current HM design, motion vector predictor values are clipped using the non-normative motion vector clipping operation in the motion compensation process. Removal of the motion vector clipping operation on the MVP candidates reduces MVP derivation complexity with negligible impact on coding efficiency. Simulation results show 0.0%, 0.0%, and 0.0% BD rate change for RA_HE, LB_HE and LP_HE cases, respectively.

One participant was asking whether clipping in motion compensation can be removed as well.

It was remarked that the implementation of the clipping function in software currently is wrongly implemented.

Decision: Adopt. Remove the current clip_mv function, implement proper (non-normative) clipping function (to maximum size) in MC (Qualcomm will implement that).

JCTVC-G344 Cross-verification report for motion vector predictor candidate clipping removal (JCTVC-G134) [H. Aoki, K. Chono (NEC)]

No one was present to report in detail about this cross-check. Comments were provided by email on the reflector:

The verification task was reportedly successfully completed; it was confirmed that the implementation conforms to the description in JCTVC-G134 and results exactly match those presented in JCTVC-G134.

The necessity of the clipping is also raised as one of open issues to be discussed in the WD4 document. It was recommended that the clipping issue is discussed and fixed at the 7th JCT-VC meeting.

JCTVC-G163 Non-CE9: simplification of merge/skip TMVP ref_idx derivation [Y. Jeon, S. Park, J. Park, B. Jeon (LG)]

This contribution reports the results when the derivation process of reference indices for temporal merging candidate is simplified. Five asserted simplifications SP01 to SP06 are tested. Simulation results revealed that no coding loss is obtained in all cases except low delay configurations of SP01. Based on test results, it was proposed to consider one of the five simplifications SP02, SP03, SP04, SP05 and SP06 because the refIdx derivation process can reportedly be simplified without any harm on coding efficiency. Among the four recommended simplifications, SP05 and SP06 were asserted to be the most preferred since they are indicated to be the simplest ones.

This is related to the low delay coding option. It was asked what are the losses without the low delay coding option.

Due to the lack of explicit reference list construction in the current HM, the low delay coding option changes the decoder as well.

An outlier (BQSquare) with high loss was reported when fixing the refidx to 0.

Simplification of temporal refidx derivation for merge was proposed.

In category A.5 (with 4 other contributions) this one has tested most variations.

Decision: Adopt SP05. Use left position ref_idx; if not available, use zero value. Further tests were suggested to be performed during the meeting (by Panasonic). It was asked whether this interferes with the ref_idx re-ordering of LD B and P configurations. If not, it was suggested to adopt; otherwise potentially use another SP0X conf. It was the verbally reported (Sat morning) that there is no problem and that this would be reported in a document. On Monday 28th the same was confirmed in JCTVC-G1027.

JCTVC-G1027 Non-CE9: Additional test result on LG's simplification of merge/skip TMVP refidx derivation (JCTVC-G163) [T. Sugio (Panasonic), S. Fukushima (JVC KENWOOD)] [late]

JCTVC-G099 Non-CE9: cross-verification of LGE's proposal JCTVC-G163 on simplification of merge/skip ref_idx derivation [M. Zhou (TI)]

Confirmed.

JCTVC-G164 Non-CE9: improvement on parallelized merge/skip mode [Y. Jeon, S. Park, B. Jeon (LG)]

Parallelized merge/skip is introduced at the Torino meeting in JCTVC-F069 to compensate the significant quality loss that can be caused when the parallel motion estimation (PME) is performed with the current HM design for throughput or implementation cost reasons. This contribution advocates the JCTVC-F069 method and additionally makes a change in the merge/skip list construction process of JCTVC-F069 to

improve the coding efficiency of JCTVC-F069 further. The simulation results reportedly revealed that this change provides significant coding efficiency improvement relative to JCTVC-F069 method resulting in 1.0%, 0.7%, 0.3%, and 0.0% BD rate reductions on average of all configurations (RA-HE, RA-LC, LB-HE, and LB-LC) for PME level 64x64, 32x32, 16x16, and 8x8 respectively (compared to the proponent's suggested reference). Compared to the HM4.0 PME in which the merge and skip modes have to be disabled inside the motion estimation region called MER except the first partition of MER, 5.6%, 4.8%, 2.5%, and 0.3% BD rate reductions are reported on average of all configurations for PME level 64x64, 32x32, 16x16, and 8x8 respectively.

General concerns on this parallel merge technique were to be discussed when presenting the CE9 proposals.

This was considered dependent on the CE9 MRG_PAR (JCTVC-F069) discussion.

The proposal was indicated to be an improvement of the CE9 test MRG_PAR JCTVC-F069.

"Scheme 5" of JCTVC-G387 is said to be exactly identical. It is said that the gap for 32x32 compared to HM anchor would be 0.9% bit rate increase. JCTVC-G416 has worse results.

It was recommended to set up an AHG which would try to reduce the performance gap between parallel and non-parallel merge, work on better understanding of the problem and alternative solutions that would not need syntax modification.

JCTVC-G100 Non-CE9: cross-verification of LGE's proposal JCTVC-G164 on improvement on parallel merge/skip mode [M. Zhou (TI)]

The JCTVC-F069 cross-checker confirms that the code is clean is does what is proposed.

The cross-checker thinks that it is a good improvement but that the design should use the top candidate instead of top left or horizontal and vertical candidates rather than diagonal ones.

JCTVC-G922 Non-CE9: cross-check of LGE's proposal JCTVC-G164 on improvement on parallel merge/skip mode [Y. Park, H. Yang (Samsung)] [late]

It was also recommended to consider this proposal to be dependent on JCTVC-F069.

JCTVC-G387 Non-CE9 Parallel Merge/skip Mode for HEVC [X. Wen, O. Au, W. Dai, C. Pang, J. Dai, F. Zou, X. Zhan (HKUST)]

The current HEVC merge/skip is copying motion parameters to the current PU from a candidate list which consists of spatial and temporal neighbouring PUs. However, it is asserted to be hard for parallel encoding and decoding due to the data dependency. Furthermore, different shapes and position of PU would result in different definition of candidate lists, and this would preortedly lead to potentially extra hardware cost and to not be easy to be efficiently implemented by the hardware. In this proposal, it was proposed to use a high level syntax to signal a parallel depth of merge/skip mode, and divide a LCU into non-overlapped square merge regions (MRs). All the PUs located inside the same MR would use the same candidate list of PUs at both encode and decoder side. By doing this, all the PUs in the same MR can be checked by a certain architecture in parallel. Simulation results reportedly reveal that an average loss of 1.5%, 1.5%, 2.4% and 2.5% in RA-HE, RA-LC, LB-HE and LB-LC for 32x32 block level parallel ME was observed when compared to the current HM4.0 design. The proposal provides different trade-off points between saving logic and coding efficiency.

This was considered dependent on CE9 MRG_PAR (JCTVC-F069) discussion.

This was basically the same as JCTVC-G164.

JCTVC-G407 Non-CE9: Cross-check of parallelized merge/skip mode for HEVC (JCTVC-G387) [B. Li (USTC), J. Xu (Microsoft)]

Confirmed.

JCTVC-G165 Non-CE9/Non-CE13: new MVP positions for merge/skip modes and its combination with replacing redundant MVPs [Y. Jeon, S. Park, B. Jeon (LG), J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)]

This contribution proposes new MVP positions for skip and merge mode. Two new spatial MVP candidate positions (A2 and B3) are introduced in addition to the spatial MVP positions (A0, A1, B0, B1, and B2) of the current HM. The proposed order for spatial MVP candidates is {A2, B3, A1, B1, B0, A0, A2} but there are some restrictions for adding the candidates to the MVP list in order to minimize the complexity which can be caused by introducing the two new candidates. Simulation results reportedly revealed that the proposed method achieves 0.1% gain for RA configurations and 0.2% gain for both LB and LP configurations without any increase in encoding and decoding time.

The proposed improvement is adding two spatial merge candidates.

The proposal increases complexity for a small gain. Several experts expressed negative opinions. No action was taken.

JCTVC-G860 Non-CE9/Non-CE13: Cross-check of JCTVC-G165 on new MVP positions for merge/skip modes [V. Seregin (Qualcomm)] [late]

Confirmed.

JCTVC-G104 Non-CE9: cross-verification of LGE and MediaTek's proposal JCTVC-G165 on new MVP positions for merge/skip modes and its combination with replacing redundant MVPs [M. Zhou (TI)]

The gain here is associated with complexity increase of the first pruning process of the merge/skip list derivation, which should be studied.

Confirmed.

JCTVC-G181 Non-CE9: Merging candidate reordering [H. Takehara, S. Fukushima (JVC Kenwood)]

In the HM4.0, motion information of the merging candidate that is located inside of the CU is not to be used. In this proposal, instead of avoiding such a merging candidate, the merging candidate is moved to the last position in the merge list after the derivation process for merging candidates. The simulation results reportedly show that the proposed technique provides 0.1% BD-rate gain for random access and 0.1%/0.2% gain for low delay B setting Merge redundancy check removal.

The same idea was also proposed in JCTVC-G681, JCTVC-G396 and JCTVC-G593.

JCTVC-G468 Non-CE9: cross-verification of JVC KENWOOD's proposal on Merge candidate reordering (JCTVC-G181) [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)] [late]

Confirmed.

JCTVC-G681 Non-CE9: Simplified Merge candidate derivation [Y. Zheng, X. Wang, W.-J. Chien, M. Karczewicz (Qualcomm)]

This contribution proposes a change to the rules currently used in determining merge candidates for a PU under 2NxN, Nx2N, NxN, or AMP mode. In HM4.0, when a current PU under these partition modes is not the first PU in a CU, the motion information of each of its merge candidates is compared with that of a previous PU to avoid a situation that a number of PUs share the same motion information so that the current prediction information can be classified into a mode with less partitions. For example, every PU has the same motion information under a mode other than 2Nx2N. This contribution proposes to remove such comparison. The proposed changes reduce the operations and also enable parallel merge candidate generation.Merge redundancy check removal

Remove the possibly redundant candidate may improve parallelism because PU1 does not depend on PU0 anymore.

Simplification on merge partition redundancy removal

JCTVC-G830 Non-CE9: Crosscheck for Qualcomm's simplified merge candidate derivation in JCTVC-G681 [J.-L. Lin, Y.-W. Huang (MediaTek)] [late]

Confirmed.

JCTVC-G593 Non-CE13: Simplification of merge mode [O. Bici, J. Lainema, K. Ugur (Nokia)]

This contribution comprises three parts aiming at reducing complexity of the merge process. In the first part, it is proposed to reduce number of motion comparisons during the first pruning process by comparing each spatial candidate with a limited number of spatial candidates and exempting the temporal motion vector prediction candidate from the pruning process. In the second part, it is proposed to derive redundancy information for the combined candidates during the first pruning process and exempting other additional candidates from pruning. In the third part, the number of contexts used for the merge index is reduced to two and the contexts are assigned according to being a skip mode or inter-merge mode. Combination of all the three parts provides the merge mode having a total of one full motion comparison per PU where other motion comparisons are either removed or replaced by simpler operations. The reported compression efficiency impact in terms of BD rate is 0.1%, 0.1%, 0.1%, 0.2% for RA_HE, LB_HE, RA_LC and LB_LC, respectively.

Source code was bundled with the proposal.

The proposal included merge redundancy check removal with additional modification of the first and second pruning as well as context reduction for CABAC.

Further study in a CE was suggested.

JCTVC-G940 Cross-check for JCTVC-G593: Non-CE13: Simplification of merge mode [Semih Esenlik (Panasonic)] [late]

Confirmed.

JCTVC-G396 Non-CE9: swapping of merge candidate [C. Kim, Y. Jeon, B. Jeon (LG)]

In this contribution, two methods for reordering the merge candidates are presented. The first method is applied only for 2Nx2N PUs of square shape. The first method (Proposed method 1) swaps A1 and B1 candidate order in the merge list if the propose condition is satisfied. It is reportedly shown in the experimental results that 0.1–0.2% BD rate reduction is achieved without increasing encoding and decoding time with the proposed method 1. The second method (Proposed method 2) is applied for the second PUs of 2NxN, 2NxnU, 2NxnD, Nx2N, nLx2N and nRx2N partitions of rectangular shape. The proposed method 2 uses the MVP candidate which belongs to the first PU of those rectangular partitions

for creating the combined bi-pred. candidates even though this candidate shall not exist in the initial list due to the avoiding check operation. It is reportedly shown in the experimental results that 0.1–0.2% BD rate reduction is achieved without increasing encoding and decoding time with the proposed method 2. In addition, the proposed methods are tested with the new anchor in which the avoiding check operation is removed. It is reportedly shown from the simulation results that the proposed 2 achieves 0.0–0.1% BD rate saving without encoding/decoding time increase relative to the new anchor and the combination of the proposed method 1 and the proposed method 2 achieves 0.1–0.2% BD rate saving. The encoding and decoding time is reportedly almost the same as the anchor.

The title was changed to “Non-CE9: reordering of merge candidate” after the first registration.

It was mentioned that there is a dependency between the first and second PU.

Method1 as a proposed improvement, while Method2 was a proposed simplification.

JCTVC-G484 Non-CE9: Crosscheck for LG's swapping of merge candidate in JCTVC-G396 [J.-L. Lin, Y.-W. Huang (MediaTek)] [late]

No one was present to report details on this contribution. The document confirms a successful cross-check.

JCTVC-G927 Non-CE9: Cross-check of JCTVC-G396 on reordering of merge candidate [V. Seregin (Qualcomm)] [late]

Confirmed.

JCTVC-G944 Cross-check report on JCTVC-G396 [I.-K. Kim] [late]

Confirmed.

JCTVC-G542 Non-CE9/Non-CE13: Simplification on AMVP/Merge [T. Sugio, T. Nishi(Panasonic)]

In this contribution, three simplification methods on AMVP/Merge were proposed. 1) On avoiding merging candidate decision 2) On AMVP spatial scaling candidate 3) On zero motion vector merging candidate. Experimental results reportedly showed no loss on average relative to the HM4.0 with reducing complexity on AMVP/Merge.

Simplification 1 was on merge partition redundancy removal.

Simplification 2 was on AMVP scaling for spatial candidates.

Simplification 3 was on zero motion vector merge candidates.

JCTVC-G891 Non-CE9: cross-verification of Panasonic's simplification on AMVP/Merge (JCTVC-G542) [M. Zhou (TI)] [late]

The proposed simplifications 2 and 3 of JCTVC-G542 are asserted to be helpful for reducing the complexity of merge/skip and AMVP list derivation process. It was recommended to consider this proposal together with other contributions in this category.

Nobody was there to report details of this cross-check. The document confirms that the cross-check was successful.

JCTVC-G878 Non-CE9: Crosscheck for Panasonic's proposals (JCTVC-G542) by JVC-KENWOOD [Hiroya Nakamura, Shigeru Fukushima (JVC Kenwood)] [late]

Confirmed.

JCTVC-G182 Non-CE9: AMVP syntax for bi-prediction [H. Takehara, S. Fukushima (JVC Kenwood)]

The proposed simplifications 2 and 3 of JCTVC-G542 are reported to be helpful for reducing the complexity of merge/skip and AMVP list derivation process. It was recommended to consider this proposal together with other contributions in this category.

The proposal suggested changing the syntax order for ref_idx_l1. No impact was shown on CAVLC BD rate, with a small impact on CABAC due to context dependencies.

The contribution was a simplification proposal for parsing throughput. There was no support for this.

JCTVC-G431 Non-CE9: Cross-verification of JVC Kenwood proposal on AMVP syntax for bi-prediction (JCTVC-G182) [T.Chujoh (Toshiba)]

Confirmed.

JCTVC-G195 Non-CE9/13: Averaged merge candidate [S. Shimada, K. Kazui, J. Koyama, A. Nakagawa (Fujitsu)]

This contribution proposes a new type of merge candidate, namely averaged merge candidate, in the derivation process for luma motion vectors for merge mode. An averaged merge candidate is derived by averaging a pair of two original merge candidates and added into the merge candidates list with higher priority than other candidates previously adopted in WD4.

The coding gains of the proposed scheme over HM4.0 are 0.2% (HE), 0.3% (LC) in RA configurations, 0.0% (HE), 0.0% (LC) in LDB configurations and 0.3% (HE), 0.6% (LC) in LDP configurations. When the proposed scheme works without non-scaled bi-predictive merge candidate in WD4, the additional coding gains are 0.2% (HE), 0.2% (LC) in RA configurations, 0.0% (HE), 0.0% (LC) in LDB configurations and 0.3% (HE), 0.6% (LC) in LDP configurations. Measured computational complexities for various configurations in encoding and decoding are 96-102% and 100-101%, respectively.

Test1: Adding up to averaged candidates

Test2: Replacing non-scaled bi-predictive candidates by averaged ones.

It was remarked that additional shifts and adds are required for the averaging and it is checked whether the refidx of the two average candidates are equal.

It was assumed that removing the additional duplicate check may not have big impact in coding efficiency.

Removing all duplicate checks was proposed in JCTVC-G397.

Even test 2 is adding some complexity (checking ref_idx). Furthermore, with the reduction of candidates as from CE13 T10 the gain could be even lower.

No support was expressed by other companies.

JCTVC-G467 Non-CE9/13: cross-verification of Fujitsu's proposal on Merge (JCTVC-G195) [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)] [late]

Confirmed.

Reported runtimes are obtained on one type of computer and they are around 100%.

JCTVC-G217 Non-CE9: Derivation process of reference indices for temporal merge candidates [H. Nakamura, S. Fukushima (JVC Kenwood)]

In HM4.0, the reference indices of temporal merging candidates are derived by a majority decision of the reference indices of three neighboring blocks. This contribution proposes a simplified derivation process

of reference indices for temporal merging candidates. The simulation results reportedly show that the proposed technique provides no coding loss for random access settings and low delay B settings.

The proposal appeared to be the same as one simplification (test2) in JCTVC-G163.

JCTVC-G742 Cross-check report on derivation process of reference indices for temporal merge candidates (JCTVC-G217) [I.-K. Kim (Samsung)]

Confirmed.

JCTVC-G219 Non-CE9: Construction of MVP list without using scaling [H. Nakamura, S. Fukushima (JVC Kenwood)]

In the HM4.0, when a MVP list is constructed, two-times scaling operations are performed at a maximum. This contribution proposes a method which reduces the number of times of scaling operation.

The simulation results reportedly show that the proposed technique provides no gain and loss for random access and low delay B settings. The contribution was a proposed simplification of AMVP list construction.

JCTVC-G105 Non-CE9: cross-verification of JVC's proposal JCTVC-G219 on construction of MVP list without using scaling operation [M. Zhou (TI)]

Confirmed.

On the encoder side, this technique would not save the number of MVP scalings, in the worst case still two scales are needed. But it would reduce the worst case scaling requirement from 2 to 1 on the decoder side. The penalties are increased latency because non-scaled and scaled MVP derivation processes now run sequentially (in the current design the non-scaled MVP derivation can be hidden by the scaled MVP derivation); motion vector reconstruction on decoder side needs two stages, i.e. first to use mvp_idx to compute the final MVP, and then add MVDs to obtain the motion vectors, and additional storage for buffering the temporal distances for all the MVPs.

JCTVC-G223 Non-CE9: Division-free MV scaling [T.-D. Chuang, Y.-W. Chen, J.-L. Lin, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)]

In HM-4.0 motion vector (MV) scaling for the derivation of spatial and temporal motion vector predictors (MVPs), a division operation is required to derive the scaling factor. In hardware and many DSP-based platforms, dividers are undesirable because of larger gate counts and more processing cycles. In this contribution, a division-free MV scaling is proposed to replace the general divider by a look-up table and simple arithmetic operations. Moreover, the effective scaling range is doubled to deal with reference pictures of longer temporal distances. Simulation results reportedly show that the proposed method has no bit rate increase in random access conditions and 0.1% bit rate reduction in low delay conditions. The proposed design was also implemented in Verilog and synthesized with TSMC 40nm process. The synthesis results reportedly show that the gate count of the MV scaling module is reduced by 54–58%.

Proposal 1: Extending the clipping range in the scaling factor clipping.

Proposal 2: Division-free MV scaling by using a LUT.

HEVC uses the same scaling as AVC. The implementation of this HM4.0 scaling that the proposal is compared to may also be table-based. Additional slides (to be uploaded) were shown with comparing this with a table-based HM4.0 scheme.

JCTVC-F068 reports that scaling needs 3 cycles. That is not affected by the tested proposal.

A version of the first proposal was adopted (see notes below). There was no support for proposal 2.

JCTVC-G523 Non-CE9: Cross-check of division-free MV scaling [P. Onno (Canon)] [late]

Divsion-free scaling is confirmed.

The clipping range extension was not verified.

JCTVC-G225 Non-CE9: Simplified AMVP derivation for Inter mode [J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)]

No presentation was requested.

JCTVC-G341 Crosscheck of MediaTek's AMVP simplification (JCTVC-G225) [J. Park, S. Park, B. Jeon (LG)]

JCTVC-G241 Non-CE9: On parallel derivation of the temporal predictor for Merge/Skip modes [G. Laroche, T. Poirier, P. Onno (Canon)]

This contribution presents an asserted simplification of the motion vector derivation process for the Merge/Skip modes. The aim of the proposed scheme is to reduce the number of cycles in hardware needed for this derivation process for the worst case. The proposed scheme consists in scaling the temporal candidates in parallel to the cascaded predictors and related pruning process. Based on the complexity analysis from Texas Instruments in JCTVC-F088 and JCTVC-F068, it was reported that 3 cycles are saved for the Merge/Skip mode derivation process (for the worst case hardware implementation) with less than 0.1% BDR loss.

Simplification of first pruning and last pruning process.

No support was expressed for this.

JCTVC-G098 Non-CE9: cross-verification of Canon’s proposal JCTVC-G241 on parallel derivation of the temporal predictor for Merge/Skip modes [M. Zhou (TI)]

The proposed parallel MVP scaling will improve the throughput of the merge/skip MVP list derivation process. The trade-off between coding efficiency and throughput improvement should be carefully considered here.

The cross-checker was not sure whether this improvement of throughput is really needed and justifies the loss.

JCTVC-G305 Non-CE9: Bi-prediction for low delay coding [Y. Suzuki, A. Fujibayashi (NTT DOCOMO)]

In this contribution the additional option of bi-prediction for low delay conditions and key pictures of random access conditions was proposed. In the proposed method, the motion vector difference for List 1 is not signaled and is set to (0, 0) when POCs of all reference pictures are smaller than that of a target picture. The average Y BD-rate gains for low delay B condition and random access condition are reportedly 0.9% and 0.2%, respectively.

An encoder only change (setting the list1 mvd to zero and signalling it) give 0.3% and 0.1% gain on average for LB and RA (available in revised document).

There is no list 1 motion vector search for bi-prediction.

It was asked what would be the impact when the list1 motion vector search for bi-prediction is enabled at the encoder. The assumption is that if the list 1 estimation is better, the loss of setting the list 1 mvd to zero is increasing.

This was suggested to be an interesting candidate to be considered after CE9/13 conclusion is reached.

Improvement

JCTVC-G603 Non-CE9: Cross-check of Bi-prediction for low delay coding (JCTVC-G305) [P. Helle, B. Bross (Fraunhofer HHI)] [late]

Confirmed. The gain is achieved by enforcing MV differences to zero (which would be the encoder-only change) and then enforcing no signalling of List 1. It was asked whether this would have any visual impact.

Further study in a CE was suggested, also including more investigation whether this can be done in a non-normative way with similar results.

JCTVC-G343 Non-CE9: Improvement in temporal candidate of merge mode and AMVP [N. Zhang, X. Fan, S. Ma, D. Zhao (Harbin Inst. Tech.)]

This contribution proposes an improved scheme in temporal candidate of merge mode and AMVP. In order to utilize motion information from the below and right sides more effectively, the scheme considers three additional temporal candidate checking positions relative to HM4.0 in some cases. Simulation results reportedly show that the proposed scheme on average provides 0.1% bit rate savings for random access, and 0.2% bit rate savings for low delay with almost the same time cost. This proposal was crosschecked by MSRA as reported in JCTVC-G406.

Solution A uses a conditional add.

Solution B always adds (preferred).

JCTVC-G406 Non-CE9: Improvement in temporal candidate of merge mode and AMVP (JCTVC-G343) [B. Li (USTC), J. Xu (Microsoft)]

No one was present to present this. The document confirms a successful cross-check.

JCTVC-G397 Non-CE9/Non-CE13: Simplification of adding new merge candidates [B. Li (USTC), J. Xu (Microsoft), H. Li (USTC)]

The parsing robustness issue was solved in JCTVC-F470 by a method similar to coding full index of merge candidate. For some other syntax elements, the parsing dependency of the surrounding information is also removed. One most important part of JCTVC-F470 is reportedly to compensate the loss introduced by coding full merge index. Some new merge candidates are also added to the set of merge candidates, which was adopted in the latest HM design. For each new added merge candidate, the duplication checking is also performed. This contribution evaluates the benefits of each individual step and proposes to remove some steps to simplify the design.

Very interesting data was provided for the discussion on the combined merge candidates.

JCTVC-G426 Cross-check of Microsoft's proposal on simplification of adding new merge candidates (JCTVC-G397) by Huawei [H. Yang, H. Yu (Huawei)]

No one was present to report on this contribution in detail. The document confirmed a successful cross-check.

JCTVC-G416 CU-based Merge Candidate List Construction [H. Y. Kim (ETRI), K. Y. Kim, S. M. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee, J. S. Choi (ETRI)]

This contribution proposes a CU-based approach for merge candidate list construction, where a CU can have at most one merge candidate list that can be constructed prior to encoding and decoding of the internal PUs. It is indicated that the proposed approach provides simpler design, reduced complexity, and

improved parallelism compared to the PU-based one used in HM4. Also, it is reported that roughly 3–6% encoding time reduction was achieved with the penalty of roughly 0.2–0.5% coding loss depending on the test configurations.

This proposed a simplification of the merge candidate list construction.

This is applied to all CU size whereas there are proposals restricting parallelism to certain sizes.

JCTVC-G899 Cross-check of CU-based Merge Candidate List Construction [S. Oudin, B. Bross(Fraunhofer HHI)] [late]

Confirmed.

JCTVC-G516 On Spatial MV Prediction [K. Sato (Sony)] [late]

Under the current HM specification, motion information of top-right PU is one of the candidates for spatial motion vector prediction. When LCU-level parallel processing is applied for HEVC encoding/decoding, extraction of motion information of the top-right PU becomes a bottleneck. This contribution proposes not using motion information of the top-right PU at LCU boundaries for motion vector coding. Average losses with the proposed method are reportedly around 0.2% for Y/U/V component with RA/RA_Loco/LD/LD_Loco conditions.

This proposal was not considered in detail, as it was late and no one requested its detailed discussion.

JCTVC-G799 Non-CE9: Crosscheck for Sony's proposals (JCTVC-G516) by JVC KENWOOD [Hiroya Nakamura (JVC Kenwood)] [late]

Confirmed. The coding loss was considered acceptable.

JCTVC-G541 Non-CE9: Simplified scaling calculation method for temporal/spatial MVP of AMVP/Merge [T. Sugio, T. Nishi(Panasonic)]

In this contribution, a simplified scaling calculation for AMVP/Merge was proposed. In the proposed method, the scaling factor is quantized to a power of 2 based on the distance among current picture, reference picture and collocated picture. Experimental results reportedly showed BD rate loss in the range of 0.0–0.1% with reducing the number of multiplier relative to the HM4.0 by applying the proposed method to temporal MVP in AMVP.

Test1: simplified scaling for temporal amvp candidate.

Test2: simplified scaling for temporal candidate.

Test3: simplified scaling for spatial amvp candidates.

Combined results were not reported.

This proposed simplification of the scaling based on temporal distance used in both amvp and merge (temporal and combined candidates).

JCTVC-G102 Non-CE9: cross-verification of Panasonic’s proposal JCTVC-G541 simplified scaling calculation method for temporal/spatial MVP of AMVP/Merge [M. Zhou (TI)]

The proposed scaling calculation was reported to be likely to reduce the cost in hardware implementation. It was suggested that the trade-off between coding efficiency and implementation cost reduction should be evaluated, its implication on the software implementations should be considered as well.

JCTVC-G551 Restriction on motion vector scaling for Merge and AMVP [I.-K. Kim, Y. Park, N. Shlyakhov, J. H. Park (Samsung)]

In this contribution, a restriction method on motion vector scaling is proposed. When POC difference between reference picture of current PU and reference picture of candidate PU (collocated PU or neighbor PU) are larger than pre-determined threshold, motion vector scaling is restricted. The motion vector predictor is marked as unavailable before the scaling process is performed. This restriction is applied to both spatial and temporal scaling. Average coding efficiency gain from this modification for each configuration are 0.0% (RAHE), 0.0% (RALC), 0.1% (LDHE), 0.0% (LDLC), 0.1% (LPHE), 0.1% (LPLC) with class F sequences. Encoding and decoding time are 100% and 101%, respectively. Coding efficiency gain for Class F only is 0.13%.

It was suggested that this should be considered in the AHG21 discussion.

It is mentioned that something like this is used in AVC. However, nobody knew whether this is useful in HEVC. In fact, it would slightly increase complexity as it is necessary to check a condition. Further study was recommended.

JCTVC-G859 Crosscheck of JCTVC-G551 proposed by Samsung [X. Zheng] [late]

No one was there to report on this. The document confirmed that the cross-check was successful.

JCTVC-G552 Simplification of temporal motion vector (TMVP) candidate derivation for Merge and AMVP [I.-K. Kim, N. Shlyakhov, J. H. Park(Samsung)]

In this contribution, two modifications are proposed to simplify TMVP derivation process of Merge and AMVP. The first item is utilization of upper-left position instead of center position. The second one is utilization of zero reference index instead of the value which has the majority of occurrence among neighbours. By utilizing upper-left position, no additional calculation is required to get the specific position since it is easy to find upper-left position which is starting point of PU. In addition, utilizing zero reference index for Merge TMVP candidate saves the steps for checking and calculating the majority of occurrence. Checking which one is majority is complex process which involves several comparisons and conditional branches. When the both simplification is combined, the average loss is 0.0% with 100% and 99% encoding and decoding time, respectively, compared to HM-4.0.

This included two aspects:

Simplification1 of temporal motion vector position

Simplification2 of temporal motion vector index derivation

It seemed questionable if this is a simplification (except that it is not necessary to compute the center position).

JCTVC-G227 Non-CE9: Cross-check for Samsung's proposals (JCTVC-G552) by JVC KENWOOD [H. Nakamura, S. Fukushima (JVC Kenwood)]

Confirmed.

JCTVC-G515 Cross-check of Samsung's TMVP simplification by Sony [K. Sato (Sony)] [late]

Confirmed.

JCTVC-G592 Non-CE9: Removal of reference index derivation for TMVP in merge mode [O. Bici, J. Lainema, K. Ugur (Nokia)]

The proposed suggestion was already discussed in several other documents.

JCTVC-G690 Non-CE9: Some possible motion vector coding related simplifications [Y. H. Tan, C. Yeo, Z. Li (I2R)]

This contribution presents several modifications that are aimed at simplifying motion vector coding. The first modification is related to the derivation of the L1 motion vector predictor (MVP) during bi-directional prediction. L0 and L1 MVP candidates are derived pair-wise such that both sets of candidates are derived from the same neighboring PU. This reportedly led to a coding loss of 0.0% and 0.1% BD-rate loss for RA and LB configurations respectively. The second modification restricts the reference index to zero during the derivation of the reference index of the temporal Merge candidate. This reportedly led to a coding loss of 0.0% and 0.1% BD-rate loss for RA and LB configurations respectively. The third proposed modification is to remove the context for coding the MVP index when CABAC is the entropy coder, which reportedly resulted in an average of 0.0% BD-Rate loss. The last two modifications are related to the addition and pruning process of 'combined' Merge candidates. The modified process limits the number of combined candidates to five and uses a simplified pruning process. When applied together, these two modifications reportedly result in an average of 0.0% BD-Rate loss in all configurations.

Simplification 1 related to AMVP_SEL03, AMVP_SEL04 CE9 tests.

A concern was raised on the dependency between list 0 and list 1 mvp derivation.

This was suggested to be discussed when CE9 tests were reviewed.

Simplification 2 is also setting refidx to 0 for temporal merge candidate.

Simplification 3 codes mvp_idx in bypass mode.

Simplification 4 reduces the possible combination of combined bi-predictive candidates to 5.

Simplification 5 combined bi-predictive candidates duplicate check is replaced by checking the candidates before combination.

This was also addressed in JCTVC-G593 part 2.

JCTVC-G970 Cross verification of Some possible motion vector coding related simplifications (JCTVC-G690) [M. Coban (Qualcomm)] [late]

Simplification 4 and 5 were reported confirmed.

JCTVC-G752 Non-CE9: Crosscheck of I2R's proposal on motion vector coding related simplifications (JCTVC-G690) [X. Zheng (HiSilicon)] [late]

Simplification 3, confirmed.

JCTVC-G733 cross check for I2R AMVP simplification [Yue Yu, Krit Panusopone, Limin Wang] [late]

Simplification 1, confirmed

JCTVC-G710 Non-CE9: The Parallel Friendly MVP Candidate Calculation for HEVC [Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)]

This contribution proposes a "parallel friendly" MVP candidate calculation when a CU consists of two PUs. Simulation results reportedly show that there is a loss of 0.3% for random access condition and a loss of 0.1% for low delay condition compared to original AMVP while it is possible to parallel process two PUs.

Results are reported for simplification combined with improvement. There were two elements in the proposal:

Simplification of AMVP replace PU0 candidate for PU1 by one outside PU0, and

Improvement of AMVP by swapping indices, i.e. having different list orders for PU0 and PU1

There was no support for this.

JCTVC-G712 Non-CE9: The Simplification of MVP for HEVC [Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)]

This contribution proposes a simplification of MVP design for HEVC. Simulation results reportedly show that a loss of 0.1% for LBHE and a loss of 0.3% for RAHE are observed compared to original AMVP while the complexity of the proposed method is reduced at least 50%, and up to 66.7% as compared to the MVP selection procedure of AMVP when a CU consist of two PUs.

Concern was raised on the additional scaling.

It cannot be combined with JCTVC-G710.

Losses of 1.1% were reported for SteamLocomotive.

It was suggested that this does not look like a real simplification. There was no support for this.

JCTVC-G740 Cross-check of Motorola's proposals on motion vector coding (JCTVC-G710, JCTVC-G712) [Y. H. Tan, C. Yeo (I2R)] [late]

Confirmed.

JCTVC-G221 Non-CE13: The maximum number of merging candidates in P-slice [H. Nakamura, S. Fukushima, H. Takehara, M. Ueda (JVC Kenwood)]

In the HM 4.0, the maximum number of merging candidates is fixed to 5 as maxNumMergeCand in both P-slice and B-slice. This contribution reports the results of investigation of the variable maxNumMergeCand in low delay P settings. The simulation results report that 0.1% BD-rate gain is obtained under the setting of maxNumMergeCand equal to 3.

Not cross-checked.

The proposal assumes a slice header flag signalling the maximum number of merge candidates as proposed in CE13 tests. These tests had to be considered first.

Simplification was enabled by the adopting of JCTVC-G091 T5…T8 from CE13.

Note: There would be a reasonable possibility to impose a restriction to 3 candidates in common test conditions for LD P. It is however suggested not to do this now as it could affect investigations that target increasing the number of candidates.

JCTVC-G224 Non-CE13: Multiple-scaled merging candidates [H. Nakamura, S. Fukushima (JVC Kenwood)]

This proposal is for the improvement of the merge mode. In the HM4.0, for the merge mode, some spatial merging candidates and a temporal merging candidate are added into a merging candidate list. After that, if needed, combined bi-predictive merging candidates, a non-scaled bi-predictive merging candidate and zero motion vector merging candidates are added. The non-scaled bi-predictive merging candidate is added under a random access condition. Therefore, the multiple-scaled merging candidate by extending the non-scaled merging candidate for low delay conditions is proposed in this contribution. The simulation results report that the proposed techniques provide no gain for random access setting, 0.1–0.2% BD-rate gain for low delay B setting, and 0.1–0.2% BD-rate gain for low delay P setting.

The contribution proposed improvement of non-scaled combined merge candidates by adding scaling.

JCTVC-G544 Non-CE13: Cross check report of JCTVC-G224 by panasonic [T. Sugio, T. Nishi(Panasonic)] [late]

Confirmed.

JCTVC-G288 Non-CE13: Complexity Reduction of MVP List Construction [Y. Yu, T. Hellman (Broadcom)]

The proponent was not available to present this contribution.

JCTVC-G097 Non-CE13: cross-verification of Broadcom's proposal JCTVC-G288 complexity reduction of MVP list construction [M. Zhou (TI)]

JCTVC-G683 Non-CE13: Simplification and improvement of additional merge candidate [Y. Zheng, X. Wang, W.-J. Chien, M. Karczewicz (Qualcomm)]

This proposal presents several changes to simplify the additional merge candidates generating process. In the proposal, scaled bi-pred candidate is removed, the additional merge candidate pruning operation is limited to the combined bi-pred candidates only, and motion offset candidates are added. With fewer operations, the proposed changes reportedly provide 0.3% bit rate savings on average based on common test conditions.

The proposed simplification: Disable remove duplicates for zero mv and remove the non-scaled bi-predictive merge candidates (also tested in JCTVC-G397).

The proposed improvement: Adding motion offset candidates.

JCTVC-G872 Non-CE13: crosscheck of Qualcomm's proposal JCTVC-G683 on simplification and improvement of additional merge candidate [Y. Jeon, B. Jeon (LG)] [late]

Confirmed, but reports slightly increased runtimes.

JCTVC-G787 Non-CE13: Additional merge candidates with MV dependent offsets [T. Lee, J. Chen, J. H. Park (Samsung), G. Laroche, P. Onno (Canon), J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)]

This contribution presents additional Merge/AMVP candidates to compensate empty positions in the fixed length candidates list. The additional Merge/AMVP candidates are produced by adding offsets to the first existing candidate where the offset value is chosen according to the first candidate's MV value. Relative to the HM4.0+MRG_ENC_FIX which is reported in JCTVC-G776, experimental results reportedly showed −0.3% BR impact on average results in RA-HE, RA-LC, LB-HE, LB-LC, LP-HE, LP-LC.

This involved combination of CE13 tests, and was discussed again when the conclusion on CE9/13 tests was discussed (see notes elsewhere).

A concern was raised regarding losses in chroma and luma for class E sequences. This may be due to removing zero motion vector merge candidates.

The fast encoding method can also be applied to other proposals.

JCTVC-G926 Non-CE13: Cross-check of JCTVC-G787 on MV dependent offset [V. Seregin (Qualcomm)] [late]

It should be ensured that the merge index encoder estimation bugfix is included in anchor and tested.

Confirmed.

JCTVC-G839 Non-CE13: cross-verification of Samsung, Canon, MediaTek proposal JCTVC-G787 on additional merge candidates with MV dependent offsets [Y. Jeon, B. Jeon (LG)] [late]

Confirmed

JCTVC-G946 Non-CE13: Cross-check report of JCTVC-G787 (MvDepOffset+Fast) [S.-C. Lim, J. Lee, H. Y. Kim (ETRI), K. Y. Kim, S. M. Kim, G. H. Park (KHU)] [late]

5.8.2 MV and mode coding

JCTVC-G209 Modified method for coding mvd in the CABAC mode [S.-T. Hsiang, S. Lei (MediaTek)]

This contribution proposes a modified method for coding the absolute value of each component of vectors mvd_l0 or mvd_l1 in the CABAC mode. The proposed method attempts to further utilize context modeling for coding the EG 1 prefix bins. Experimental results reportedly show Y BD-rate gains 0.1%, and 0.0% for HE-RA and HE-LDB, respectively, under the common test conditions and Y BD-rate gains 0.3%, 0.1% for HE-RA and HE-LDB, respectively, over QP = 32, 37, 42, and 47.

Increases complexity. No significant gain was reported and no interest was expressed.

JCTVC-G985 Crosscheck on JCTVC-G209 Modified method for coding mvd in the CABAC mode [W. -J. Chien (Qualcomm)] [late]

JCTVC-G705 CABAC simplification for explicit signaling mode of AMVP [K. Misra, A. Segall (Sharp)]

This document proposes to remove the CABAC context models for the motion vector predictor index, mvp_idx_lX (mvp_idx_l0, mvp_idx_l1, mvp_idx_lc), and use CABAC bypass mode instead. It is asserted that this change reduces the number of CABAC contexts in memory and eliminates the associated CABAC context update step while having negligible impact on compression efficiency. For HM-4.0, high efficiency common test conditions, the proposed change reportedly shows an average BD bitrate impact of:

RA_HE Y:0.0% U:0.0% V:0.0%; **LB_HE** Y: 0.0% U: 0.1% V: 0.1%; **LP_HE** Y: 0.0% U: 0.2% V: −0.1%.

(With Class F sequences)

RA_HE Y: 0.0% U: 0.0% V: 0.0%; **LB_HE** Y: 0.0% U: 0.1% V: 0.1%; **LP_HE** Y: 0.0% U: 0.1% V: −0.1%.

(Without Class F sequences)

The proposal slightly increases the number of bypass mode (by 1% perhaps)

JCTVC-G690 is the same (presented in breakout discussion).

Some entropy coding impact was noted (reduction of number of contexts by 2 according to software and 3 according to text).

The results may somehow be interrelated with the RDO in ME decisions.

No interest was expressed.

JCTVC-G996 Cross check of Sharp's JCTVC-G705 [G.v.d.Auwera (Qualcomm] [late]

JCTVC-G785 Unified Pred_type coding in CABAC [Y. Piao, J. Min, J.H. Park (Samsung)]

This document proposes to unify pred_type coding of slice B and P in CABAC. Prediction mode and partition mode coding in slice B is modified to be same as that of slice P to simplify the pred_type coding and enhance the readability of specification. The average BD-rate by this unification is reportedly 0.01% in RA and 0.03% in LD high efficiency configuration.

No results were reported on a bug fixed implementation mentioned in the document.

In software implementation, there are some restrictions on B slice. There are also some mismatches between text and software for P slices, so this one would introduce this bug in B as well.

JCTVC-G151 is related (does it the other way round, and both were mutually cross-checkers), also JCTVC-G718.

(There was the intention that intra would be more probable in P than NxN and 2Nx2N, which is the only difference.)

Disposition:

- We want only one solution
- Side activity was requested (joint with WD and software coordinator; see result in JCTVC-G1042)

JCTVC-G1042 Harmonization of the prediction and partitioning mode binarization of P and B slices [S. Oudin, B Bross et al.] [late]

This document suggests to use P slice binarization (as per JCTVC-G785), but cleaning up various issues. One issue about describing context derivation may need further study and cleanup.

Decision: Adopt.

JCTVC-G906 Cross check report of Samsung's Unified Pred_type coding in CABAC (JCTVC-G785) [W. Zhang (ZTE)] [late]

5.9 High-level syntax and slice structure

5.9.1 High-level syntax and systems usage of bitstreams

JCTVC-G110 Implication of parallelized bitstreams on single core decoder architectures [W. Wan, T. Hellman (Broadcom)]

There have been several methods proposed and adopted in previous JCT-VC meetings to enable parallelism for multi-core architectures. It was reported to be currently unclear whether keeping these multiple approaches is necessary in the final HEVC design as they may be redundant and/or could be

unified. This contribution suggests that single core decoder architectures may not benefit and in fact, may be penalized by having to support some of these parallelism techniques. As an example of this, this submission reports on the impact of several parallelism techniques on a single core hardware-based design in an effort to aid the effort to better understand the trade-offs between different techniques to enable parallelism.

Discussion:

- Slices become difficult when the number of slices gets high – establish appropriate level limits, etc., as in AVC
- Entropy slices, similar to regular slices, require CABAC initialization – can be handled by a similar approach
- Wavefronts – similar re-initialization issue – also requires multiple sub-stream pointers – processing affected by maximum number and interleaving of sub-streams (which may mean that there should be bounds on these aspects)
- Tiles – impact depends on the variant:
    - tile_boundary_independence_idc
    - potential interaction with filtering across tile boundaries
    - Storage requirements for vertical tile boundaries – substantial penalty. It was remarked that JCTVC-G197 can help with this.

Among these issues, most were suggested to be minor (if we pay attention to the details of the implications) except, depending on how it is handled, the vertical boundaries of tiles.

JCTVC-G149 Options for High-Level Syntax for Multistandard Scalability [S. Wenger (Vidyo)]

(Submitted as an information document.)

Discussed are options for high level syntax for multistandard scalability, with a focus on the case of an AVC or SVC base layer, and one or more spatial/SNR HEVC enhancement layers, and with RTP transport/multiplexing. A few remarks are included with respect to other standards and other transport/multiplexing schemes. It is the author's belief that multistandard-scalability can be enabled with only moderate increases in high level syntax complexity.

In AVC there are 6 remaining "reserved" NUTs (falling into two categories of allowed NAL unit ordering behaviour) and 9 "unspecified" (at least 6 of which have been used by others).

The emphasized potential approach is to use external multiplexing (e.g. through RTP), although this may require a relatively tight design coupling with specification of external interface points.

It was noted that the NAL unit type design for HEVC uses a different number of bits than AVC.

5.9.2 Supplemental information

JCTVC-G079 SEI message for display orientation information [J. Boyce, D. Hong, S. Wenger (Vidyo)]

This contribution proposes an SEI message for describing display orientation information, to be included in an amendment to include in the HEVC design (and in AVC, although that is outside the scope of JCT-VC). The proposed SEI message indicates to the renderer a request to rotate and/or flip the decoded picture for proper display, after the normal decoding process. Because handheld video capturing devices allow changing the picture capture orientation dynamically, using an SEI message allows dynamic changes to the picture display orientation, temporally aligned with the compressed video data.

The same proposal was made to MPEG as m21659, and to VCEG as T09-SG16-C-0690, for consideration as an amendment to AVC. The concept was originally proposed in contribution JCTVC-E280.

It was asked why the semantics are in units of degrees, and in whole-integer units in particular, and why this is variable-length coded. The contributor indicated that the VLC coding was an error, and that there was no particular need for whole-degree units.

A participant remarked that the persistence syntax should be checked.

Another participant expressed potential interest in three-dimensional coordinates rather than just rotation (and flip).

It was noted that there was a "shall" in the proposed text, which was indicated to be an error.

Our plan of action is to wait to see what the parent bodies do with this in the AVC context and coordinate the outcome.

JCTVC-G092 AHG22: High-level signaling of lossless coding mode in HEVC [M. Zhou (TI)]

Efficient lossless coding is asserted to be required for real-word applications such as automotive vision, video conferencing and long distance education. This contribution proposes signalling methods to enable lossless coding at picture, region and LCU levels. Specifically, sps_lossless_coding_enabled_flag and pps_lossless_coding_enabled_flag are defined in SPS and PPS to signal whether a group of pictures are encoded losslessly; if pps_lossless_coding_enabled_flag is not set in PPS, aps_lossless_coding_enabled_flag is defined in APS to indicate whether there are regions in a picture are encoded losslessly, if yes, the lossless coding region information is encoded into in APS; if aps_lossless_coding_enabled_flag is not set in APS, slice_lossless_coding_enabled_flag is defined in slice_header() to signal whether 1-bit lossless coding flag is present at LCU level. This three-level signaling method provides a flexible way of signaling lossless coding for different use cases.

This proposal focuses only on high-level syntax for support of this functionality. (Obviously, that is only desirable if the low-level syntax also supports this functionality.)

Further study of lossless coding has already been (and remains) encouraged, and we have had AHG22 to investigate this topic.

JCTVC-G583 Reducing output delay for "bumping" process [J. Samuelsson, R. Sjöberg (Ericsson)]

(Discussion chaired by J. Boyce.)

This document proposes to add a flag to the slice header called output_process_flag and that the "bumping" process is replaced by an output process invoked based on the value of output_process_flag of the current picture. The document claims that the use of output_process_flag reduces unnecessary picture output delay. It is also claimed to be well suited for temporal scalability, in which sub-sequences may use a smaller DPB size.

When the decoder receives a picture with the flag set, all pictures with lower POC values are ready to be output.

The proposal would replace the current bumping process. This may restrict the encoder's possible picture coding patterns and impose additional constraints including buffering capacity impacts. Perhaps a real-time encoder would not know this information at the time of encoding. Possible error resiliency concerns if a picture with this flag set was lost.

There was a suggestion to retain the existing bumping process but add this as a decoder hint, putting a flag in the sequence header to indicate the presence of this flag in the slice header. This would allow for quicker output of frames at the decoder.

There was a suggestion to show example picture coding patterns where this would provide additional benefit over the latency count limit adopted in JCTVC-G546. A participant pointed out that putting a "non-normative" syntax element in the slice header would differ from past practice. It could be put in an SEI message, but is a lot of overhead for a single bit flag. It could alternatively be put into a VUI-like part of the PPS.

The subject was designated for further study.

5.9.3 Parameter sets and slice header

JCTVC-G325 AHG15: Picture size signaling [Y. Chen, Y. -K. Wang, M. Karczewicz (Qualcomm)]

The current HEVC WD signals the decoded picture size, for both width and height, in luma samples. In this document, it is proposed that to signal the coded picture size is in units of LCUs, and in addition to signal the offset between the coded picture size and the decoded picture size, in units of SCUs. Furthermore, this document raises a discussion on the value range of picture sizes.

Remarks:

- What about the cropping window? That would still be used on top of this, as in AVC.
- It was suggested that if the picture size is signalled in LCU and SCU units, those should be signalled before the parameters that depend on them.
- It was noted that the proposed signalling, which would require computations involving several variables to determine the width of the picture, seems undesirably obtuse. For now, let's keep the current syntax element pic_width_in_luma_samples. Decision: However, the width and height should be coded using ue(v) rather than u(16). No range needs to be directly specified, as this would be a profile/level constraint.
- The current software requires the image to be an integer multiple of the SCU size. The cropping window is presumed to apply as in AVC to support other picture sizes.
- We note that this means that the actual width of an encoded picture to support a particular image width in luma samples (e.g., a picture 14 samples wide) becomes a function of the selected SCU size, which seems undesirable.
- Where should be the boundary for picture extrapolation for motion compensation purposes?
- The subject needs further thought.

JCTVC-G330 AHG15: Syntax elements in adaptation parameter set [Y. Chen, Y. -K. Wang, M. Karczewicz (Qualcomm)]

This document discusses what syntax elements should be included into the Adaptation Parameter Set (APS). Currently, the APS may include ALF and SAO parameters. In this document, inclusion of other syntax elements, namely 1) reference picture list construction related syntax elements; 2) weighted prediction related syntax elements; 3) decoded picture buffer management related syntax elements; and 4) quantization matrices table, in APS is discussed.

For the RPLS and DPB aspects, there are other contributions relating to this (e.g. AHG21 related).

For the quantization matrices, previous discussions have indicated that these should not change within a picture.

One question is whether the APS can be sent out of band. Another is how much data will be in it, how often it can change, and whether it can change from slice to slice within the same picture.

For loss resilience, a system design might want to repeat the APS data or send it out of band, but that gets difficult if it has a lot of data in it.

In AVC, quantization matrix data is sent at the SPS or PPS level. In HEVC, there are more transforms and bigger transforms, and thus more data to represent quantization matrices.

It appears that weighted prediction and reference picture list construction data should be treated similarly.

JCTVC-G332 Multiple Adaptation Parameter Sets Referring [M. Li, P. Wu (ZTE)]

In this document, a multiple adaptation parameter sets (APSs) referring approach is proposed. As described, the APS tends to carry the coding parameters which are more likely to be changeable from picture to picture, or even from slice to slice. This referring design is proposed to be at the slice layer. In a slice layer encoding/decoding, multiple APS IDs can be made available, and each coding tool, such as SAO or ALF, etc., is initialized by activating only once in one APS of the several referred ones. The encoder would be allowed to code SAO and/or ALF parameters by directly utilizing whole or partial information already presented in the existing APSs. This facilitates flexible configuration of the coding tools and saves bits when re-using the former tool parameters while coding the current slice. The proposed scheme can also serve both the case when parameters change from slice to slice, such as in video coding tool with Weighted Prediction, and the case when parameters intend to be unchanged for the whole sequence.

Quantization matrix could also end up in the APS (not there currently). It was mentioned that JCTVC-G295 also discusses the idea of different APS IDs for different aspects,. Contribution JCTVC-G658 was also mentioned to be relevant.

At the moment we have three things in the APS. Each APS could hypothetically be populated with only one of these things. It seems undesirable to have a scheme in which the size of the slice header would keep growing as more things are put into the APS syntax.

The idea of parameter set updates was proposed in JCTVC-E309. It could be an interesting alternative.

For further study. Some form of increased flexibility for APS formatting and usage may be desirable.

A BoG (coordinated by S. Wenger) was asked to consider APS-related contributions (JCTVC-G122, JCTVC-G220, JCTVC-G295, JCTVC-G330, JCTVC-G332, JCTVC-G570, JCTVC-G658, JCTVC-G566).

JCTVC-G566 Syntax refinements for SAO and ALF [S. Esenlik, M. Narroschke, T. Wedi (Panasonic)]

(Initial discussion in Track A.)

The Adaptation Parameter Set (APS) syntax structure has been adopted during the 6th JCT-VC meeting in Torino to be used in the conveyance of parameter sets of Adaptive Loop Filter (ALF) and Sample Adaptive Offset (SAO). However APS is a very recent syntax structure whose performance and usage needs to be improved and refined. In the current proposal 3 issues related to APS and ALF/SAO syntax are addressed. The proposed solutions provide on average 0.2% coding gain for low-bitrate applications, improve parsing robustness and reduce latency of HEVC.

3 issues related to APS and ALF/SAO syntax are addressed. The problems stated in this contribution are resolved by three minor modifications in the slice header syntax structure and one minor modification in the alf_cu_control_param syntax structure.

(1) Introduction of new flags in slice header (ALF_flag and SAO_flag). ALF_flag eliminates dependency of decoding APS and slice header. (2) ALF_CU_control_flag is coded by fixed code.

1500Byte slice results: HE: xx/0.0/0.1/xx LC: xx/0.0/0.0xx

If higher Qp is used, 0.1% gain is observed.

Comments from BoG: It seem worth it to have ALF_flag in slice header (as the loss of this flag would affect parsing). Support was expressed for not using CABAC on ALF_cu_control_flag. SAO_flag might be useful in slice header when previous frame's APS parameters shall be re-used, but SAO flag in slice

header shall overwrite the previous APS. As this relates to concepts of using APS parameters, this relates to high-level syntax (APS) discussion.

Decision: Adopt duplicate ALF_flag in slice header (value of duplicate flag must always match), discard using CABAC for ALF_cu_control_flag.

Further study on duplicate SAO flag in slice header, as this may be conditional on decision on APS concepts (re-use of previous SAO). May be discussed in track B.

(Further discussion was held in Track B and in a BoG coordinated by S. Wenger.)

JCTVC-G122 VLC for high level syntax (ALF and SAO parameters) [V. Sze (TI)]

Reviewed in BoG coordinated by S. Wenger.

JCTVC-G606 Crosscheck - VLC for high level syntax (ALF and SAO parameters) (JCTVC-G122) [T. Nguyen (Fraunhofer HHI)] [late]

Reviewed in BoG coordinated by S. Wenger.

JCTVC-G334 AHG15: On sequence parameter set and picture parameter set [Y. -K. Wang, Y. Chen, Y. Zheng, W. -J. Chien (Qualcomm)]

This document includes some discussions on some SPS and PPS syntax elements, on their value ranges, syntax element coding, and/or semantics.

Value ranges were discussed. It is clear that value ranges need to be specified, although it may be appropriate for the range to be specified in the Profile/Level definitions rather than in the semantics section in some cases.

Regarding the part of the proposal on a PPS-level flag to disable the temporal MV predictor, the contributor indicated that it is not necessary to further consider this.

5.9.4 Tiles

A BoG (coordinated by M. Horowitz) was requested to discuss tiles and wavefronts.

JCTVC-G183 Test result of low delay tile [K. Kazui, S. Shimada, J. Koyama, A.Nakagawa (Fujitsu)]

JCTVC-G968 A Cross-check report for JCTVC-G183 on low delay tile [K. Misra, A. Segall (Sharp)] [late]

JCTVC-G194 AHG4: Non-cross-tiles loop filtering for independent tiles [C.-Y. Tsai, C.-W. Hsu, C.-Y. Chen, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek), A. Fuldseth (Cisco)]

Same concept as disabling filtering across slice boundaries as adopted in Daegu in response to JCTVC-D128.

Decision: Adopted (as recommended by BoG, see JCTVC-G1025).

JCTVC-G197 AHG4: Low latency CABAC initialization for dependent tiles [C.-W. Hsu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)]

This proposal included not only CABAC initialization, but also requiring entry point signalling for dependent tiles. (Entry points were already present for independent tiles.)

Decision: Adopted (as recommended by BoG, see JCTVC-G1025).

JCTVC-G961 Cross-check for JCTVC-G197 (AHG4: Low latency CABAC initialization for dependent tiles) [J. Zhao, A. Segall (Sharp)] [late]

JCTVC-G315 AHG4: Unification of picture partitioning schemes [M. Coban, Y. -K. Wang, M. Karczewicz, Y. Chen, I. S. Chong (Qualcomm)]

JCTVC-G317 AHG4: Dependency and loop filtering control over tile boundaries [Y. -K. Wang, Y. Chen, I. S. Chong, M. Coban, M. Karczewicz (Qualcomm)]

JCTVC-G318 AHG4: Tile groups [Y. -K. Wang, Y. Chen, M. Coban, M. Karczewicz (Qualcomm)]

JCTVC-G453 New definition for tile/slice boundary [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]

JCTVC-G454 Parallel processing of ALF and SAO for tiles [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]

JCTVC-G618 Line buffers problem in HEVC [Andrey Norkin, Rickard Sjöberg (Ericsson)]

Note from track A: It was suggested to consider the context with JCTVC-G212 which was adopted and gets rid of line buffers except for de-blocking – therefore JCTVC-G618 will be tested only in context of de-blocking.

JCTVC-G802 Cross-check of "AHG4: Non-cross-tiles loop filtering for independent tiles" (JCT-VC-G194) [M. Horowitz, S. Xu (eBrisk)]

5.9.5 Wavefront parallel processing

JCTVC-G199 **AHG4: Wavefront tile parallel processing [C.-W. Hsu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)]**

JCTVC-G627 **Cross-check of JCTVC-G199, "AHG4: Wavefront tile parallel processing" [A. Fuldseth (Cisco)] [late]**

JCTVC-G722 **Harmonization of entry points for tiles and wavefront processing [A. Segall, K. Misra (Sharp)] [late]**

JCTVC-G815 **Category-prefixed data batching for HEVC wavefront and PIPE/V2V/V2F coding [G. J. Sullivan (Microsoft)]**

5.9.6 NAL unit header

JCTVC-G331 **AHG 15: On NAL unit types and slice types [Y. -K. Wang, Y. Chen (Qualcomm)]**

At the previous JCT-VC meeting, it was agreed to change nal_ref_idc (2 bits) to nal_ref_flag (1 bit), and change nal_unit_type from 5 bits to 6 bits. Consequently, the total number of hypothetically possible NAL unit types doubled from 32 to 64. This document proposes an allocation of the 64 values to different categories of NAL unit types, and raises some NAL unit type related questions for discussion.

Issues that were discussed included whether to make access unit delimiters mandatory (without a decoding process), whether to put POC in the access unit delimiter, or to put it in SEI, and make SEI the first NAL unit of the picture.

Also, it was proposed to add slice types 3 to 5, with similar semantics as slice types 5 to 7 in AVC. No action was taken – as it doesn't seem clear that this trick had substantial value for AVC, and it was informally reported that some encoders may have violated the constraint. (If the values cannot be relied on, the trick is useless.)

Some other aspects were discussed in the contribution, such as slice-level SEI.

For further study.

JCTVC-G336 **AHG 17: Unified NAL unit header design for HEVC and its extensions [Y. Chen, Y.-K. Wang, M. Karczewicz (Qualcomm)]**

In AVC extensions, such as SVC and MVC, NAL unit header extensions were added. This reportedly made AVC, SVC and MVC substantially different from each other in terms of NAL unit headers. In HEVC, the current NAL unit header contains basic syntax elements similar to AVC NAL unit header, except for the temporal_id that indicates the temporal layer of the NAL units when the bitstream is temporally scalable. The contributor said that if we follow the design principles in AVC scalable or multiview extension, the HEVC extensions may have similar NAL unit header extensions.

In this proposal, a NAL unit header is proposed which is suggested to be used for both the HEVC non-scalable bitstreams as well as the scalable bitstreams conforming to potential scalable or multiview extensions of HEVC. This NAL unit header differs from the current HEVC NAL unit header in the following properties: 1) Fixed NAL unit header length for one whole coded video sequence while the length can vary across different coded video sequences; 2) Representation of the scalability syntax elements in the NAL unit header, and when a particular syntax element it is not needed it is not present.

The scheme has a "NAL unit header parameter set" that determines the properties of the NAL unit header.

A participant asked how the network would know which NUHPS is active.

It was commented that a "middle box" scanning a bitstream would need to be more intelligent and capable of handling parameter sets and to be "stateful", and that this seems undesirable. It was also remarked that supporting flexible positions of syntax elements may be harder to handle than fixed-position processing.

It was suggested to have a relationship to the concept proposed in JCTVC-E279.

JCTVC-G607 High-Level Syntax for Bitstream Extraction [R. Sjöberg, T. Rusert (Ericsson)]

This contribution proposes changes to the NAL unit header and SPS, aiming at providing high-level signalling to support bitstream extraction for both temporal scalability (as supported in the current WD) and any other bitstream scalability (as defined in the future). Compared to the current WD, it is proposed to remove the second byte from the NAL unit header, and instead introduce a NAL unit header extension bit in the first byte. If the extension bit is equal to 0, the NAL unit header has only one byte. If the extension bit is equal to 1, a byte-aligned SPS identifier is sent in the NAL unit header, which co-serves as generic layer identifier and priority indicator.

Syntax for signaling of dependencies between scalable layers and layer properties such as temporal_id and level_idc are introduced in the SPS. The proposed mechanism is claimed to be beneficial both in the context of temporal scalability as supported in the current WD, and when HEVC is extended with new scalability tools in the future. HM-based software implementation of the proposed signaling and bitstream extraction are available as part of Ericsson's response to MPEG's Call for Proposals on 3D Video Coding Technology.

It is claimed that setting the proposed extension bit to 0 in applications where no temporal (and no other) scalability is required avoids a small but (asserted to be) unnecessary bit rate overhead that is present according to the current WD. It is further claimed that if temporal scalability is supported in the bitstream, the proposed mechanism enables encoders to provide a separate level_idc indication for each temporal layer, and thus more accurate signaling of required decoder capabilities than in the current WD. It is also claimed that when new mechanisms for scalability are introduced in the future, the proposed design can be extended to provide signaling for both existing and new scalability mechanisms without changing the NAL unit header. Finally, it is claimed that if temporal scalability is used (or other scalabilities in the future), the proposed mechanism facilitates a bitstream extraction process that can associate both VCL and non-VCL NAL units with scalable layers in a simple way.

It was noted that we have output_flag in the NAL unit header. It was remarked that this was to enable uses such as indicating that a base layer is such low quality as to be not used for output.

The scheme includes sending an SPS ID in the NAL unit header.

The contribution raises some similar issues as with JCTVC-G336.

For further study.

5.9.7 Random access

JCTVC-G159 Random Access Detection and Notification [Hendry, S. Park, Y. Jeon, B. Jeon (LG)]

The submitter indicated that "leading pictures" that follow a Clean Random Access (CRA) picture in decoding order can still use reference pictures that preceded the CRA in both decoding order and output order. It is suggested that when random access event occurs, a decoder may suddenly be fed with an encoded stream started from a CRA NAL unit, and that the decoder should be told by syntax that decoding leading pictures that follow the CRA. The current WD 4 of HEVC does not have any

mechanism for decoder to detect or to be aware of random access event. This contribution proposes two mechanisms for random access detection and one mechanism to enable any application (e.g., video player application) to notify HEVC decoder in syntax when random access occurs.

This is essentially a proposal to provide the same thing as an MPEG-2 “broken_link” flag.

It is proposed to put a flag for this in the NAL unit header.

Some possible types of indicators would be

- SEI
- Buffer description list
- NAL unit header flag
- Slice header
- System-level indicators (e.g., APIs) external to the bitstream

Some skepticism was expressed regarding the need for syntax support – some participants expressed the view that a syntax indicator is not needed. It was remarked that we are generally especially reluctant to use NAL unit header bits for such indicators.

JCTVC-G158 Undiscardable Leading Picture for CRA [Hendry, S. Park, B. Jeon (LG)]

In current WD 4 of HEVC, decoder flushes all reference pictures in Decoded Picture Buffer (DPB) prior to decoding the first key picture that follows a CRA picture in decoding order. This contribution suggests that in some use cases when some reference leading pictures should not be flushed out, which are called Undiscardable Leading Pictures (ULPs), prior to decoding the key picture and are allowed to be used as reference for inter prediction for pictures that follow the key picture in order to improve coding efficiency. The contribution proposes some syntax and semantics of new elements to signal ULPs in header of CRA slice. It is reported that by using special input sequences that contains scene change before CRA picture, modified HM-4.0 that implements ULP concept gives gains 0.2% Y, 0.2% U, 0.2 V for RAHE and 0.3% Y, 0.1% U, 0.2% V for RALC.

Suggestion: This is already supported, by using a recovery point SEI message (already included in HEVC, in principle), rather than using IDR or CRA.

JCTVC-G319 AHG15: Conforming bitstreams starting with CRA pictures [Y. Chen, Y. -K. Wang, M. Karczewicz (Qualcomm)]

In the current HEVC design, CRA (Clean Random Access) pictures are identified by a new NAL unit type. It is reportedly common that a device with a conforming decoder performs random access at a CRA picture. However, a bitstream starting at a CRA picture is considered non-conforming, thus a conforming decoder may not be able to properly handle such bitstreams.

In this proposal, it is proposed that a bitstream starting from a CRA picture can 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; 2) HRD modifications to guarantee that all bitstream conforming conditions are 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 remarked that it may be difficult to specify conformance of a bitstream in such a case, as there would be implied dangling references to non-existing information. A bitstream needs to be testable for conformance (without access to unavailable data).

The concept seems useful, if it is possible to specify the bitstream conformance clearly, and the decoder behaviour as well. Further study is encouraged.

JCTVC-G533 On syntax for clean random access (CRA) pictures [Y. Park, H. Yang, C. Kim (Samsung)]

This contribution discussed syntax for clean random access (CRA) pictures.

Some new material had been added in revisions of the original contribution.

The contributor assumed that the "leading pictures" are decoded and displayed, which is not the model of what we refer to as CRA. As currently specified, decoder behaviour for random access is not specified (as this functionality is considered out of the scope of the standard).

It was suggested that some of the concerns expressed in the contribution might be addressed by adding some informative note in the standard to describe how a system can use CRA pictures (e.g. with some external signal to indicate that random access is being performed or with some external discarding of "leading pictures" from the bitstream before the decoder processes the remaining data.

JCTVC-G584 Temporal layer access pictures and CRA [Jonatan Samuelsson, Rickard Sjöberg (Ericsson)]

The contribution explores the relationship between the current CRA design and temporal layering.

This contribution presents a proposal to change the signaling of Clean Random Access (CRA) pictures and Temporal Layer Switching Points in what is referred to as Temporal Layer Access (TLA) pictures. It is proposed to replace the CRA Network Abstraction Layer (NAL) unit type with a TLA NAL unit type. The proposed TLA NAL unit type imposes constraints on the bitstream and does not have an 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 NAL unit header, independent of data outside that NAL unit header, specifically in the Sequence Parameter Set (SPS) and Picture Parameter Set (PPS). It is further stated that a unified syntax and definition of TLA pictures makes the standard text more readable and comprehensive.

It was remarked that a CRA must be an intra picture.

The proposal suggests, for temporal_id values greater than 0, to replace the current CRA design with a temporal layer switching point indicator.

It was suggested that the current CRA design seems to not be useful for temporal layer 0. This seemed to be generally agreed. So it may be interesting to explore an alternative specification for the syntax flag in that case. Some misgivings were expressed about the specifics of the proposal, although the general idea appears interesting and potentially useful.

It was noted that this proposal changes the temporal layer switching behaviour from what is currently specified. This proposal disallows having a switching point picture that uses an earlier picture in the same temporal layer as a reference, and it was questioned whether this is desirable or not.

Further study was encouraged (delegated to an AHG).

JCTVC-G834 Cross-check result of Samsung's proposal JCTVC-G533 by LG Electronics [Hendry, S. Park, B. Jeon (LG)] [late]

Was not necessary to be presented – can be studied.

5.9.8 Decoded picture buffering and reference picture signaling

JCTVC-G157 Reference List Construction for Random Access Settings [Hendry, S. Park, B. Jeon (LG)]

(This had not been reviewed in the BoG relating to DPB topics.)

In the 6th JCT-VC meeting, based on contribution JCTVC-F433 and JCTVC-F701, reference picture list construction by using 3 higher quality and 1 nearest reference pictures has been adopted in the common conditions for low delay settings. This contribution proposes to construct default reference picture lists differently. When constructing RefPicListX, the proposed scheme suggests sorting reference pictures in Decoded Picture Buffer by POC first and then by the picture-level QP value relative to the QP value of current picture, instead of only by POC as it is done currently.

It was noted that the described behaviour is only correct for B pictures, and that the description is only a matter of the default list order; the default can be changed by reference picture list modification syntax. If this behaviour is desirable, it can be done explicitly by the encoder in this way.

It was remarked that this adds an extra sorting step and complication to the initialization.

It was noted that explicit mode reference picture marking can also be used to change the default list initialization values.

It was noted that larger aspects of reference picture list construction are being considered, and remarked that this may be an over-optimization relative to excessively emphasizing our common conditions configurations, which are not part of the standard – rather, they are just a matter of how we are using the standard in some example tests.

It was noted that the selection of QP values could end up being manipulated for purposes of reference picture list construction, which seems like an unusual repurposing, and might result in sending more PPS syntax structures so that this manipulation can be done.

The group found it interesting that gain was being reported due to using a different set and ordering of reference pictures than what is our current common conditions. So there could be an opportunity here for non-normative coding efficiency improvement of future common conditions (0.4% Y, 0.4% U, and 0.4% V for RA HE).

It was noted that JCTVC-G589 showed some gain (0.2%) relative to our current common conditions while using much less picture storage. See notes elsewhere. This aspect was discussed again on Nov 29 (F. Bossen chairing). Further study was encouraged.

JCTVC-G500 Cross-verification of LG's Reference List Construction for Random Access Settings (JCTVC-G157) by Panasonic [C. S. Lim, S. M. T. Naing, V. Wahadaniah (Panasonic)]

JCTVC-G166 AHG21: Explicit Reference Pictures Signaling with Output Latency Count Scheme [Hendry, S. Park, B. Jeon (LG)]

Reviewed in BoG.

JCTVC-G832 Cross-check of "AHG21: Explicit Reference Pictures Signaling with Output Latency Count Scheme"(JCTVC-G166) [Y. Park, I.-K. Kim, C. Kim (Samsung)] [late]

JCTVC-G198 AHG21: Inter reference picture set prediction syntax and semantics. [T.K. Tan, C.S. Boon (NTT Docomo)]

Document JCTVC-F493 proposed the explicit signaling of reference pictures needed for the inter prediction of the current and future pictures, using buffer descriptions (reference picture sets). A reference picture set is a set of ΔPOC values. ΔPOC values are picture order count (POC) of the reference pictures relative the current picture. Template reference picture sets are signaled in the picture parameter set (PPS) and referred to by each slice.

This contribution proposes to further reduce the amount of bits necessary for signalling the reference picture set by predicting the ΔPOC values using the ΔPOC values from a reference picture set already present in the PPS.

Based on the latest draft of the reference picture set syntax from the ad hoc group on Reference picture buffering and list construction (AHG21), the number of additional PPS signaling bits needed for the random access (RA) and low delay (LD) common conditions are reported to be 288 and 201 bits, respectively. Using the proposed inter reference picture set prediction method, the numbers of bits needed are reported to be reduced to 144 and 106 bits, respectively. This represents a reduction of 50% and 47%, respectively.

It was noted that there are multiple inputs that remain under consideration regarding the APS and details of the RPS design.

It was suggested that this may be a degree of over-optimization within the context of a scheme that is not yet a really settled area of the design. There are also multiple ideas on the table that are available for compressing the number of bits needed for the RPSs. JCTVC-G643 was suggested as one example. However, it was also suggested that this proposal has been well studied and implemented, has good text, etc., and seems relatively mature. It was remarked that without this proposal, the current JCTVC-G1002 scheme would have an obvious redundancy in relation to cyclic picture structure encoding.

Decision: Adopted (Part 1 “full inter-RPS prediction”).

JCTVC-G314 AHG21: On DPB management [Y.-K. Wang, Y. Chen (Qualcomm)]

Reviewed in BoG.

JCTVC-G398 High-level Syntax: Marking process for non-TMVP pictures [B. Li (USTC), J. Xu (Microsoft), H. Li (USTC)]

(Chaired by J. Boyce.)

In the current HM design, MVP and merge candidates may be incorrect when packet loss exists. The error may influence motion vectors of all the following pictures. Disabling some pictures’ TMVP (non-TMVP pictures) may stop the error propagation for motion vectors. However, it cannot be always guaranteed that the error can be stopped with non-TMVP pictures. This contribution presents a mechanism to make sure that the error can be stopped after non-TMVP pictures

enable_temporal_mvp_flag had been previously adopted at Torino meeting to the PPS, but not included in the WD yet. The contribution proposes semantics changes for the use of that flag.

There was a suggestion to move the enable_temporal_mvp_flag to SPS, which would have a cost of 3% if turned off, but may be worthwhile in error prone conditions.

Decision: Adopted solution 2.

Work with editors was requested to incorporate both this adoption and the previous BoG adoption of the enable_temporal_mvp_flag in the WD text and software.

JCTVC-G526 AHG21: Combined signaling for reference picture set [Y. Park, I.-K. Kim, C. Kim (Samsung)]

Reviewed in BoG.

JCTVC-G546 On high-level syntax for maximum DPB size and frame latency [Y. Park, K. P. Choi, C. Kim (Samsung)]

Chaired by J. Boyce.

JCTVC-E339 proposed to move max_dec_frame_buffering and num_reorder_frames from the optional VUI to mandatory SPS. The JCTVC-F541 proposed to add max_latency_frames_plus1 or max_latency_increase_plus1. It was proposed to move max_dec_frame_buffering and add max_latency_frames_plus1 in SPS. It was proposed for the num_reorder_frames to be left in VUI without change.

If an encoder doesn't send the VUI parameters, capabilities determination by decoder would be negatively impacted.

Without max latency, output is delayed.

Suggestion to also move num_reorder_frames to SPS.

Decision: Adopt put three syntax elements in the SPS, max_dec_frame_buffering, num_reorder_frames, and use max_latency_increase. (Also JCTVC-G779)

JCTVC-G779 Proposed constraint on reordering latency (for further consideration of JCTVC-F541) [G. J. Sullivan (Microsoft)]

Chaired by J. Boyce

This contribution repeats the content of JCTVC-F541 to propose to add an SPS-level parameter in HEVC that expresses a constraint on the maximum amount of reordering that can be applied to any frame in a coded video sequence. By comparing the latency status of each frame in the DPB to the value of the maximum latency constraint, a decoder can determine when the maximum latency limit has been reached, and can immediately output any frame that has reached this limit. It is asserted that this can enable the decoder to more rapidly identify frames that are ready for output than with the current syntax for a variety of video encoding structures that includes typical cases. It is also asserted that directly expressing such a limit on the amount of reordering latency allowed through the encoding-decoding process would be a useful characteristic to be established for system-level negotiation and characterization purposes.

This proposal essentially just repeated the content of JCTVC-F541 of the previous meeting, as the disposition of that contribution at the previous meeting was to essentially allow time for further study.

There was a suggestion to express the value as a POC difference rather than a picture count difference.

Covered in JCTVC-G546.

JCTVC-G548 AHG21: Construction and modification of predefined reference picture sets and reference picture lists [V. Wahadaniah, C. S. Lim, S. M. T. Naing (Panasonic)]

Reviewed in BoG.

JCTVC-G635 Coding with a unified reference picture list [M. Naccari (BBC), G. Van Wallendael (Ghent University), M. Mrak, D. Flynn (BBC)]

The unified reference picture list (LU - List Unified) was presented in contribution JCTVC-F549 with the aim of providing a simpler and more flexible structure to map the reference picture used during the inter coding process in the HM codec. The main idea behind the LU is to simplify mapping of reference

pictures by using only a single reference list whereby reference frame pairs are stored. A reference pair consists of two reference frames (in the case of bi-directional prediction) or one reference frame and a null element (in the case of uni-directional prediction). It was asserted that the usage of the LU reduces the bitstream parsing and enables adding/removing some combinations of references in a more flexible fashion than the current HM design using two reference lists. In this context, this contribution addresses the reference list indexes usage in the current HM 4.0 codec and describes an implementation of the LU scheme based on the default HM reference settings. It is reported that the experimental results obtained for this implementation show that the LU scheme can handle usual HM conditions, while providing a space for more flexible selection of reference frames.

It was asked what is the impact of the scheme on coding efficiency? Some loss in compression was reported. It was suggested that this was due to the fact that the different method of coding of the reference picture indexes was not included in the R-D decision-making process. (At the previous meeting, some gain had been shown when using a similar but slightly different scheme, in a usage that included the scheme within the R-D optimization.)

It was remarked that this may require a difficult coupling of the encoder's decision-making process of joint selection of the two reference pictures to use for references. For example, if there are 10 pictures in each list, then there would be 120 entries needed in the combined list. Initalizing, reordering, and managing such a large list might get difficult. The overhead for reference picture list reordering might be large.

It was remarked that the only clear benefit would seem to be simplification of the parsing of the reference indexes at the PU level. Further study would be needed to identify and clarify whether a significant benefit can be shown for this concept.

JCTVC-G991 Cross-check of contribution JCTVC-G635: Coding with a unified reference picture list [J. Jung (Orange Labs)] [late]

JCTVC-G549 Syntax rearrangement for list combination [Y. Park, S. Jeong, C. Kim (Samsung)]

A list combination (LC) scheme was proposed for uni-prediction at B-slices to improve coding efficiency.

The current syntax bit ref_pic_list_combination_flag seems a bit redundant.

Proposes to put a default combined list length in the PPS and modify the slice-level syntax and remove that bit.

There were some differences in the proposed design aspects in the newer version of the proposal.

Another way to deal with that bit was suggested – further study was suggested.

JCTVC-G717 Improvements on reference picture buffering and list construction [Y. Yu, K. Panusopone, X. Fang, L. Wang (Motorola Mobility)]

This contribution proposes changes of reference picture construction of combined list and an explicit way for signalling collocated pictures according to the value of delta POC. The proposed scheme was reported to be more efficient to build the combined list and signal the collocated picture.

The proposal assumes the RPS (JCTVC-G021) style of buffer control.

It is proposed to allow any picture within list 0 or list 1 (or perhaps within the RPS list) to be specified to be the "collocated picture" (using an index syntax element in the RPS syntax or in the slice header). Currently the collocated picture is always the first picture in list 0 or the first picture in list 1.

Some tests were done to see that the proposed technique works; however, there was no compression benefit shown overall. Further study would be needed to determine whether there may be a significant benefit for this concept.

Also proposed was a change of the default order of combined reference picture lists, based on pair-wise minimization of POC distance. Test results were not provided, so the work seemed somewhat preliminary, and further study would be needed to determine whether it has value.

JCTVC-G637 AHG21: Long-term pictures and pruning of reference picture sets [Rickard Sjöberg, Jonatan Samuelsson (Ericsson)]

Reviewed in BoG.

JCTVC-G643 AHG21: On reference picture list construction and reference picture marking [M. M. Hannuksela, S. M. Gopalakrishna (Nokia)]

Reviewed in BoG.

JCTVC-G668 POC type 1 [M. M. Hannuksela (Nokia)]

This contribution proposes POC type 1 as specified in H.264/AVC, which can be summarized in a simplified form to use frame_num in the slice header to index a POC pattern provided in the sequence parameter set. In order to support POC type 1, it is proposed to include the frame_num syntax element into the slice header and the gaps_in_frame_num_value_allowed syntax element into the sequence parameter set when the use of POC type 1 is indicated in the sequence parameter set.

It is asserted that POC type 1 offers the opportunity to encode POC values of regular GOP structures more efficiently compared to POC type 0. Moreover, it is asserted that any POC type coding may be used with the reference picture lists and marking proposals in JCTVC-F493 and its later revisions and JCTVC-G643.

The decoder reference picture marking in AVC and its “non-existing pictures” are not part of this proposal.

It was remarked that POC type 1 requires frame_num, which is a syntax element that is not needed anymore with POC type 0 as proposed in JCTVC-F493, and that the need for this data reduces the efficiency benefit of using POC type 1.

The frame_num would not be present when POC type 0 is used.

It was suggested that it may be desirable to test how many bits this would actually save. Such further study is encouraged, although some skepticism was expressed regarding whether having this POC type supported is desirable.

JCTVC-G713 AHG21: Long term picture referencing using wrapped POC [K. Misra, S. Deshpande, A. Segall (Sharp)]

Reviewed in BoG.

JCTVC-G714 AHG21: On picture referencing [K. Misra, S. Deshpande, A. Segall (Sharp)]

Reviewed in BoG.

JCTVC-G788 AHG21: Proposal on Decoded Picture Buffer Description Syntax Relating to JCTVC-F493 [G. J. Sullivan, Y. Wu, J. Xu (Microsoft), B. Li (USTC)]

Reviewed in BoG.

JCTVC-G1036 Common conditions for reference picture marking and list construction proposals [Y.-K. Wang, M. M. Hannuksela, T.K. Tan (editors)] [late]

5.9.9 HRD issues

JCTVC-G188 Enhancement on operation of coded picture buffer [K. Kazui, S. Shimada, J. Koyama, A. Nakagawa (Fujitsu)]

This contribution proposes to enhance the operation of the coded picture buffer (CPB), following up on prior proposals JCTVC-C021, JCTVC-D053.

The specification of CPB operation in WD4, inherited provisionally from the AVC specification, only defines picture-based timing of bitstream operation, where the decoder does not process the picture until it has completely arrived.

The proposed operation is a sub-picture based bitstream removal from CPB in order to realize interoperable very low delay coding – less than 1 picture period.

The degree of realism of achieving a delay of less than 1 picture period was discussed, along with some discussion of typical and achievable delays in videotelephony and local display applications.

It was remarked that the instantaneous decoding time assumption of the current HRD is a clearly unrealistic assumption.

The proponent suggested, as an example, an HRD model in which the HRD decoder would operate in units of LCU rows instead of whole pictures.

It was remarked that CABAC is not a "low-latency" entropy coder. Slice-level termination of CABAC was proposed a way to define the HRD (using the end_of_slice_flag position). For HRD purposes, the cabac_zero_word and RBSP trailing bits might also be counted.

Specific syntax and text specification was proposed.

The concept was of interest to a number of participants. The idea seems coupled with the concept of having a decoder that does not operate instantaneously, and the desire is to avoid phenomena such as the case where nearly all of the bits for a picture are for the last LCU in the picture.

At this point the group did not seem to have studied the subject well enough to have a clear consensus on the value of the concept or the specifics of the proposed text. Further study was encouraged.

5.10 Quantization

5.10.1 QP prediction / delta QP coding

JCTVC-G213 Non-CE4: Performance comparison between temporal QP prediction and temporal MV prediction [H. Aoki, K. Chono (NEC)]

This contribution provides an additional analysis report of temporal QP prediction (TQPP) which is listed in CE4 Subtest 1 as the test 1.4. TQPP introduces additional buffer for storing QPs of reference frames for temporal prediction, as temporal MV prediction (TMVP) does. As a measure to evaluate the balance between compression performance and memory requirement, ratio of coding gain to bits per reference CU, namely relative coding gain, is introduced. For the comparison purpose, the performance of TMVP is evaluated in this contribution. It is reportedly shown that the relative coding gain of TQPP is more than that of TMVP.

Temporal MV prediction does not really seem analogous to QP prediction. Temporal QP prediction seems to have loss resilience issues.

JCTVC-G936 Cross verification of NEC's proposal JCTVC-G213 on TMVP [Y. Lin, J. Zheng(HiSilicon)] [late]

JCTVC-G353 Non-CE4: QP prediction using spatial QP [H. Nakamura, M. Nishitani, S. Fukushima, T. Kumakura (JVC Kenwood)]

In the HM4.0, the predictive QP is always the QP of left neighbor quantization group for delta QP signaling. In this contribution, it is proposed to calculate the predictive QP based on the QP of previously coded neighboring quantization groups. It is reported that 0.3%, 0.2%, 0.3%, 0.3%, 0.4%, and 0.5% luminance BD-rate reductions were obtained by the proposed method for AI HE, AI LC, RA HE, RA LC, LD HE, and LD LC configurations, respectively, when tested with the QP setting scheme used in CE4.

Relates to CE4 1.3.c (JCTVC-G067). For AI, 1.3.c did a little better. Regarding complexity, this proposal seems somewhat simpler.

JCTVC-G772 Cross-check result of JCTVC-G353 [K Sato (Sony)] [late]

JCTVC-G357 Non-CE4: Improvement of Intra prediction based QP prediction [J. Xu, A. Tabatabai, K. Sato (Sony)]

Proposed improvement of 1.3.c (JCTVC-G067) with special treatment of the 45 degree case, benefit relative to HM in CE4 test conditions, obtained 0.5% for AI HE (JCTVC-G067 had about 0.4%).

JCTVC-G739 Non-CE4: Cross-verification report for improvement of intra prediction based QP prediction (JCTVC-G357) [H. Aoki, K. Chono (NEC)] [late]

JCTVC-G362 Non-CE4: Efficient binarization of delta_QP in CABAC with signaling of Max and Min QP [J. Xu, K. Kondo, K. Sato, A. Tabatabai (Sony)]

Related to 1.2.a (min and max QP signalling, JCTVC-G462), 0.1% better than JCTVC-G462 as tested.

JCTVC-G956 Non-CE4: Cross-verification of Sony's proposal JCTVC-G362 by Nokia [J. Kang, A. Hallapuro, J. Lainema (Nokia)] [late]

JCTVC-G850 Non CE4: Fine granularity QP offset [X. Li, X. Guo, S. Lei (MediaTek), X. Wang, R. Joshi, G. Auwera, M. Karczewicz (Qualcomm)]

Relates to CE4 Subtest 2, discussed together with those proposals.

JCTVC-G1040 non-CE4: Crosscheck of updated fine granularity QP offset (JCTVC-G850) by Intel [Y. Chiu, W. Zhang (Intel)] [late]

JCTVC-G979 Consideration on the Hybrid Structure of Channel, Scene, and Object based 3D Audio Systems [Jeongil Seo, Kyeongok Kang] [late]

JCTVC-G451 Qp offset for intra block [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]

This contribution proposes to add a syntax signaling a qp offset value for intra blocks at the slice header. Syntax and semantics of the proposed offset is provided. Two particular examples were described:

- Vertical intra column refresh for very-low-delay operation
- Generally using smaller QP with intra for visual quality optimization

The offset value was proposed to be added to the slice header.

It was remarked that it might be desirable to have a flag at the SPS level to indicate the presence or absence of the flag at the slice header level.

It was noted that it is necessary to understand how this affects the prediction of subsequent CU QPs. This does not seem to have been accounted for in the contribution. Further study was encouraged.

JCTVC-G509 Support of ChromaQPOffset in HEVC [S. Liu (MediaTek), K. Sato (Sony)]

In AVC there is chroma qp offset and second chroma qp offset, sent at the PPS level with a range of +/−12.

It is proposed to use the same scheme as in AVC.

In principle, this seems to fall into the category of something that we already have intended to be in our design, but may not have integrated into the text yet. (For monochrome, the syntax elements should not be sent.) This was agreed.

Some test results were shown (some similar results are in JCTVC-G401).

JCTVC-G907 Crosscheck of JCTVC-G509 - Support of ChromaQPOffset in HEVC [E. S. Ryu (InterDigital)] [late]

JCTVC-G759 Cross-check report for ChromaQPOffset [H. Sasai, T. Nishi (Panasonic)] [late]

JCTVC-G550 TU_size based dQP [C. Kim, Y. Park, K.P. Choi, J.H. Park (Samsung)]

Suggests to establish offsets to QP that apply, depending on TU size. For example, a large block size might use a smaller QP to get good fidelity in smooth or well-predicted regions. Visual quality was not tested. No change of PSNR was observed. Lambda was not modified when QP was not modified.

Related to JCTVC-G721 and JCTVC-G893 and JCTVC-G451. Seems interesting. For further study, with a plan to establish AHG and/or CE.

JCTVC-G925 Cross-check of JCTVC-G550 on TU_size based dQP [V. Seregin (Qualcomm)] [late]

JCTVC-G893 Unified QP signaling [X. Fang (Motorola)] [late]

Suggests the ability to change QP at the TU branch or leaf level as well as at the CU branch or leaf level. Relates to CE4 subtest 1.1.a JCTVC-G721, but with some modifications to constrain the usage. For further study.

JCTVC-G1028 Non-CE4: Rate control friendly spatial QP prediction [H. Aoki, K. Chono (NEC), M. Kobayashi, M. Shima (Canon), M. Coban, M. Karczewicz (Qualcomm), K. Sato (Sony)] [late]

Compared to preceding QP in scan order, more gain would be achieved by this scheme than for the comparison to HM 4. Further study in a CE was suggested.

JCTVC-G1029 Non-CE4: Crosscheck for JCTVC-G1028 by JVC KENWOOD [H. Nakamura (JVC Kenwood)] [late]

5.10.2 Quantization matrices

JCTVC-G094 Non-CE4: Carriage of large block size quantization matrices with up-sampling [M. Zhou, V. Sze (TI)]

The contribution related to upsampling of quant matrices (somewhat discussed elsewhere). Detailed presentation did not seem necessary at this time.

JCTVC-G506 Non-CE4: Crosscheck report of carriage of large block size quantization matrices with up-sampling proposed by TI (JCTVC-G094) [M. Shima (Canon)]

JCTVC-G152 Method and syntax for quantization matrices representation [X. Zhang, S. Liu, S. Lei (MediaTek)]

Detailed presentation did not seem necessary at this time.

JCTVC-G529 Non-CE4: Cross-Check for MediaTek quantization matrices representation (JCTVC-G152) [J. Zheng (HiSilicon)] [late]

JCTVC-G711 Non-CE4: Cross-verification of MediaTek's proposal JCTVC-G152 on method and syntax for quantization matrices representation [M. Zhou (TI)] [late]

JCTVC-G295 Non-CE4 Subtest3 : Extension of Adaptation Parameter Sets syntax for Quantization matrix [J. Tanaka, Y. Morigami, T. Suzuki (Sony)]

Detailed presentation did not seem necessary at this time.

JCTVC-G352 Parameterization of Default Quantization Matrices [E. Maani, M. Haque, A. Tabatabai (Sony)]

Default quantization matrices have to be stored in the decoder for the case where no explicit visual scaling matrices are transmitted in the bit stream. These matrices, in the AVC case were explicitly defined and stored in decoder since the transform sizes included only 8x8 and 4x4 transform. However, in HEVC, it was suggested that with additional 16x16, 32x32, and non-square transforms the memory size to store these matrices may be excessive. This document presents a method to parameterize the default matrices such that they can be efficiently stored at the decoder memory. When these matrices are needed they can be derived using simple operations. Using this technique can reportedly save up to 8 KB of ROM compared to explicit representation of the matrices (reducing the storage of values from 8160 elements of 8 bits each to 96 elements of 15 bits each).

The four suggested parameters can be stored as fixed values or sent in syntax.

One participant remarked that using a sub-sampled matrix might be preferable if it would avoid the need to use the full matrix while using it (regardless of how the matrix is generated or stored). Recomputing the matrix on the fly does not seem appropriate.

For further study.

JCTVC-G530 Non-CE4: Layered quantization matrices compression [Y. Wang (Tsinghua), J. Zheng, X. Zheng (HiSilicon), Y. He (Tsinghua)]

Detailed presentation did not seem necessary at this time.

JCTVC-G730 Non-CE4: Cross check of layered quantization matrices compression in JCTVC-G530 [T. Suzuki (Sony)] [late]

JCTVC-G992 Cross-check of JCTVC-G530 – Layered quantization matrices compression [X. Zhang, S. Liu (MediaTek)] [late]

JCTVC-G578 Non-CE4: Quantization matrix compression and signaling [R. Joshi, J. Sole, M. Karczewicz (Qualcomm)]

Detailed presentation did not seem necessary at this time.

JCTVC-G826 Non-CE4: Cross check of quantization matrix coding in JCTVC-G578 [T. Suzuki (Sony)] [late]

JCTVC-G658 Quantization matrices in fragmented APS [Y. Chen, Y.-K. Wang, R. Joshi, M. Karczewicz (Qualcomm)]

Trying to minimize the quantity of data in the APS.

JCTVC-G880 HVS Model based Default Quantization Matrices [M. Haque, A. Tabatabai, Y. Morigami (Sony)] [late]

This document presents a set of default Quantization Matrices designed by using a Human Visual System (HVS) Model for HEVC. A list of these matrices are provided in the appendix. The contributor reported that the proposed matrices provided some subjective quality benefit (in informal subjective testing).

Decision: Adopt these as the starting point default values for 16x16 and 32x32 and use AVC defaults for the other cases.

JCTVC-G1026 Using Multiple APSs for Quantization Matrix Parameters Signaling [Ming Li, Ping Wu (ZTE), Junichi Tanaka, Yoshitaka Morigami, Teruhiko Suzuki, Kazushi Sato (Sony)] [late]

This late contribution was provided as a step toward dealing with the issue of conditional update of APSs. It was agreed that this should be studied as part of future AHG activity.

5.10.3 Dequantization

JCTVC-G154 De-quantization without Rounding Offset [X. Zhang, S. Liu, S. Lei (MediaTek)]

This contribution proposes to remove the round offset from the dequantization process. By doing this, one addition operation can be saved for each coefficient and in many cases, one shift operation can be saved for each coefficient as well. Experimental results report identical BD-rates under common test condition. Very small bit impacts on bit rate and PSNR (up to 0.x% bit rate increase and/or up to 0.04 dB PSNR degradation at >50dB PSNR quality) are reported for some very high bit rate (small QP) cases.

Reconstruction rule in current software is ((piQCoef[n] * scale + iAdd) >> iShift, with iAdd = 1 << (iShift−1).

If the scale is a power of 2, adding iAdd or not adding it are mathematically the same.

In the common conditions, there is only one very small QP.

Analyzing various very small QP values, the worst identified case (qp=9) had somewhat more than 0.7% loss.

It was asked whether QP=1 was tested. This wasn't known.

It was noted that on some implementation architectures, the add comes for free.

For further study.

JCTVC-G816 Cross verification of JCTVC-G154, De-quantization without Rounding Offset [R. Cohen (MERL)]

JCTVC-G555 One-addition dequantization [N. Shlyakhov, I.-K. Kim, J. H. Park (Samsung)]

Generic set of integer multipliers {5, 6, 7, 8, 9} is proposed for dequantization. Multiplication by each value of this set may be performed with no more than 2 shifts and 1 addition or subtraction. This set of multipliers increases bit-depth of dequantized transform coefficient by no more than 4 bits. It is reported that current QP control schemes of common test conditions are compliant with the proposed quantization modification.

Closely related to JCTVC-G154.

Proposes to change the period of 6 in the QP increments to be a period of 5 and reduce the range of QP values.

Proposed to change the chroma QP offset.

Eliminates the multiply in the dequantization (but requires customized shifts).

It was remarked that this doesn't seem to work with quantization weighting matrices.

It was remarked that in software this would not have a benefit.

It was also remarked that, in general, there are other areas where there is more opportunity for meaningful complexity reduction.

For further study.

JCTVC-G720 Dequantization with symmetric reconstruction points [L. Kerofsky, A. Segall, K. Misra (Sharp)]

This contribution notes that the dequantization formula currently used in HM 4 has the property that the reconstructed values are not always symmetrically distributed about zero. A modification to the dequantization formula is proposed which creates reconstructed values symmetrically distributed about zero under all conditions. The modified dequantization process operates on the absolute value of levels and then applies the sign rather than operating on signed levels. For quantization parameters of the common test conditions, the dequantization results are unchanged for any level or block size.

The dequantization formula presently used in HM is based on JCT-VC-E243. This formula is summarized below:

Definitions

B = source bit width (8 or 10 bit in the experiments described below)

DB = B−8 (internal bit-depth increase with 8-bit input)

N = transform size

M = log2(N)

Q = f(QP%6), where f(x) = {26214,23302,20560,18396,16384,14564}, x=0,…,5

IQ = g(QP%6), where g(x) = {40,45,51,57,64,72}, x=0,…,5

coeffQ = ((level*IQ << (QP/6)) + offset)>>(M−1+DB), offset = 1<<(M−2+DB)

It is asserted that the worst case dequant has a 17 bit signed multiply range.

It was remarked that this may imply that the quantized level values also have a 17 bit range, which seems troubling. The symmetric rounding approach does not solve that issue.

We may want a clipping at the input of the dequant operation (see discussion in JCTVC-G719).

We would seem to want such a scheme if we have adaptive offset addition.

It was noted that imposing symmetry at the input of the first stage of the inverse transform does not mean that we will have symmetric behaviour at the output of the final inverse transform.

Proposes to instead use

coeffQ = Sgn(level)*((|level|*IQ << (QP/6)) + offset)>>(M−1+DB), offset = 1<<(M−2+DB)

Our understanding is that symmetric reconstruction is already what is proposed in the adaptive offset schemes.

It doesn't seem clear that we would need this change if we do not use an adaptive offset scheme.

For further study.

JCTVC-G723 Support for finer QP granularity in HEVC [K. Panusopone, A. Luthra, Xue Fang, J. H. Kim, L. Wang (Motorola Mobility)]

Closely related to JCTVC-G721, does not need further detailed review.

5.11 Alternative coding modes

5.11.1 Lossless coding and I_PCM

JCTVC-G093 AHG22: Sample-based angular prediction (SAP) for HEVC lossless coding [M. Zhou (TI)]

Efficient lossless coding is asserted to be required for real-word applications such as automotive vision, video conferencing and long-distance education. This contribution proposes to use sample-based angular intra prediction (SAP) in lossless coding mode for better coding efficiency. The proposed sample-based prediction is exactly same as the HM4.0 block-based angular prediction in terms of prediction angles and sample interpolation, requires no syntax or semantics changes, but differs in decoding process in terms of reference sample selection. In the proposed method a sample to be predicted uses its direct neighboring samples for better intra prediction accuracy. Compared to the HM4.0 anchor lossless method which bypasses transform, quantization, de-blocking filter, SAO and ALF, the proposed method provides an average gain of 6.71% in AI-HE, 7.83% in AI-LC, 2.29% in RA-HE, 2.64% in RA-LC, 1.57% in LB-HE and 1.85% in LB-LC. For class F sequences only, the average gain is 8.95% in AI-HE, 8.88% in AI-LC, 5.64% in RA-HE, 5.61% in RA-LC, 4.58% in LB-HE and 4.61% in LB-LC. SAP is 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 anchor is a modified HM with transform bypass, quant. bypass as described above, entropy coding is used as is, i.e. the contexts are becoming spatial. Directional prediction "as is" is included here for intra coding.

The goal is to use HM tool "as is" without major re-design.

JCTVC-G115 AHG22: Cross-verification of TI's Sample-based angular prediction (SAP) for HEVC lossless coding (JCTVC-G93) [K. Chono, H. Aoki (NEC)]

JCTVC-G118 Potential enhancement of signaling of I_PCM blocks [K. Chono, H. Aoki (NEC)]

This contribution presents the concept-level idea of a method for transmitting successive I_PCM blocks. The method counts the number of successive I_PCM blocks in the Z-scan order in the same layer of the CTB and signals that number minus 1 at the PU header of the first I_PCM block. PCM sample data of the subsequent I_PCM blocks immediately follow that of the first I_PCM block, that is, signaling of the PU headers of the subsequence I_PCM blocks is skipped. Thereby the method reportedly enhances the throughput of transmitting PCM sample data of successive I_PCM block while reducing some bits of side-information.

Currently, an IPCM block consists of variable-length header data and fixed-length PCM payload.
Suggestion to bundle several headers and several payloads together, to increase the length of concatenated fixed-length data. Maximum number of concatenated IPCM blocks is 4.

The main advantage is for more deterministic buffer behaviour.

Better understanding of the application is needed – further study (AHG – lossless coding? Or other?)

JCTVC-G268 AHG22: Lossless Transforms for Lossless Coding [W. Dai, M. Krishnan, J. Topiwala, P.Topiwala (FastVDO)]

This submission is based on proposal JCTVC-G266, “Lossless Core Transforms for HEVC,” and focuses on the lossless transforms themselves. This work is submitted in reference to AHG22 on Lossless Coding. A coding framework has been created in that AHG for development purposes, which at this time includes prediction, and entropy coding, but bypasses transform and quantization. It is the purpose of this proposal to supply lossless transforms, which can assist in data decorrelation, and potentially improve the performance of the lossless coding framework. Such experiments were reportedly planned in the next meeting cycle.

The contribution explained ways how to construct lossless transforms esp. "lifting".

JCTVC-G664 AHG22: A lossless coding solution for HEVC [W. Gao, M. Jiang, Y. He, J. Song, H. Yu (Huawei Technologies)]

This contribution proposes a lossless coding solution that involves a few modifications to the current HEVC WD. To achieve lossless coding in both intra and inter coding operations, the transform and quantization modules are bypassed. Due to the nature of lossless coding, the existing intra predictions are extended to pixel based prediction (DPCM), taking into account that there is no transform applied to prediction residuals. Furthermore, since the statistical properties of prediction residuals are quite different from those of transform coefficients, the CABAC coding of intra prediction residuals are also modified accordingly.

No additional flag is introduced in this proposal, the lossless coding mode is signaled by QP_Y=0. As a result, no change to the HEVC syntax specification is needed, and the lossless mode can be applied to the entire picture or to individual CUs conveniently.

A combination of CABAC and Golomb-Rice coding is used.

The anchor is HM with QP=0, which is still lossy. Compared to that, the proposed method saves roughly 9.5% for AI and roughly 7% for LD B.

JCTVC-G885 Cross-check of JCTVC-G664 [B. Li (USTC), J. Xu (Microsoft)] [late]

Continued study in AHG was requested.

It seemed unclear whether lossless coding would be supported in a profile/level. If it can be done “for free”, it may be attractive, but this may be in contradiction with bit rate limitations that are usually defined in levels.

5.11.2 Variable resolution coding

JCTVC-G264 AHG18: Adaptive Resolution Coding (ARC) [T. Davies (Cisco), P. Topiwala (FastVDO)]

This contribution reports the results of further investigations into resolution adaption. Adaptive Resolution Coding (ARC) is described, in which resolution is selected dynamically by means of a threshold test, and the compression performance investigated in a rapid bit-rate reduction/high QP scenario against simply increasing QP with and without pre-filtering. Mean luma BD-Rate gains range from 6.9–14.3% in Class A and 3.5–11.5% in Class B but performance depends greatly on picture content and configuration. Individual luma BD-rate gains can range from negligible up to 30%. Typically chroma has lower objective quality by a fixed penalty of around 0.5dB but this is asserted to have little subjective impact. The contribution includes modified Working Draft text.

Resolution can be changed in both directions (up or down)

Heuristic criterion based on PSNR

PSNR is computed at high resolution

It was asked whether the same effect could be achieved by pre-filtering. It is said that some investigations on this were performed, but the same performance was never achieved.

Upsampling and downsampling filters would need to be normative (for the results, down- and upsampling filters were aligned) – in contrast to that, in scalable coding only the upsampling needs to be specified.

An application scenario is transmission with large variation of bandwidth.

A worst case would be when resolution changes every frame, which would require a more complex decoder – would be necessary to restrict frequency of changes.

Would the decoder need to keep both resolutions all the time? Can down- and upsampling be performed on the fly in any case of frame structure?

One expert suggested that upsampling and downsampling filters should be consistent with possible scalable extension. The studying of the relation with scalable coding was suggested to be in the mandates of the relevant AHG.

From Tue. 29th discussion: Normative (in-loop) down- and upsampling is only necessary at the switching points (which should be rare). Therefore, it may not be necessary in the context of ARC to define sophisticated decimation/interpolation filters.

One expert commented that reduced DPB memory could also be an advantage, where only lower resolution references are stored, but prediction would be performed at high resolution.

JCTVC-G597 AHG 18: Cross-check of Adaptive Resolution Coding (ARC) (JCTVC-G264) [Glenn Van Wallendael, Jan De Cock, Rik Van de Walle (Ghent Univ.), David Flynn (BBC)] [late]

JCTVC-G329 AHG18: Comments on the Implementations of Resolution Adaption on HEVC [M. Li, P. Wu (ZTE)]

This document presents an analyses of signaling and potential decoding rules for motion compensated prediction (MCP) if resolution adaption (RA) is integrated into the current HEVC design. The designs in the existing H.263 and MPEG-4 Part 2 standards, especially with two modes involving resolution changes, i.e., reduced resolution update (RRU) and dynamic resolution conversion (DRC), were studied as the references for identifying the areas where the standard texts and the coding algorithms will require specific changes to enable the resolution adaption as a video coding feature. Therefore, firstly, some key check items on MCP are listed, and the changes in the syntax and coding rules brought by RRU and DRC to H.263 and MPEG-4 Part 2 are analysed, respectively. Then some heuristic principles are described based on the common features distilled from the designs of RRU and DRC in order to achieve compact HEVC syntax design for RA. Finally, following these principles, key issues regarding MCP with RA integration into HEVC are elaborated with some recommendations.

Presented Tuesday 29th afternoon.

The contribution was meant as information document. It is suggested to change the resolution of the reference pictures (not of residual pictures as in the RRU of H.263) – similar as in JCTVC-G264.

JCTVC-G715 AHG18/21: Absolute signaling for resolution switching [K. Misra, S. Deshpande, L. Kerofsky, A. Segall (Sharp)] [late]

This document describes a technique which enables signalling of reference picture resolutions to be maintained in the decoded picture buffer.

Presented Monday 28th evening

Relates to DPB signaling – which resolution of the reference picture should be stored in DPB: Original, subsampled or both resolutions.

Does not relate to how the resolution switching is managed at the coding layer.

JCTVC-G862 Advanced Resampling Filters For HEVC Applications [W. Dai, M. Krishnan, P. Topiwala (FastVDO)]

Resampling filters are commonly used in a variety of image processing tasks. They are intimately related to two- and multi-channel filter banks, as well as to the well known Laplacian Pyramid. They arise in video coding applications in several instances: (a) spatial scalability, (b) resolution adaptation, and (c) color sampling, as part of 4:4:4 coding. All three application spaces are currently being explored in the HEVC project. The contributor proposed a general design methodology, and specific sampling filter instances, which can reportedly meet all of these demanding applications simultaneously.

Continue AHG

- Investigate use of simple filters (e.g. bilinear) for the down- and upsampling switching
- Investigate subjective quality, as frequent switching may be annoying
- Investigate necessity of keeping both resolutions in buffer
- Relationship with alternatives: pre / post processing

Discussion about the BD gains that were reported:

- For some sequences, the effective resolution is lower than pixel density, such that gains by encoding at lower resolution are found even at high rates
- Comparing PSNR values at different resolutions is problematic

5.11.3 Transform skip

JCTVC-G575 Transform skip mode [M. Mrak, A. Gabriellini, D. Flynn (BBC)]

This contribution is related to the work of Ad Hoc Group 19: Transform Skipping. Starting from the initial Transform Skip Mode (TSM) proposal (JCTVC-F077), this contribution reports a number of harmonization and evaluation aspects of TSM. The harmonization aspects include interaction with RQT, NSQT, scans, and signaling. Also, a detailed study of skip transform throughput is provided and a new implementation of transform skipping is presented achieving the same compression performance of the original implementation while providing stricter guarantees in terms of data not overflowing 16-bit registers for worst case input sets. The tests evaluate the compression performance of TSM at different levels of complexity. In all tested configurations gains are the highest for class F, showing BD-rate gains of up to 4.6% for the luma component.

There is a possibility that only one transform dimension is skipped (in that case, only 1D scan), or skipped entirely All block sizes including non-square are considered. JCTVC-G577 puts some restrictions e.g. only 4x4 blocks.

Large increase in encoding time seemed evident (as all possible modes in RQT are used).

Average gains: Without class F 0.3/0.6/0.7% for RA/LD B LD P, with class F 0.6/1.3/1.6%.

Current implementation does not give gain for intra.

Highest gain was for class F (screen content).

When skipping is imposed on 4x4 only (as from JCTVC-G577), gain is reduced (0.1/0.2/0.3 without class F), 2D transform used on 55%, other 45% are some version of skipping (only 8% 2D skips)

Somehow the 1D skip cases would be like NSQT with 1xN and Nx1, however the situation is different in that there is no dependency and all 1D transforms can be performed in parallel.

Entropy coding is unchanged (same contexts as for conventional 2D transform).

Scale factors were adjusted for quantization.

Results for flat quantization; would it be possible to apply the new default 2D quantization matrix? This was not investigated and requires further study

JCTVC-G894 Cross check for JCTVC-G575 K. Panusopone [late]

JCTVC-G908 Cross-check of BBC's transform skip mode (JCTVC-G575) [J. Sole (Qualcomm)] [late]

JCTVC-G933 Cross-check for skipped transform from BBC (JCTVC-G575) by Samsung [I.-K. Kim, E. Alshina, J.H. Park (Samsung)] [late]

JCTVC-G577 Transform skipping dependant on block parameters [Glenn Van Wallendael, Jan De Cock, Rik Van de Walle (Ghent Univ.), Marta Mrak (BBC)]

In this contribution a mechanism for selection of transform skip mode (TSM) depending on current block parameters is presented. TSM was introduced in JCTVC-F077 and it enables skipping transform on a row and/or a column of motion compensated residuals. The transform skip mode choice is signalled to the decoder where inverse transforms of rows/ columns are performed or skipped.

In this contribution, TSM is enabled or disabled depending on the size or the QP of the TU. Results are presented when only applying TSM on TU sizes 4x4. Additionally TSM is restricted to QPs under a threshold. These two scenarios offer an improved BD-rate performance and a lower encoder's execution time compared to TSM that is applied on all block sizes or QPs. To support such more customized selection of TSM, SPS signaling for TSM on larger blocks is proposed.

This was included in presentation of JCTVC-G575.

JCTVC-G971 Crosscheck of BBC's Transform Skip proposal [H. Yang, X. Zheng, H. Yu] [late]

JCTVC-G663 AHG19: Modification to HE transform coefficient coding for transform skip mode [R. Joshi, J. Sole, X. Wang, M. Karczewicz (Qualcomm)]

Transform skip mode was proposed in JCTVC-F077. Instead of always applying a 2-D transform to the prediction residual, transform in the row or column direction can be skipped. JCTVC-F077 did not propose changes to transform coefficient coding. In this contribution, changes were proposed to the coding of the last non-zero transform coefficient and coding of significance flags. Compared to HM 4.0, BD-rates of −0.6% (without class F) and −1.4% (with class F) are observed. The proposed modifications to HE transform coefficient coding for transform skip modes contribute BD-rates of −0.1% (without class F) and −0.2% (with class F).

Unlike the original version of JCTVC-G575, entropy coding is changed which could be an additional burden.

In JCTVC-G575 the entropy coder is agnostic about the transform mode, therefore context adaptation may not really be working.

Additional gain over the other method without class F was 0.1% over all cases, with class F 0.1/0.2/0.2.

JCTVC-G941 AHG19: Cross-check of JCTVC-G663, modifications to HE transform coefficient coding for transform skip mode [R. Cohen (MERL)] [late]

JCTVC-G945 Cross-check of JCTVC-G663, modifications to HE transform coefficient coding for transform skip mode [Andrea Gabriellini, Marta Mrak (BBC)] [late]

JCTVC-G586 Parallelizable context for significance coding of large transform blocks [J. Kang, J. Lainema, A. Hallapuro, K. Ugur (Nokia)]

JCTVC-G1003 Integration of proposals on transform skipping [M. Mrak, A. Gabriellini, D. Flynn (BBC), G. Van Wallendael (Ghent University), R. Joshi, J. Sole, X. Wang, M. Karczewicz (Qualcomm)] [late]

This contribution presents integration of 3 proposals from AHG19 on transform skipping. Transform skipping by omitting the transform on rows and/or columns is defined by four modes (including 2D transform). The proposals from AHG19 addressed entropy coding tools to support transform skipping, modified quantization to support different signal levels when the transform is skipped and proposed configurations for coding with transform skipping dependant on block parameters. The proposals have been integrated and the results for the unified solution are tested with transform skipping on 4x4 blocks.

Combination of JCTVC-G575, JCTVC-G577, JCTVC-G663: only 4x4 blocks.

Gain without class F: 0.4/0.7/0.9%.

Should there be a flag for disabling in SPS?

Investigate in new CE on transform skipping:

- Is it possible to achieve gain with as minimum changes as possible? (e.g. only 4x4 blocks, only changing the transform to variants 2D, 1D-H, 1D-V, NO, without changing quantization, entropy coding etc.
- The result of the CE should give information that allows judgement whether the amount of necessary changes is justified by the gain.
- Harmonization with quant matrices may be needed.

JCTVC-G1007 Crosscheck of JCTVC-G1003 [T. Davies] [late]

5.11.4 Other

JCTVC-G669 Delayed Duplicate I-Frame for Video Conferencing [R. Srinivasan, C. Ghone, M. Mody, M. Zhou (TI)]

This contribution presents a technique to reduce the peak data bandwidth on constant bandwidth network (resulting packet loss) because of I/IDR-Frames in a video-conferencing use-case or other real-time multimedia exchange use-cases. Delayed Duplicate I-Frame (DDI-Frame) is an error resiliency tool to enable reliable transmission on constant bit-rate network for bursty IDR/I frame traffic. DDI-Frame is identical to I/IDR-Frame except having additional P-Frame generated from the same input frame. The DDI bit-stream is not sent real-time, unlike P frame which is sent in real time to the decoder end. Bit-stream will have later reference (after N frames) to the DDI-Frame. This relaxes the transmission time requirement by factor of N for given DDI frame and smooth out bit-rate peaks which essentially cause latency. With this modification, it is claimed that peak bit-rate requirement because of I-Frame reduces by more than 3 times with a marginal increase in computation and bit-rate. The measured DDI-frame bit-rate overhead is around 3% for an I-frame period of 100 frames in simulation, the real overhead should be much smaller because the I-frame period used in the application is 3600 frames (or every 2 minutes). The proposed change is applied for low-delay LC as well as HE cases and not applicable for Random-Access and All-Intra cases.

DDI is like a long-term reference frame in the DPB.

This should be discussed in the context of error resilience activities and picture buffering.

The relation with “pictures not output for display” in AVC was mentioned. A potential relation with SP/SI was also mentioned.

Is there a normative decoder behaviour (beyond the DPB)? It was suggested to be better to leave it as non-normative “concealment” when a loss occurs.

Further study.

JCTVC-G795 Crosscheck of TI’s JCTVC-G669 on delay dependent intra frame for video conferencing [J. Min, Y. Piao, J.H. Park (Samsung)] [late]

5.12 Entropy coding

5.12.1 CAVLC

JCTVC-G247 Non-CE5: CAVLC counters normalization per LCU [E. François, S. Pautet, C. Gisquet (Canon)]

No need to review.

JCTVC-G405 Non-CE5: Cross-check of CAVLC counters normalization per LCU (JCTVC-G247) [B. Li (USTC), J. Xu (Microsoft)]

JCTVC-G312 Non-Square Partition Mode Grouping for CAVLC [T. Yamamoto (Sharp)]

No need to review.

JCTVC-G743 **Cross-check report on Non-Square Partition Mode Grouping for CAVLC (JCTVC-G312) [I.-K. Kim (Samsung)]**

JCTVC-G355 **Non-CE5: joint coding of splitting flag and inter modes [W. Zhang, P. Wu (ZTE)]**

No need to review.

JCTVC-G741 **Cross-check report on joint coding of splitting flag and inter modes (JCTVC-G355) [I.-K. Kim (Samsung)] [late]**

JCTVC-G905 **Crosscheck report of ZTE's joint coding of splitting flag and inter modes (JCTVC-G355) [X. Wang (Qualcomm)] [late]**

JCTVC-G365 **Non-CE5: Redefined contexts for last nonzero coefficient coding of 4x4 TU in CAVLC [J. Xu, A. Tabatabai (Sony)]**

No need to review.

JCTVC-G626 **Cross-check of JCTVC-G365, "Nonzero coefficient coding in CAVLC" [A. Fuldseth (Cisco)] [late]**

JCTVC-G692 **Intra Table for CAVLC [S.-H. Kim, A. Segall] [late]**

No need to review.

5.12.2 CABAC

JCTVC-G829 **Context modeling of split flag for CABAC [W. -J. Chien, M. Karczewicz]**

Is discussed in context of CE1 BoG (see under JCTVC-G1022).

JCTVC-G849 **Non-CE1: Crosscheck for Qualcomm's context modeling of split flag for CABAC in JCTVC-G829 [T.-D. Chuang, Y.-W. Huang (MediaTek)] [late]**

JCTVC-G326 **Non-CE1.b: On the exponential memory decay probability update [J. Sole, M. Karczewicz (Qualcomm)]**

Modifications to the memory decay function for probability update in CABAC as presented in JCTVC-F254 are proposed in order to have a symmetric estimator that disallows highly skewed distributions. Further modifications include the replacement of the range multiplication by a series of shifts, thus largely reducing the size of the LPS table. The BD-rates for AI-HE, RA-HE and LB-HE configurations are −0.50%, −0.61%, and −0.55%, respectively.

Relates to JCTVC-G764. Has a much smaller LPS table (factor 288).

The table to be added would increase the current HEVC table size by factor 1.5.

However, it is necessary to perform 5 shifts and 3 additions (could be replaced by multiply and one shift).

The added complexity would not justify adoption.

Combination with multi-parameter would be possible (as in CE1b) and increase performance but likely improve table size by 5.

JCTVC-G974 Cross-check for JCTVC-G326: On the exponential memory decay probability update [Gergely Korodi, Jinwen Zan, Dake He] [late]

JCTVC-G413 Modified probability update and table removal for multi-parameter CABAC update (F254) [C. Rosewarne, M. Maeda (Canon)]

This contribution presents a method of updating probability estimates of a context model that enables the substitution of the look-up table required for determining an offset for the range update with a function. The intention of removing the look-up table is to reduce area for hardware implementations. The intention of the modification to the probability estimate updating method is to remove one operation from the substituted function, which was asserted to provide a timing benefit for hardware implementation. When implemented on the multi-parameter version of JCTVC-F254 integrated in HM-4.0, the proposed technique has a reported 0.01% increase in IA-HE, a 0.02% increase in RA-HE, a 0.00% effect on LB-HE and a 0.01% increase in LP-HE.

Restricts the range of probability update operation.

Bitrate reduction 0.9%, 0.9%, 0.8% and 0.4% for AI, RA, LDB and LDP.

Similar to JCTVC-G764 without table lookup and probability update.

Probability of bin 0 is kept in memory (not of LPS).

JCTVC-G805 Cross-check of Canon's modified probability update and table removal for multi-parameter CABAC update (JCTVC-G413) [J. Sole (Qualcomm)] [late]

JCTVC-G547 Counter-based probability model update with adapted arithmetic coding engine [J. Stegemann, H. Kirchhoffer, D. Marpe, T. Wiegand (Fraunhofer HHI)]

This contribution presents a counter based probability model update algorithm for the usage with an adapted version of the M Coder of HEVC. The proposed method is closely related to Samsung's Multi-Parameter probability update proposal (JCTVC-F254) in conjunction with a design of the arithmetic coding engine but asserted to be retaining the R-D performance improvements of sophisticated probability estimation. Gains in coding efficiency reportedly amount from 0.5 to 0.8%.

Numbers are for single-parameter and multi-parameter update (as CE1b)

It was commented that a single estimator would be more interesting in terms of complexity tradeoff.

It was also commented that improved initialization may reduce the compression gain

It was planned to establish/continue CE1b from JCTVC-G764, JCTVC-G326, JCTVC-G413, JCTVC-G547.

JCTVC-G470 Non-CE1: Cross-check on HHI's proposal (JCTVC-G547) [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)] [late]

JCTVC-G440 Non-CE1: Modified probability model update for complexity reduction [A. Tanizawa, T. Shiodera, T. Yamakage (Toshiba)]

This contribution presents a technique to reduce complexity for CABAC probability model update process. In this contribution, the coding efficiency of probability model update for several syntax elements was evaluated, and a recommended combination is proposed.

Experimental result by disabling of probability model update for six syntax elements shows less than 0.1% BD-rate performance changes for four (IO/RA/LB/LP) HE conditions.

One comment: Invoking probability process depending on check of the given syntax element may be even more complex than always doing it.

JCTVC-G833 Non-CE1: Adaptive initialization for CABAC with fixed probability contexts [L. Guo, J. Sole, X. Wang, M. Karczewicz (Qualcomm)]

This contribution describes an adaptive initialization method for CABAC with fixed probability contexts. At the beginning of each slice, a context can be initialized in one of two ways: 1) initialized using the pre-defined (m,n) value (i.e., original HM method), or 2) initialized using a state value selected by the encoder. For each context, the encoder signals the selection of initialization method to the decoder as well as the new state value (if the second method is selected). No probability/state update will be performed in the encoding/decoding process, and thus the proposed method is asserted to be friendly to possible parallel-processing applications. Experiments in HE compared to CABAC with context update show a BD rate change of 0.3%, 2.4%, 2.8%, 2.6% for AI, RA, LD and LDP, respectively. If combined with a new set of (m,n) that are more suitable for fixed probability contexts, the BD rate change of 0.1%, 1.0%, 1.3%, 1.3% for AI, RA, LD and LDP, respectively

Explicit signalling of probability state (derived by decoder) instead of update.

Losses compared to HE (fully adaptive) configs, but gains compared to “old” LC with CAVLC

Study in CE.

JCTVC-G909 Non-CE1: Cross-check of JCTVC-G833 on adaptive initialization for CABAC [C. Yeo (I2R)] [late]

JCTVC-G848 Non-CE1: Crosscheck for Qualcomm's context reduction for CABAC in JCTVC-G718 [T.-D. Chuang, Y.-W. Huang (MediaTek)] [late]

JCTVC-G593 Non-CE13: Simplification of merge mode [O. Bici, J. Lainema, K. Ugur (Nokia)]

Has one aspect of entropy coding similar to JCTVC-G718: Context reduction for merge index coding (other aspects were presented in MV coding category). Two contexts for bin 0, other 3 bins are bypass coded. Gives 0.1% BR reduction in case of LD P.

It is reported that another version was tested where only 1 context bin 0 was bypass coded – then no gain (was not cross-checked) – would be preferred version, CE or BOG (as JCTVC-G718) ; JCTVC-G718 uses one context for all 4 bins.

JCTVC-G940 Cross-check for JCTVC-G593: Non-CE13: Simplification of merge mode [Semih Esenlik (Panasonic)] [late]

JCTVC-G324 Modified LPS range and state transition tables for BAC J. Sole, M. Karczewicz (Qualcomm)

The proposal modifies the binary arithmetic coder to allow a slower probability adaptation process and the coding of more skewed binary distributions than HM4.0. The entries of the range LPS table are changed and the number of probability states increased from 64 to 128. BD-rate for AI-HE, RA-HE and LB-HE configuration is −0.34%, −0.26%, and −0.05%, respectively. When the range LPS table size is divided by 2, the BD-rates are −0.26%, −0.21%, and 0.07% for AI-HE, RA-HE and LB-HE, respectively. A third variant using bit-shift operations that reduces the table size by 25% provides BD-rates of −0.36%, −0.28%, and −0.13%.

Results are better for larger resolutions.

Interest was expressed: Versions of full and half table size were discussed.

To be investigate in a CE.

With proper adjusted initialization, results might even be better (include in CE plan).

JCTVC-G984 Cross check result of Modified LPS range and state transition tables for BAC by Qualcomm (JCTVC-G324) [C. Rosewarne, M. Maeda (Canon)] [late]

JCTVC-G999 Verification of JCTVC-G324 on CABAC state machine [F. Bossen] [late]

JCTVC-G492 Maximum VLC Limits in CABAC Escape Coding [K. Sharman, J. Gamei, N. Saunders, P. Silcock (Sony)]

This contribution presents two alternative sets of *g_auiGoRicePrefixLen* and *g_auiGoRiceRange* values, which are used for CABAC escape codes. Possible inconsistencies and omissions in and between WD4 text and HM4.0 source code were also presented.

There is certainly some inconsistency.

Decision: adopt the following version (relative to the current software):
const UInt g_auiGoRicePrefixLen[4] = {8, 10, 10, 8}; (different from the 4.1 software in 3rd element)
const UInt g_auiGoRiceRange[4] = {7, 20, 42, 70}; (already in the 4.1 software)

JCTVC-G700 was pointing out the same issue.

JCTVC-G493 CABAC Stream Termination [K. Sharman, J. Gamei, N. Saunders, P. Silcock (Sony)]

A technique to terminate a CABAC stream is presented, and it is stated that the method produces a loss of on average 1.5 bits. A second alternative method is also presented which is claimed to produce an average loss of 1 bit. Applications of these techniques have been suggested to include termination of the CABAC stream prior to IPCM data, and termination of the stream for row-per-slice. In the working-draft HEVC design (JCT-VC F803), use of the CABAC stream termination method causes 8 bits to be flushed to the stream. The technique is illustrated with an example where intra frames are terminated after each LCU, allowing the coefficient bypass data (sign bits/escape codes) to be placed into the bit-stream in a raw format.

Seems to target some very specific cases (including IPCM where saving some bits seems to be marginal)

Some other syntax elements are in fact coded that consume additional bits.

In common conditions, the saving should be unnoticeable.

JCTVC-G494 CABAC Packet-based Stream [K. Sharman, J. Gamei, N. Saunders, P. Silcock (Sony)]

A method of arranging CABAC data and bypass data into packets is presented, where the bypass data comprises equal-probability bits. This method is stated to allow the insertion of bypass data into the bit-stream in raw binary form, which then allows the bypass data to be read and decoded in parallel with CABAC data. The reported cost of this method is an average of 8 bits per slice with no effect on software encoding and decoding times.

Interesting, somehow similar idea as of PIPE, but how is multiplexing/demultiplexing done? Making this normative would be undesirable as it somehow would prescribe the way of implementation of the decoder; the encoder might be complicated.

No action.

JCTVC-G963 Cross verification of CABAC packet based stream (JCTVC-G494) [M. Coban (Qualcomm)] [late]

JCTVC-G501 CABAC with Arithmetic Context Variables [K. Sharman, J. Gamei, N. Saunders, P. Silcock (Sony)]

This proposal reports on a technique to remove the look-up tables within the CABAC engine, replacing them with arithmetic operations. Claims are made that this could potentially reduce hardware size and complexity even if the Context Variables used are all increased from 7 to 8-bit. Results are reported for two different variants of the system, showing average {Y, U, V} BD-rate changes of {0.0%, -1.1%, -1.1%} and {0.0%, −0.9%, and −1.0%} respectively; encoder and decoder processing times were 101% and 100% respectively for both systems.

Two methods: One multiplier-based, one adder-based.

Increase of complexity of CABAC only? Some runtime numbers are given, but in software, the update is still implemented as table.

General remark: Whenever a change is made to the core of the CABAC engine, a more in-depth study should be performed on complexity impact (software, hardware).

JCTVC-G504 CABAC with Combined Context Variables [K. Sharman, J. Gamei, N. Saunders, P. Silcock (Sony)]

This proposal presents an adaption of the CABAC entropy coder that is claimed to be able to decode multiple coefficients per clock and therefore capable of decoding even the sustained worst case for 4:4:4 data.

The reported method encodes or decodes all of the required CABAC context variables (CV) for each coefficient in a single cycle using a quaternary arithmetic coding function; the bypass (sign and escape codes) are not explicitly discussed in this contribution, although a method whereby the bypass data can be decoded in parallel to the CV CABAC data is assumed, such as claimed in JCTVC-G494 “CABAC Packet-based Stream”.

The reported method encodes or decodes coefficients in a single pass of the data. Problems regarding the speculation required to maintain the throughput are discussed, and it is indicated that with changes to the CV selection system, speculation for large blocks (16x16, 32x32) can be completely removed. For small blocks (4x4 and 8x8), two methods of CV selection are presented that reduce speculation to 2 levels and 3 levels respectively (that is, a system with 2 levels of speculation would prepare 2 possible values per coefficient, requiring less than 2x the amount of logic than that of a system with no speculation). Results

are presented that indicate average BD-rate changes of +0.1%, −1.1% and −1.2% for Y, U and V respectively for the 3x speculation system, and average BD-rate changes of +0.2%, −1.0% and −1.1% for Y, U and V respectively for the 2x speculation system. In both systems, the context variables have not been re-optimized/adjusted from the values in HM4.0.

In addition, results are presented for an unoptimized packet-based system with 2 levels of speculation that indicates average BD-rate changes of 0.2%, −1.0% and −1.1% for Y, U and V respectively; the software times have increased by 3% and 0.5% for the encoder and decoder, with increases believed to be caused by the deferred ACV update mechanism and the neighbourhood-based method to select context variables ACV_1 and ACV_2, both designed to reduce the speculation requirements in hardware.

Further Study in AHG on throughput of coefficient entropy coding.

JCTVC-G934 Non CE1: cross-check for CABAC probability up-date modification from Sony (JCTVC-G501, JCTVC-G504) by Samsung [A. Alshin, E. Alshina, J.H. Park (Samsung)] [late]

JCTVC-G570 Byte alignment overhead reduction [S. Esenlik, M. Narroschke, T. Wedi (Panasonic)]

In the current HM4.0 byte alignment is used in various places in order to facilitate several purposes such as Emulation Prevention Byte (EPB) insertion and alignment of the bitstream in the encoder and decoder. The proposal introduces a coding method for the coding of syntax elements such that byte alignment condition is achieved automatically and the need for an explicit byte alignment function is eliminated. As a result the 0.1% bit rate reduction is reportedly achieved on average.

No support for adoption was expressed.

JCTVC-G972 Cross-verification of Panasonic's proposal JCTVC-G570 on byte alignment overhead reduction [O. Bici, J. Lainema, K. Ugur (Nokia)] [late]

Cross checker could see some advantage, but was neutral in terms of adoption.

JCTVC-G716 On CABAC Init IDC [K. Misra, A. Segall (Sharp)] [late]

This contribution proposes modification of the cabac_init_idc indicator that is associated with CABAC initialization. In HEVC, cabac_init_idc is carried over from the H.264/AVC design but not well defined. Specifically, the indicator appears in the HEVC WD but not in the HM software. This document proposes to define the meaning of this indicator. Compared to H.264/AVC, the proposed approach results in fewer tables available for CABAC initialization (reduced from seven to three). Additionally, the proposed approach allows different slice types to use the same table. Results show that the method provides improvements in coding efficiency. It is asserted that the proposal provides clarification to the HEVC design, simplification relative to H.264/AVC and coding efficiency improvement.

Definitely needs cleanup.

Included in side activity on 8-bit initialization.

JCTVC-G983 Cross-check Sharp's contribution On CABAC Init IDC (JCTVC-G716) by Qualcomm [L. Guo] [late]

JCTVC-G837 Non-CE1: 8-bit Initialization for CABAC [L. Guo, R. Joshi, J. Sole, X. Wang, M. Karczewicz (Qualcomm)]

This contribution describes an 8-bit initialization method for CABAC. The 8-bit *m* (slope) and 8-bit *n* (intersection) are replaced by a single 8-bit *InitIdx* for each context. SlopeTable (16 elements) and IntersecTable (16 elements) are introduced to convert the 8-bit *InitIdx* to a CABAC probability state in the initialization stage. Two sets of table values are presented in this contribution. For both of these two sets, the table look-up operations can be implemented using formula calculation and thus the table storage is not necessary. The average BD-rate reduction is 0.0%/0.3%/0.5% /0.3% for AI/RA/LD/LDP (HE) for the first set of tables, and 0.0%/0.2%/0.4% /0.3% for AI/RA/LD/LDP (HE) for the second set of tables.

Current method of initialization is certainly not good (e.g. range of n values useless).

Training was performed on class D (where the gain is a little bit larger).

8 bit initialization is seen as relevant.

Another method was used in CE1 where the mapping is not linear (more staircase).

JCTVC-G913 Cross-check for Qualcomm's proposal on 8-bit initialization for CABAC (JCTVC-G837) [Y. Piao, J. Min, J.H. Park (Samsung)] [late]

JCTVC-G155 Non-CE1: On CABAC context initialization [C. Yeo, Y. H. Tan, Z. Li (I2R)]

This contribution presents an implementation of the 8-bit CABAC context initialization proposed by HHI in JCTVC-F268. In this proposal, the initial CABAC context variable is directly computed using an 8 bit initialization value instead of first computing a PIPE index and its internal sub-state before converting that to a CABAC state. Coding results on HM-4.0 reportedly show an average Luma BD-Rate of 0.0% for each of the AI-HE, RA-HE and LB-HE configurations.

The presentation deck also contains (slide 7) some issues observed with unused contexts in WD (editors to check)

Conclusions:

Further investigate / continue CE?

8-bit context initialization is something we definitely will have in the CD, and should have it already in the next WD.

Proper initialization could also be relevant in context of other decisions such as context reduction and probability.

Side activity (B. Bross, proponents of JCTVC-G837, JCTVC-G155, JCTVC-G716): Reporting back with a proposal on a reasonable method for 8-bit initialization (representation and init values)

- No consensus.
- Both methods (JCTVC-G633 and JCTVC-G837 / JCTVC-G155) would fulfill the purpose.
- In the CE (JCTVC-G633), a piecewise linear approximation was tested. This method has been available for study for sufficient amount of time, whereas the other is a new contribution.
- The method investigated in the CE was originally designed to support both PIPE and CABAC, the original code is not in best shape; now a cleaned-up version exists which has not yet been inspected.
- Conclusion: The cleaned-up version of JCTVC-G633 will be inspected by the proponents of JCTVC-G837 / JCTVC-G155. If it is bit-wise exact, it will adopted, otherwise the method of JCTVC-G837 / JCTVC-G155 will be adopted. The CE will be continued to further improve or replace the adopted method; in the context of the CE, the algorithms for training of the respective representations(including the method of WD/HM) will be exchanged.

- Topic of JCTVC-G716 shall stay part of this effort.

It was then confirmed (Mon 28 morning) that the cleaned-up version exactly reproduces the results that were reported in JCTVC-G633 in CE1c.

Decision: Adopt the cleaned-up version of JCTVC-G633; still to be done: Cleanup of WD text, to be checked by the investigators of software and to be uploaded as revision of JCTVC-G633.

Investigation on improvement of 8-bit initialization will continue in CE1. In that context, inclusion of JCTVC-G716 will also be investigated.

JCTVC-G867 Non-CE1: Crosscheck of I2R's CABAC Context Initialization (JCTVC-G155) by Qualcomm [L. Guo (Qualcomm)] [late]

5.12.3 Other

JCTVC-G064 Results of the PA-Coder [H. Zhu]

The proposal reports the design, fast decoding algorithm, probability estimation and coding results of the arithmetic coder based on the probability aggregation.

The submitted document seemed unclear about the method and had some empty chapters.

0.2% Y bit rate increase was reported for all HE test cases.

The contribution was noted.

JCTVC-G452 SABAC - Scalable-complexity Adaptive Binary Arithmetic Coding [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]

This contribution proposes a mechanism to realize scalable complexity entropy coding architecture by signaling flags at slice header to disable some parts of functionalities of CABAC process.

SABAC enable and fast mode flags: When set “on”, context derivation and probability updates are disabled.

This method would just help a realtime encoder which is not powerful enough.

Comments: The main problem is the complexity at the decoder side. Turning updates off does not help entirely, as this may not be the main bottleneck. Such a method could end up in designing two different engines.

No action was taken on this.

JCTVC-G659 Non CE1: Study of Entropy Coding Methods Complexity [M. Karczewicz, I.S. Chong, X. Wang, R. Joshi (Qualcomm)]

This document summarizes some asserted key issues in hardware implementation of CABAC and CAVLC decoding. Throughput numbers obtained for these methods for H.264/AVC are quoted. Statistics of number of symbols and bins decoded per frame for the current test conditions are given.

This was an informative contribution. It was claimed that there is still reason to reduce throughput in CABAC.

JCTVC-G568 HM 4.0 entropy coding complexity study and software improvements [M. Viitanen, J. Vanne, T. D. Hämäläinen (TUT), J. Lainema, K. Ugur (Nokia)]

This contribution presents a software complexity analysis of CAVLC and CABAC entropy decoders. The contribution also identifies some obsolete code as well as possibilities to avoid division operations in HM software and proposes to clean up those in the next HM release. It is reported that the HM4 CABAC decoding is on average 53%, 28%, 8%, and 10% more complex than CAVLC decoding in the studied software environment for AI_LC, RA_LC, LB_LC, and LP_LC configurations, respectively. It is further reported that the relative burden of CABAC decoding gets more significant when operating at higher bit rates.

(This was already partially considered during CE1 review)

The gap between CABAC and CAVLC (based on cycle count of HM) tends to become larger towards higher rates (with CABAC having roughly 50% more cycles than CAVLC at QP22).

JCTVC-G569 Single entropy coder for HEVC with a high throughput binarization mode [J. Lainema, K. Ugur, A. Hallapuro (Nokia)]

This contribution proposes a modified entropy coding architecture for HEVC. The proposed architecture contains the current HM 4.0 CABAC engine (and its associated binarizations) in its entirety. In addition, it also contains a so-called "high-throughput binarization" (HTB) mode for transform coefficient coding for use under some circumstances. The proposed HTB is identical to the current HM 4.0 CAVLC coefficient coding, except that the CAVLC codewords are fed to the bypass coding mode of CABAC. This approach was asserted to significantly reduce the worst-case complexity of CABAC, which is asserted to make it more suitable for low-complexity use cases. It was reported that the proposed method reduces the number of context-adaptive coded bins by 61% under the common test conditions, and by 88% in the low QP range (QP 2 to 17), where the complexity of CABAC is reportedly more problematic. It was further reported that by replacing the current CAVLC with the proposed entropy coding method, the objective coding efficiency of low complexity configurations can be improved by 1.1% (AI_LC), 2.1% (RA_LC), 2.7% (LB_LC) and 3.1% (LP_LC), when utilizing the existing high efficiency CABAC binarization. It was reported that the high efficiency results stay unaffected.

It was asserted that the main problem in throughput is the encoding of transform coefficients.

The contribution proposed to have two different binarizations: a "high efficiency mode" and a "high throughput mode".

In high throughput mode, it was suggested to use the CABAC binarization for motion/mode/cbf data, and the CAVLC binarization for transform coefficients.

Altogether, the proposal uses only 30% of the previous CAVLC syntax elements, and 15% of its code tables.

The proponent was asked how much faster the software ran for the extreme low QP range. The proponent indicated that they had not analysed this.

A desire to analyse the amount of CABAC bypass bins used at lower QP values was also discussed.

JCTVC-G1008 Cross-check of JCTVC-G569 [T. Davies] [late]

JCTVC-G1008 is a cross-check but was performed without thorough study of the JCTVC-G569 software.

Conclusions:

- There is no doubt (as said in the context of CE1) that reducing throughput is an issue
- The problem can be specifically targeted to transform coefficient coding
- The solution suggested here is not necessarily the most desirable design, as in principle it still means implementing “roughly two” entropy coders (not “1.2”)

- Establish/continue CE and AHG for study of throughput particularly of TC coding
- Define a measure for measuring throughput – measure of bins/pixel may be one, but disputable
- Establish a HM5 software branch out of JCTVC-G569

5.13 Transform coefficient coding

5.13.1 Luma and chroma ordering

JCTVC-G112 Changing luma/chroma coefficient interleaving from CU to TU level [T. Hellman, Y. Yu (Broadcom)]

JCTVC-G645 Crosscheck of JCTVC-G112 – Changing Luma/Chroma Coefficient Interleaving from CU to TU level [M. Budagavi (TI)] [late]

JCTVC-G381 Nearest placement of Y/Cb/Cr transform coefficients locating at same spatial position [Y. Shibahara, K. Uchibayashi, T. Nishi (Panasonic)]

JCTVC-G904 Cross Check of JCTVC-G381 [Ankur Saxena, Felix Fernandes (Samsung)] [late]

General

The main part of JCTVC-G112 and JCTVC-G381 is the same, relating to the order of syntax elements. The proposal was asserted to provide a substantial hardware decoder complexity savings.

Decision: Adopted the common part of JCTVC-G112 and JCTVC-G381.

An aspect particular to JCTVC-G381 was noted, regarding the placement of chroma relative to luma in the minimum transform size case. In this aspect, JCTVC-G381 was suggested as preferable.

Decision: Adopted this aspect of JCTVC-G381.

An aspect particular to JCTVC-G112 was noted, regarding interleaving of chroma and luma in IPCM mode.

Decision: Define MaxIPCMcuSize and require it to always be at most 32x32 (to provide text consistent with ability to disable IPCM).

It was noted that JCTVC-G118 (avoiding sending other stuff between luma and chroma IPCM) has a relationship with this, but seems non-conflicting in spirit.

Another aspect particular to JCTVC-G112 was behaviour with MinTrafoSize equal to MaxTrafoSize in regard to chroma. Two possible solutions were suggested.

Decision: Establish MinChromaTrafoSize = (chroma_format == 4:4:4) ? MinTrafoSize : (Max(MinTrafoSize − 1, 4x4)).

5.13.2 Significance map coding

JCTVC-G308 Complexity reduction of significant map coding [T. Ikai (Sharp)]

JCTVC-G751 Cross-check report for Sharp's proposal (JCTVC-G308) on Complexity reduction of significant map coding [H. Sasai, T. Nishi (Panasonic)] [late]

JCTVC-G366 Non-CE11: Context reduction of significance map coding with CABAC [C. Auyeung, J. Xu (Sony)]

JCTVC-G127 Cross-check of Sony's proposal on context reduction for significance map (JCTVC-G366) [V. Sze (TI)]

JCTVC-G644 Multi-level Significant Maps for Large Transform Units [N. Nguyen, T. Ji, D. He, G. Martin-Cocher, L. Song (RIM)]

The objective is to reduce the number of significant coefficient bins to be decoded for large transforms.

Average bin count benefit was shown (3–4%), especially on larger block sizes (14% AI, 12% RA, 30% LB).

Part of this contribution depends on JCTVC-G323.

When combined with JCTVC-G323, some coding efficiency benefit was reported (0.1−0.3%) and it was reported that more use of the larger block sizes occurs.

The technique was also reported to work with other types of scans (although it fits best structurally with the sub-block scan scheme).

The scheme seems particularly "clean" in conjunction with the 4x4 sub-block scan of JCTVC-G323.

The response from discussion of this proposal was quite positive, at least when used in conjunction with JCTVC-G323.

Decision: Adopt (whichever variant, depending on JCTVC-G323 decision).

JCTVC-G1001 Cross-check of RIM's multi-level significant maps for large transform units (JCTVC-G644) J. Sole [late]

JCTVC-G657 Encoding and decoding significant coefficient flags for small Transform Units using partition sets [G. Korodi, J. Zan, D. He (RIM)]

JCTVC-G796 Cross-check for RIM's proposal on small TU significance map coding (JCTVC-G657) [Y. Piao, E. Alshina, J. Min, J.H. Park (Samsung)]

JCTVC-G725 **Non-CE11: Simplification of significant coding for CABAC [V. Kung, K. Panusopone (Motorola Mobility)]**

JCTVC-G876 **Cross-check of Motorola's proposal (JCTVC-G725) - Simplification of significant map coding for CABAC [H. Yang, H. Yu (Huawei)] [late]**

JCTVC-G768 **Reduced contexts for significance map coding of large transform in CABAC [Y. Piao, J. Min, J. H. Park (Samsung)]**

JCTVC-G642 **Cross-check of Samsung context reduction in significance map coding [J, Zan, D. He] [late]**

JCTVC-G781 **Reduced chroma contexts for significance map coding in CABAC [Y. Piao, J. Min, E. Alshina, J. H. Park (Samsung)]**

JCTVC-G917 **On significance map coding for CABAC [V. Sze (TI)] [late]**

JCTVC-G981 **Crosscheck of JCTVC-G917 on significance map coding in CABAC from TI [C. Auyeung (Sony)] [late]**

JCTVC-G986 **Fast algorithm and some comments on the significance map coding [H. Zhu] [late]**

Information document (late) – contributor not available – not presented.

JCTVC-G1015 **A combined proposal from JCTVC-G366, JCTVC-G657, and JCTVC-G768 on context reduction of significance map coding with CABAC [C. Auyeung, J. Xu (Sony), G. Korodi, J. Zan, D. He (RIM), Y. Piao, E. Alshina, J. Min, J. Park (Samsung)] [late]**

Context selection

For 16x16 and 32x32, currently there is diagonal wavefront-ish scanning, and 44 contexts for luma, and 44 for chroma.

A common theme: Sharing contexts for higher frequencies for 4x4 and 8x8. Generally there is no coding loss from these various proposals.

A new context initialization (Track A) has approximately 0.3% benefit, from improving the probability estimates of the values.

Testing with the new context initialization may be necessary.

Comment: We hope that these have been tested with low QP. Low QP is generally more sensitive to context reduction and less sensitive to initialization.

The CE did not test significance map proposals.

It was remarked that context selection logic may typically be more important than quantity of contexts.

It was remarked that the interaction with the level coding is also important.

JCTVC-G1015 is a new combined proposal that has been tested on low QP. It was remarked that JCTVC-G1015 removes about 40 contexts for the significance map (about half of the current total for that purpose, which is roughly 10% of the global total). It was suggested that this is a substantial amount, so it seems clear that some action is needed.

Regarding impact on software, it seems to change only one function. Text is available for JCTVC-G1015.

In the interest of trying to have a solution rapidly, JCTVC-G1015.

Decision: Adopt JCTVC-G1015 (pending appropriate text availability – provided in -v3 of document – seems generally acceptable).

The other significance map proposals are for further study in a CE (JCTVC-G308, JCTVC-G725, JCTVC-G448, JCTVC-G781).

Context selection

JCTVC-G917 simplification of context selection for high-frequency positions in order to increase parallelism

This was asserted to enable up to 5 bins per cycle of parallelism.

Some skepticism was expressed about the need for this; since it was a late document, it was suggested to defer its consideration to further study.

5.13.3 Last coefficient flags (x and y)

JCTVC-G201 Non-CE1: Codeword reordering for last_significant_coeff_x and last_significant_coeff_y [T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)]

JCTVC-G761 Cross-check report for MediaTek's proposal (JCTVC-G201) [H. Sasai, T. Nishi (Panasonic)] [late]

JCTVC-G239 Non-CE11: Modified method for coding the positions of last significant coefficients in the CABAC mode [S.-T. Hsiang, S. Lei (MediaTek)]

JCTVC-G947 Crosscheck for Modified method for coding the positions of last significant coefficients in the CABAC mode (JCTVC-G239) [G. Clare, F. Henry (Orange FT)] [late]

JCTVC-G370 **Binarization of last position for higher throughput [C. Auyeung (Sony)]**

JCTVC-G900 **Cross-check of binarisation of last position for higher throughput (JCTVC-G370) [V. Drugeon, M. Narroschke (Panasonic)] [late]**

JCTVC-G520 **Non-CE11: Modified Context Derivation for last coefficient flag [H. Sasai, T. Nishi (Panasonic)]**

JCTVC-G942 **Non-CE11: Cross-check of Modified Context Derivation for last coefficient flag (JCTVC-G520) [T. Tsukuba, T. Ikai (Sharp)] [late]**

JCTVC-G554 **Grouping of bypass bins for last position coding of transform coefficients [I.-K. Kim, V. Seregin, J. H. Park(Samsung)]**

JCTVC-G704 **Last position coding for CABAC [W.-J. Chien, J. Sole, M. Karczewicz (Qualcomm)]**

JCTVC-G873 **Cross-check of JCTVC-G704 on last position coding for CABAC from Qualcomm [E. François (Canon)] [late]**

5.13.4 Coefficient level coding

JCTVC-G301 **Test Results On Context simplification for coefficients entropy coding [X. Che, W. Ding, Y. Shi (Beijing Univ. Tech.)]**

JCTVC-G128 **Cross-check of proposal on context simplification for coefficients entropy coding JCTVC-G301 (F148) [V. Sze (TI)]**

JCTVC-G989 **Cross-check of JCTVC-G301 on the context simplification for coefficients coding by Huawei [H. Yang (Huawei)] [late]**

JCTVC-G448 **Non-CE11: Context reduction for coding transform coefficients [S.-T. Hsiang, S. Lei (MediaTek)]**

JCTVC-G997 Non-CE11: Cross-check of JCTVC-G448 on context reduction for coding transform coefficients V. Seregin, J. Sole (Qualcomm) [late]

JCTVC-G522 Non-CE11:Context reduction for coefficient level [K. Terada, H. Sasai, T. Nishi (Panasonic)]

JCTVC-G126 Cross-check of Panasonic's proposal on context reduction for coefficient levels (JCTVC-G522) [V. Sze (TI)] [late]

JCTVC-G700 On coeff_abs_level_minus3 coding [J. Lou, L. Wang (Motorola Mobility)]

This proposes fixing the inconsistency also noted in JCTVC-G492. See notes for JCTVC-G492.

Additionally, a new updating rule was proposed as a regularity cleanup (and hardware implementation simplification) for the current cRiceParam table.

If the table is implemented as combination logic, it has fewer cases to check.

The cross-checker commented that it would be beneficial to test this in the low QP range (e.g. using QP range previously used for transform CEs). Decision: Adopt this aspect.

The adoption was initially conditioned on the result of this low QP range test degrading luma BD rate less than 0.1% as a global average. A revision of JCTVC-G700 (-v9) was uploaded, which reported that the result is actually an improvement on average (albeit small).

There is also a third element of the proposal, which was suggested to not need to be presented.

JCTVC-G854 Crosscheck – On coeff_abs_level_minus3 coding (JCTVC-G700) [T. Nguyen (Fraunhofer HHI)] [late]

JCTVC-G783 Context number reduction for level coding in CABAC [Y. Piao, J. Min, J.H. Park (Samsung)]

JCTVC-G125 Cross-check of proposal on context reduction for coefficient levels (JCTVC-G783) [V. Sze (TI)] [late]

JCTVC-G718 Context reduction for CABAC [W.-J. Chien, J. Sole, M. Karczewicz (Qualcomm)]

(First discussed in Track A.)

This proposal reduces the number of contexts in CABAC. The number is reduced by 56 contexts. Experimental results reportedly show 0.00%, −0.01% and -0.12% BD-rate changes in high efficiency intra-only, random access and low-delay test conditions respectively.

1st part relates to using same coding for P and B (see under JCTVC-G785)

2nd part relates to context number reduction (151 to 95)

Some relate to transform coefficient coding and CBF – how does it behave at low QP?

Some imbalance for the color components – clarify.

Very interesting, but major package of changes where it must be ensured that it is stable – investigation in CE or before in BoG (if one is installed in context of transform coefficient coding in track B; aspects of transform context modification should also be presented there).

CBF and coefficient coding part of the contribution were discussed in Track B. see discussion in CBF section.

General

Regarding low QP testing, all but JCTVC-G522 have reportedly been tested for low QP. The contributor of JCTVC-G522 indicated that they have the results for low QP and will provide them. Cross checks for low QP may be missing in some cases.

JCTVC-G121 was in CE11, and seems like a step in the right direction. It is generally compatible with the others.

Again, it seems clear that the benefit is substantial and some action will be needed.

Decision: Adopt JCTVC-G121.

Further study of the others should be done in a CE.

It was suggested that the first part of JCTVC-G783 is simple, beneficial and non-conflicting with most others.

Decision: Adopted (the chroma-only part of JCTVC-G783 – pending availability of appropriate text).

5.13.5 Scans

JCTVC-G226 Non-CE11: Extending MDCS to 16x16 and 32x32 TUs [C.-W. Hsu, X. Zhao, X. Guo, Y.-W. Huang, S. Lei (MediaTek)]

This contribution is intended to improve coding efficiency by adding two more scans; the measured impact was approximately −0.1%. This gain seems insufficient.

JCTVC-G187 Non-CE11: Cross-verification of MediaTek's proposal (JCTVC-G226) by JVC KENWOOD [S. Fukushima (JVC Kenwood)]

JCTVC-G285 Non-CE11: Methods for Solving the Parsing Issue of MDCS [X. Zhao, X. Guo, C.-W. Hsu, T.-D. Chuang, Y.-W. Huang, S. Lei (MediaTek)]

Scans depend on the intra mode; the suggestion is to remove that dependency. Similar loss (0.2%) with a CE proposal on the subject. This proposal was asserted to be simpler than the CE proposal, which was not adopted. However, the group did not think that the design had a significant problem that needed to be solved.

JCTVC-G531 Cross verification of MediaTek's proposed methods for solving the parsing issue of MDCS (JCTVC-G285) [Y. Chiu, L. Xu (Intel)] [late]

JCTVC-G323 Non-CE11: Diagonal sub-block scan for HE residual coding [J. Sole, R. Joshi, M. Karczewicz (Qualcomm)]

This contribution relates to JCTVC-G644 and JCTVC-G958. It suggests to break 32x32 and 16x16 into sub-blocks for scanning of significance maps and coefficients. Modifies context selection to avoid a neighbour bottleneck.

It suggests to revert part of the design to pre-Torino behaviour.

It was remarked that the proposal would negatively affect the maximum parallelism for the coding of the significance map. Some other participants expressed skepticism about whether the maximum parallelism limitation was a significant issue in actual practical use.

There seems to be a question over which issue is more important – the sub-block handling or the significance map coding parallelism.

There are other contributions that relate to this (JCTVC-G644 and JCTVC-G958).

Another aspect, proposed in JCTVC-G320, involves interleaving of 5 classes of data at the 16x16 level, which is a small change that is subordinate to the decision on the sub-block scanning.

Decision: Adopt JCTVC-G323 / JCTVC-G320 (text was provided during the meeting and considered acceptable). Flags for sub-blocks of JCTVC-G644 are to be similarly interleaved.

JCTVC-G810 Crosscheck of JCTVC-G323 on sub-block scan for residual coding from Qualcomm [C. Auyeung (Sony)] [late]

JCTVC-G957 Non-CE11: Cross-check result of Diagonal sub-block scan for HE residual coding by Qualcomm (JCTVC-G323) [C. Rosewarne, M. Maeda] [late]

JCTVC-G1021 Non-CE11: Cross check result of JCVC-G323 proposed by Qualcomm [J. Kim] [late]

JCTVC-G491 Hybrid Horizontal/Vertical with Diagonal Mode Dependent Coefficient Scan [K. Sharman, J. Gamei, N. Saunders, P. Silcock (Sony)]

Not necessary for presentation.

JCTVC-G943 Non-CE7: Crosscheck for Sony's MDCS in Proposal JCTVC-G491 [X. Zhao, X. Guo (MediaTek)] [late]

JCTVC-G958 Non-CE11: Modified context selection for significant coefficient flags with diagonal sub-block scan [C. Rosewarne, M. Maeda] [late]

Depends on JCTVC-G323.

In JCTVC-G323, there are two locations where the current flag depends on the previous one. JCTVC-G323 addresses this by excluding the previous flag from the context selection. Here this is dealt with by making a guess about the probable value of the missing neighbour flag.

The reported gain was considered too small to justify the added complication.

JCTVC-G976 Cross-check of Canon modified context selection for significant coefficient flags with diagonal sub-block scan (JCTVC-G958) [J. Sole] [late]

5.13.6 NSQT (scans and contexts)

(JCTVC-G517 is also related.)

JCTVC-G123 Non-CE11: Simplified Coefficient Scans for NSQT [V. Sze (TI)]

JCTVC-G758 Non-CE11: Cross-check report for TI's proposal (JCTVC-G123) on Simplified Coefficient Scans for NSQT [H. Sasai, T. Nishi (Panasonic)] [late]

JCTVC-G724 Non-CE11: Entropy coding for non-square TU blocks [Vivian Kung, Krit Panusopone (Motorola Mobility)]

JCTVC-G875 Cross-check of Motorola's proposal (JCTVC-G724) - entropy coding for non-square blocks [H. Yang, H. Yu (Huawei)] [late]

General

Three aspects in JCTVC-G724 and JCTVC-G750:

- Scan
- Last
- Significance map

There was a suggestion to harmonize JCTVC-G323 and JCTVC-G1015 – regarding how to do last significant coefficient coding.

There was side work to work on this in a BoG (coordinated by J. Sole)

5.13.7 Sign coding

JCTVC-G271 Sign Data Hiding [G. Clare (Orange Labs), F. Henry (Orange Labs)]

The concept of this was previously proposed in JCTVC-A114 and in JCTVC-E428.

Proposes to "hide" one sign bit into the parity of the sum of the transform coefficient levels between the first and last non-zero coefficient.

An average 0.6−0.7% benefit reported.

It was asked what would happen if RDOQ is disabled? The encoder would need to be somewhat more complex if it wants to use this technique effectively.

Syntax was described to send four thresholds (one each for luma and chroma, inter and intra).

Question: Is this sensitive to TU depth?

Question: What is the decoder complexity impact? It was suggested not to be difficult to support.

Question: Are there any visual artifacts?

Further study was highly encouraged (in a CE).

JCTVC-G889 Crosscheck of JCTVC-G271 on Sign Data Hiding [Andrea Gabriellini, Marta Mrak (BBC)] [late]

JCTVC-G372 Coding order of sign and level minus 3 with CABAC [C. Auyeung, T. Suzuki (Sony)]

This suggests to send the sign flag after the level_minus3 instead of before it, for improved throughput in a hardware implementation. This approach was suggested to require less memory and have lower latency, at least in some implementations.

In hardware it was suggested that the proposed approach may be preferable to enable earlier availability of some of the transform coefficient values from the decoding process.

Another participant suggested that in another implementation (software-based), the change would not be beneficial – that since the (16) sign bits can be stored with less memory than the level values, it is preferable to store the sign bits than to store the level values. Also, the level_minus3 would have many more bins to decode than the sign.

Support for adoption was only expressed by the proponent, and further study was recommended to determine whether there is a significant problem with the current approach.

JCTVC-G744 Cross-check report on Coding order of sign and level minus 3 with CABAC (JCTVC-G372) [I.-K. Kim (Samsung)]

5.13.8 CBF

(See also notes for JCTVC-G718.)

JCTVC-G444 Proposed fix on cbf flag signaling [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)]

This contribution proposes to modify the condition for inferring cbf flag. It identifies one additional case where cbf for luma can be inferred.

Multiple alternate configurations were tried for min/max CU and TU size settings.

This applies to common conditions and other conditions as well.

Cross-checked in JCTVC-G760.

Some details of the proposal were not easily understood. Proponents were asked to discuss the proposal with WD editors and report back.

This was discussed again on Nov. 29. B. Bross confirmed the correctness of the proposal which would not worsen the quality of text.

Decision: Adopt.

JCTVC-G760 Cross-check report for Mitsubishi's proposal (JCTVC-G444) on Proposed fix on cbf flag signaling [H. Sasai, T. Nishi (Panasonic)] [late]

Discussion

JCTVC-G718 proposes to share the CBF contexts for the U and V components in order to reduce the number of CABAC contexts (saving 5).

The result is a small (less than 1%) improvement in coding efficiency of V component.

Decision: Adopt this aspect of JCTVC-G718.

5.13.9 CAVLC

Not reviewed due to decision to remove CAVLC.

JCTVC-G537 Table reduction and Improvement of last position coding in CAVLC [C. Kim, Y. Park, J.H. Park(Samsung)]

JCTVC-G838 Cross-check of CAVLC last position coding (JCTVC-G537) [T. Yamamoto (Sharp)] [late]

JCTVC-G545 Improvement of level coding in CAVLC [C. Kim, Y. Park, J.H. Park(Samsung)]

JCTVC-G801 Cross-check for Samsung's proposal (JCTVC-G545) [J. Xu (Sony)] [late]

JCTVC-G685 Selective Run-Level Coding for CAVLC [S.-H. Kim, A. Segall (Sharp)]

5.13.10 Other

JCTVC-G202 Non-CE2: Modified NSQT coefficient scan for CAVLC [C.-W. Hsu, Y.-W. Huang, S. Lei (MediaTek)]

JCTVC-G747 Non-CE2: Crosscheck of MediaTek's proposal on NSQT coefficient scan for CAVLC (JCTVC-G202) [X. Zheng (HiSilicon)] [late]

JCTVC-G750 Non-CE2: Harmonization of HE residual coding and NSQT [J. Sole, X. Wang, M. Karczewicz (Qualcomm), J. Kim, B. Jeon (LGE)]

JCTVC-G596 Crosscheck report of Harmonization of HE residual coding and NSQT by Qualcomm and LGE (JCTVC-G750) [J. Kim, M. Kim] [late]

General

JCTVC-G201, JCTVC-G370, JCTVC-G554, part of JCTVC-G520

Group together the bypass bins as done in some other places

Decision: Adopted.

Remark: MSBs first for last_significant_coeff_x, _y, please

Decision: Adopted.

JCTVC-G239, JCTVC-G520, JCTVC-G704

Change of binarization to reduce bin count, reduction of number of contexts, simplification of context selection

JCTVC-G239 was reported to do both, but contrib does not report the average (max 5 CABAC coded bins for something rather than 16, no LUT for CABAC bins, adds 2*4 contexts, 0.1% improvement in coding eff)

JCTVC-G704 similar (drops 2 contexts)

JCTVC-G520 same binarization as somewhere else in the standard, reduction in number of contexts (loss of efficiency 0.06–0.08%, up to 0.23% loss if the number of contexts is reduced – asserted to have no loss if number of contexts is not reduced, but that doesn't seem to be described).

Decision: Adopt JCTVC-G704 (with adjustments above and below).

Remark: We should harmonize the unary code convention – should use 1's followed by a 0. Decision: Agreed.

5.14 Intra prediction and intra mode coding (ref CE6)

5.14.1 Intra prediction

5.14.1.1 Predicting chroma from other colour channels

Review of contributions in this area by a BoG on chroma intra prediction (coordinated by A. Tabatabai) was requested.

(JCTVC-G119 also discusses this topic; see the section on that contribution.)

JCTVC-G173 Cross-channel intra chroma residual prediction [Y. Chiu, Y. Han, L. Xu, W. Zhang, H. Jiang (Intel)]

JCTVC-G676 Non-CE6: Crosscheck for Intel's Intra Chroma Prediction in JCTVC-G173 [M. Guo, X. Guo (MediaTek)] [late]

JCTVC-G244 **Luma-based chroma prediction – Model correction [C. Gisquet, E. François (Canon)]**

JCTVC-G646 **Crosscheck of JCTVC-G244 – Luma-based chroma prediction - Model correction [M. Budagavi (TI)] [late]**

JCTVC-G270 **Non-CE6a: Cross-checking of JCTVC-G244 – Luma-based chroma prediction - Model correction [P.Bordes, P.Salmon (Technicolor)] [late]**

JCTVC-G346 **Chroma intra prediction based on residual luma samples [K. Kawamura, T. Yoshino, H. Kato, S. Naito (KDDI)]**

JCTVC-G069 **Cross-verification of KDDI's proposal on intra coding (JCTVC-G346) [Masaaki Matsumura, Shohei Matsuo, Seishi Takamura, Hirohisa Jozawa (NTT)]**

JCTVC-G911 **Cross verification of KDDI's Chroma intra prediction based on residual luma samples (JCTVC-G346) [Y. Chiu, W. Zhang, L. Xu, Y. Han (Intel)] [late]**

JCTVC-G245 **Non-CE6a: Use of chroma phase in LM mode [E. François, C. Gisquet, S. Pautet (Canon)]**

JCTVC-G511 **Performance Evaluation of Luma-based Chroma Intra Prediction [K. Sato (Sony)]**

JCTVC-G1009 **A joint contribution on the coding tools of residual prediction for intra chroma prediction [Y. Chiu, Y. Han, L. Xu, W. Zhang, H. Jiang (Intel), K. Kawamura, T. Yoshino, H. Kato, S. Naito (KDDI)] [late]**

JCTVC-G1024 **Report of combining two coding tools for Chroma intra prediction (JCTVC-G173 and JCTVC-G358) [Xingyu Zhang, Oscar Au, Xing Wen, Yi-Jen Chiu, Yu Han, Lidong Xu, Wenhao Zhang] [late]**

JCTVC-G419 Inconsistency of intra LM mode between HM and WD [J. Lee, S.-C. Lim, H. Y. Kim, J. S. Choi (ETRI)]

Partly on padding, and partly on prediction of chroma from luma.

JCTVC-G886 Cross-verification of ETRI's Inconsistency of intra LM mode between HM and WD (JCTVC-G419) [T. Lee, J. Chen, J. H. Park] [late]

JCTVC-G1037 Non-CE6: Crosscheck of JCTVC-G419 with alpha7bit bugfix [K Sato (Sony)] [late]

JCTVC-G358 New modes for chroma intra prediction [X. Zhang, O. C. Au, J. Dai, F. Zou, C. Pang, X. Wen (HKUST)]

5.14.1.2 Other chroma intra prediction

Review of contributions in this area was requested by a BoG on chroma intra prediction (coordinated by A. Tabatabai).

JCTVC-G273 Crosscheck for JCTVC-G358 new modes for chroma intra prediction [J. Dong (InterDigital)] [late]

JCTVC-G1030 Crosscheck for Canon's, Intel's, Mitsubishi's, NHK's integration of several chroma coding tools in JCTVC-G955 [T.-D. Chuang, Y.-W. Huang (MediaTek)] [late]

JCTVC-G955 Joint contribution on the integration of several chroma coding tools [Gisquet Christophe (Canon), Chiu Yi-Jen (Intel), Minezawa Akira (Mitsubishi), Ichigaya Atsuro (NHK)] [late]

JCTVC-G995 Cross-verification of joint contribution on the integration of several chroma coding tools (JCTVC-G955) [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)] [late]

5.14.1.3 SDIP-related

JCTVC-G354 Non-CE6: Improvements for SDIP [J. Xu, E. Maani, A. Tabatabai (Sony)]

Discusses the new part of JCTVC-G558.

In this proposal, two modifications are proposed relative to SDIP for coding efficiency improvement. First, MPMs in intra mode coding for non-square CU are modified and achieves BD rate saving −0.04% for AI_HE and −0.1% for AI_LC. Second, contexts for the significance map of non-square TUs are redefined, which provides additional −0.1% for AI_HE. Combing both algorithms, there is −0.14% BD-rate saving for AI_HE.

Within the context of SDIP, this was agreed to be an improvement of the reference design.

JCTVC-G804 Crosscheck for Sony's JCTVC-G354 on Improvements for SDIP [C. Lai, L. Liu, J. Zheng (HiSilicon)] [late]

JCTVC-G135 Non-CE6: Rectangular (2NxN and Nx2N) Intra Prediction [S. Liu, X. Zhang, Z. Zhou, S. Lei (MediaTek)]

This contribution proposes to add two new intra prediction modes, i.e. 2NxN and Nx2N Intra prediction to the existing 2Nx2N and NxN (only in SCU) intra prediction modes in current HM. Experimental results report an average 1.6% BD rate reduction for AI HE, with encoder run-time increase 31%; or average 1.52% BD rate reduction for AI HE, with an encoder run-time increase 27% (with HM 4 non-SDIP branch as the anchor). Decoding run-time is increased by 3% on average. All results are generated by current software implementation; further coding efficiency improvement and/or implementation complexity reduction are reported to be expected with further investigation.

In intra, currently, "PU" is the level at which the prediction type is indicated, and "TU" is the level at which the prediction type is operated.

Although the title of the proposal refers to 2NxN and Nx2N, at the TU level the sizes are 2Nx(N/2) and 2Nx(N/4) and the rotated equivalents. At PU 32x16, the TU is 32x8 and 32x2; at PU 16x8, the TU is 16x4; at PU 8x4, the TU is 8x2.

It was commented that harmonizing the set of segmentations between intra and inter is desirable. The degree of alignment between this and SDIP and the inter NSQT and RQT was discussed.

The proposal did not include support at the 64x64 level. It was suggested that the reason that this was not used was encoder search complexity, but that perhaps it would be best not to do something architecturally different from the decoder perspective.

In the proposal, a subset of the intra prediction modes was searched, while the syntax is proposed to support a full set of 35 modes.

It was remarked that the encoder search is a significant consideration in these comparisons.

The cross-checker remarked that there is substantial commonality between this proposal and the prior SDIP scheme; for 8x2 this scheme searches more modes.

Interest was expressed in obtaining test results that included cases other than AI, and with NSQT in particular.

The proponent acknowledged that such study was desirable.

Further study in a CE (as in prior CE6) was encouraged.

The AHG on block sizes and partitions was encouraged to consider issues of harmonization in both directions between intra and inter designs.

JCTVC-G809 Crosscheck of JCTVC-G135 on rectangular (2NxN and Nx2N) intra prediction from MediaTek [C. Auyeung (Sony)] [late]

JCTVC-G965 Cross-check report for MediaTek rectangular Intra prediction by Motorola Mobility [J. Lou, L. Wang (Motorola Mobility)] [late]

JCTVC-G598 Non-CE6: Intra prediction based on weighted template matching predictors (WTM) [T. Guionnet, L. Guillo (INRIA)]

This contribution presents an intra prediction method based on weighted template matching predictors (WTM) and the results of its integration in HM 4.0. The resulting codec reportedly always improves the intra prediction. Without the class F, the average BD-rate gain is 0.5% for High Efficiency (HE) and 0.6% for Low Complexity (LC) profiles. With the class F, the average BD-rate gains are 1% for HE and 1.1% LC. BD-rate gains within only class F are 3.1% and 3.4% for HE and LC, respectively. Outside from class F, it was reported that class C provides the largest benefit.

Preliminary tests were run when SDIP was jointly activated with WTM in HM4.0. BD-rate gains were reportedly largely cumulative.

Decoding time increase is reported as 4%, with 15–20% encoding time increase.

In this proposal, the shape of the template is signalled by syntax (which involves encoder search).

There were some prior template matching proposals (not at the last few meetings) – although it was remarked that those were more complex.

There were some remarks that we seem to be entering a stage of work where more of a focus on stabilization is needed, so it seems unlikely that such a significant modification would be included in the design (in a first phase of standardization).

JCTVC-G604 Non-CE6: Cross-checking of JCTVC-G598: Intra prediction based on weighted template matching predictors (WTM) [P Bordes, P Salmon (Technicolor)] [late]

JCTVC-G754 Non-CE6: Line buffer reduction for CABAC context of SDIP syntax [L. Guo, X. Wang, M. Karczewicz (Qualcomm)]

SDIP (short-distance-intra-prediction) introduces two extra syntax elements sdip_flag and sdip_direction. The CABAC context modeling of these two syntax elements involves the corresponding syntax values from above blocks, and thus introduces line buffer storage. This contribution describes modified CABAC contexts for sdip_flag and sdip_direction that avoid upper block data and thus eliminates the line buffer for these two syntax elements. The average B-D rate change is 0.0% and no encoding/decoding time change is observed.

It was commented that coding the segmentation as mode-level information without adding other context models is preferable to using the additional context models for sdip_flag and sdip_direction. If that suggestion is pursued, this modification would not be necessary. This seems desirable to study.

However, without that suggestion incorporated – within the context of SDIP, this was agreed to be an improvement of the reference design.

General

It was agreed that our primary SDIP reference design is JCTVC-G558 + JCTVC-G754.

It was later discussed at plenary level whether SDIP should be in WD 5.

5.14.1.4 Intra prediction complexity reduction

A BoG on Intra prediction complexity reduction and filtering was created (coordinated by R. Joshi).

JCTVC-G145 Non-CE6: Reducing Line Buffers for intra mode [J. Lim, Y. Jeon, S. Park, B. Jeon (LG)]

JCTVC-G474 Non-CE6b: Crosscheck for LG's intra mode line buffer reduction in JCTVC-G145 [T.-D. Chuang, Y.-W. Huang (MediaTek)]

JCTVC-G447 Reduced number of intra 64x64 prediction mode [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]

JCTVC-G193 Cross-verification result of JCTVC-G447 on reduced number of intra 64x64 prediction mode [K.Kazui (Fujitsu)]

JCTVC-G449 Reduced number of intra chroma prediction mode [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]

JCTVC-G840 Cross-verification of Mitsubishi's reduced number of intra chroma prediction mode (JCTVC-G449) [T. Lee, J. Chen, J. H. Park (Samsung)]

JCTVC-G567 Simplified DC prediction [J. Lainema, K. Ugur (Nokia)]

JCTVC-G966 Non-CE6: Cross-verification of Nokia's proposal on Simplified DC prediction (JCTVC-G567) [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)] [late]

5.14.1.5 Intra prediction filtering

JCTVC-G139 Non-CE6.d: Intra Prediction With Selective Secondary Boundary [G. Van der Auwera, M. Karczewicz (Qualcomm)]

JCTVC-G960 Cross-check for JCTVC-G139 (Non-CE6.d: Intra Prediction With Selective Secondary Boundary) [J. Zhao, A. Segall (Sharp)] [late]

JCTVC-G373 Non-CE6: Performance of secondary boundary DC intra prediction [C. Auyeung (Sony)]

JCTVC-G861 Crosscheck results of JCTVC-G373 on the performance of secondary boundary DC intra prediction from Sony [X. Zhang, S. Liu (MediaTek)] [late]

JCTVC-G443 Improved directional intra prediction smoothing [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)]

JCTVC-G896 Cross verification of improved directional intra prediction smoothing (JCTVC-G443) [J. Lainema, K. Ugur (Nokia)] [late]

5.14.1.6 Angular intra prediction

(Also see notes for JCTVC-G119.)

JCTVC-G350 Modification of angular intra prediction [S. Matsuo, S. Takamura, Hirohisa Jozawa (NTT)]

This document introduces an angular intra prediction method exploiting interpolation technique whose tap length is more than 2. In the proposed method, reference samples for angular intra prediction are generated by either 4-tap DCT-IF or conventional 2-tap filter. The proposed intra prediction is applied to chrominance components as well as luminance component. Compared to the HM4.0 anchor, in the HE configuration, the overall average coding gains of Y, Cb and Cr were about 0.4%, 0.5% and 0.5%, respectively. Regarding LC configuration, those of Y, Cb and Cr were about 0.5%, 0.6% and 0.6%, respectively. The maximum coding gains of Y, Cb and Cr were about 1.9%, 1.8% and 2.2%, respectively, for the sequence "BasketballDrill" in LC case. The encoding and decoding run-times of the proposal were about the same as the anchor on average, respectively. Additional experimental results reportedly showed that the proposal provided about 0.1 to 0.4% coding gain on average for inter-frame coding.

This was proposed for small blocks because it is not as beneficial for large blocks.

Different filters were proposed for each position – for example, 16 filters of 4 taps each – with symmetry applied to produce 31 filters.

Due to concerns of complexity and design stability, interest was not expressed by non-proponents.

JCTVC-G348 Cross-check report of NTT's intra prediction approach (JCTVC-G350) [T. Yoshino, S. Naito (KDDI)]

JCTVC-G374 Improving the Intra Prediction Based on a Uniform Probability Model [L. Liu (HiSilicon and Huawei)]

The prediction values of intra prediction are calculated through the predefined angTable table in the HM. A performance decrease is observed when there are varied diagonal textures. This contribution presents a

proposed additional table based on a uniform probability model. It is proposed to select either the original and newly-proposed angTable value depending on the left and above intra prediction modes.

No benefit was shown for most sequences, but 0.9% benefit was shown for AI HE and 0.8% AI LC for BasketballDrill.

The proponent indicated that this method is just one potential solution for this issue, and other approaches might be possible. The purpose of the proposal was essentially to provide information to point out that the current table does not seem to fit the characteristics of all video sequences – perhaps because of the particular effective angles of the current table.

JCTVC-G762 Cross-check of JCTVC-G374 on improving Intra prediction [H. L. Tan, C. Yeo (I2R)]

JCTVC-G481 Cross verification of Huawei's intra prediction improvement based on a uniform probability model (JCTVC-G374) by Intel [Y. Chiu, L. Xu (Intel)] [late]

JCTVC-G738 On angular intra prediction main array extension [M. Coban (Qualcomm)]

This contribution presents a proposed simplification to the subsampling process of the main array extension scheme by using reduced-precision slope computation. The current design uses 12-bit precision slope tables to compute the subsampling positions given a block size and the prediction angle. Using 8-bit precision slope tables reportedly has negligible impact on coding efficiency. Simulation results reportedly show 0.00%, and 0.00% BD rate change for AI HE and AI LC cases, respectively.

It was remarked that the current tables are essentially an editorial convenience to provide an equivalent of a true division operation. The specification could just describe the process as a division instead of providing the tables. It was also remarked that, in some implementations, the operation would not be done as written and so it seems questionable whether the proposal provides any actual benefit to implementations. The proposed modification would make the operation become no longer equivalent to a true division. No action was taken. The editors are requested to study the subject and determine the best editorial approach to specifying this part of the design.

JCTVC-G882 Cross-verification report for 8-bit precision slope computation on angular prediction array extension (JCTVC-G738) [H. Aoki, K. Chono (NEC)] [late]

5.14.1.7 Padding

JCTVC-G791 Non-CE6: Simplified reference samples padding for intra prediction [T. Lee, J. Chen, J. H. Park (Samsung)]

This contribution removes two sides checking of unavailable pixels range in reference samples padding in HM4.0 to reduce the complexity. The unavailable pixels range are padded by the nearest available pixel in one fixed direction instead of adapting direction or averaging by the nearest available pixels. It is reported that no BD-rate loss is observed for all configurations (AI, RA, LB in HE, LC) with 1500-byte slice mode setting or/and constrained intra prediction setting.

Two methods were tested. An additional method was added in a later revision.

The quality of the affected part of the software was discussed.

It was asked whether any testing was done for increased intra refresh; this had not been tested.

Testing was done with and without constrained intra prediction.

It was commented that Method 2 is appealing (simpler than Method 1, and both have no loss).

See notes below regarding JCTVC-G812.

JCTVC-G120 Cross-verification of Samsung's proposal on padding process (JCTVC-G791) [Y. Lin, C. Lai (HiSilicon)] [late]

JCTVC-G812 AHG16: Padding process simplification [X. Wang, W. J. Chien, M. Karczewicz (Qualcomm)]

This contribution provides a single-pass padding scheme for generating reference samples used for intra prediction. With the proposed scheme, memory access is more regular and consistent than the current one in HM4.0. Simulation results reportedly show that with constrained intra prediction enabled and 1500 bytes/slice, its impact on coding performance with HE configurations is on average 0.00% for all intra, 0.04% for random access and 0.01% for low delay. For LC configurations, it is on average 0.00% for all intra, 0.06% for random access and 0.01% for low delay.

Average 0.07 benefit and chroma PSNR improvement reported in AI.

It was asked whether there might be any visual artifacts with this method or JCTVC-G791.

Suggestion: Choose based on max per-sequence degradation among all configs and 1500 byte slices between JCTVC-G812 Scheme A and JCTVC-G791 Method 2.

0.4% loss on CIP for one sequence in class E with 1500 bytes for JCTVC-G791 Method 2.

Decision: Adopt JCTVC-G812 Scheme A.

JCTVC-G916 AHG16: Crosscheck of JCTVC-G812 on Padding process simplification [X. Li, X. Guo (MediaTek)] [late]

JCTVC-G572 AHG16: Reference sample padding harmonization for intra DC mode [V. Wahadaniah, C. S. Lim (Panasonic)]

This contribution reports the HM-4.0 simulation results of a revised reference sample padding scheme for intra DC mode initially presented in JCTVC-F414. The revised padding scheme is reported to give average BD-rate gains of 0.1% for intra-only setting with 1500-byte slices and constrained intra prediction enabled. It is reported that encoding and decoding runtimes are not affected by the revised padding scheme. It was proposed that JCT-VC consider the trade-off between design simplicity and conceptual accuracy of intra DC prediction and subsequently decide whether a revised padding scheme for intra DC prediction is desirable.

It was remarked that although this proposal may provide some (small) benefit, the current scheme is a "cleaner" design that avoids undesirable interactions. No action was taken.

JCTVC-G897 AHG16: Cross-verification and additional results of reference sample padding harmonization for intra DC mode (JCTVC-G572) [K. Chono, H. Aoki (NEC)] [late]

5.14.2 Intra mode coding

Also see the JCTVC-G1017 BoG report (coordinated by V. Sze).

JCTVC-G109 On Intra Mode Mapping [X. Zhang, S. Liu, S. Lei (MediaTek)]

JCTVC-G148 Non-CE6: Cross-check of MediaTek's MPM mapping by LG (JCTVC-G109) [J. Lim, S. Park, B. Jeon (LG)]

JCTVC-G119 Modifications to Intra-frame coding [Y. Lin, H. Yang, L. Liu, J. Zheng, H. Yu (Huawei)]

The first part of this is related to predicting chroma using luma. This aspect was requested to be reviewed in chroma intra prediction BoG.

A second part is about how to code intra modes. This aspect was reviewed in the intra mode coding BoG.

A third aspect is to remove one mode and modify the prediction formed in another mode.

JCTVC-G117 Non-CE6: Cross-verification of Huawei's Modifications to intra frame coding (JCTVC-G119) [K. Chono, H. Aoki (NEC)]

JCTVC-G144 Non-CE6: on MPM mapping [J. Lim, S. Park, B. Jeon (LG)]

JCTVC-G473 CE6b: Crosscheck for LG's MPM mapping modification in JCTVC-G144 [T.-D. Chuang, Y.-W. Huang (MediaTek)]

JCTVC-G153 Non-CE6: On intra prediction mode coding [C. Yeo, H. L. Tan, Y. H. Tan, Z. Li (I2R)]

JCTVC-G106 Cross-Check for G153: On Intra Mode Coding [A. Saxena, F. Fernandes (Samsung)]

JCTVC-G254 Non-CE6b: Cross-check of JCTVC-G153 on MPM index bypass coding from I2R [E. François (Canon)]

JCTVC-G184 Non-CE6: Unified neighboring positions for intra mode coding [S. Fukushima, H. Nakamura (JVC Kenwood)]

JCTVC-G475 **Non-CE6b: Crosscheck for JVC KENWOOD's unified neighboring positions for intra mode coding in JCTVC-G184 [T.-D. Chuang, Y.-W. Huang (MediaTek)]**

JCTVC-G185 **Non-CE6: On intra chroma mode coding [T. Kumakura, S. Fukushima (JVC Kenwood)]**

JCTVC-G784 **Crosscheck on JCTVC-G185 Non-CE6: On intra chroma mode coding [W.-J. Chien]**

JCTVC-G488 **Non-CE6a : Cross check on use of chroma phase in LM mode (JCTVC-G245) [T. Guionnet, L. Guillo (INRIA)]**

JCTVC-G756 **Non-CE6: Crosscheck of Canon's improvement on LM mode (JCTVC-G245) [X. Zheng] [late]**

JCTVC-G359 **Non-CE6: Coding of luma intra prediction modes that are not in the MPM set [R. Cohen, X. Xu, A. Vetro, H. Sun (MERL)]**

JCTVC-G456 **Non-CE6: Cross check report of MERL's intra prediction mode coding (JCTVC-G359) [Atsuro Ichigaya (NHK)]**

JCTVC-G377 **Non-CE6: Cross-check report of proposal on coding of luma intra prediction modes that are not in the MPM set (JCTVC-G359) [Y. Shibahara, T. Nishi (Panasonic)]**

JCTVC-G418 **Simplification of intra prediction mode mapping method [J. Lee, S.-C. Lim, H. Y. Kim, J. S. Choi (ETRI)]**

JCTVC-G870 **Cross-check report of JCTVC-G418 [K Sato (Sony)] [late]**

JCTVC-G423 **Non-CE6: Remove potential duplicate modes from the candidate mode list for chroma intra prediction [H. Yang, J. Zhou, H. Yu (Huawei)]**

JCTVC-G408 **Non-CE6: Cross-check of Remove potential duplicate modes from the candidate mode list for chroma intra prediction (JCTVC-G423) [B. Li (USTC), J. Xu (Microsoft)]**

JCTVC-G707 **Using CABAC bypass mode for coding intra prediction mode [K. Misra, A. Segall (Sharp)]**

JCTVC-G767 **Non-CE1: Bypass coding of Intra prediction modes in CABAC [T. Lee, J. Chen, J. H. Park (Samsung)]**

JCTVC-G871 **Non-CE6: Crosscheck of Qualcomm's buffer reduction for CABAC context of SDIP syntax (JCTVC-G754) by HKUST [Xing Wen, Oscar Au, Xingyu Zhang] [late]**

5.15 Transforms

5.15.1 Core transform implementation (see also CE10)

JCTVC-G272 **Non-CE10: Core Transform Design for HEVC [J. Dong, Y. Ye (InterDigital)]**

This contribution presents a core transform design for HEVC, including 4×4, 8×8, 16×16 and 32×32 forward/inverse transforms. The proposed design has the following properties:

- 16 bit data representation before and after each transform stage (which the proponent contrasted with JCTVC-G737)
- Transforms can be implemented by full factorization, partial butterfly, or matrix multiplication (a property shared by JCTVC-G737 but not JCTVC-G495)
- 4×4 and 8×8 transforms are orthogonal (unlike in some other proposals such as JCTVC-G737 and JCTVC-G495), and 16×16 and 32×32 transforms are asserted to be nearly orthogonal
- N×N transform matrix is reused as the even part of the 2N×2N transform matrix (a property shared by the other major candidates)
- The norms of basis vectors are not equal, but are asserted to be sufficient similar to avoid frequency-specific scaling.

This design was integrated into HM4.0, using both full factorization and partial butterfly. It is reported full factorization for 32×32 transform achieves 6X reduction in the number of multiplications, compared with partial butterfly. The R-D performance was tested under the common test conditions specified in JCTVC-F900. The average BD-rate increase is 0.1% to 0.2% for all intra coding, 0.1% for random access coding, and 0.0% to 0.1% for low delay coding.

The number of shifts was not presented, and this would be important to know.

It was asked whether there are test results for such scenarios as low-QP and high-QP – such information was not yet available.

A small loss was observed in coding efficiency.

JCTVC-G386 Non-CE10: Cross Check Report for JCTVC-G272 Core Transform Design for HEVC. [X. Zhang, O. C. Au, X. Wen (HKUST)] [late]

JCTVC-G333 Accuracy improvement of HM's transform bases [Y. Sugito, A. Ichigaya, S. Sakaida (NHK)]

This contribution proposes 16x16 and 32x32 transform bases based on the transform proposed by Cisco and TI (JCTVC-G495). The bases are asserted to have near orthonormality. To derive transform bases, two options are used. Option 1 is the same as JCTVC-F193. Option 2 has a feature that the value range of elements is wider than Option 1 and waveform of basis is made consideration. Proposed bases are reported to have been verified according to CE10's coding efficiency of normal QP range and low QP range. The results for the common conditions QP range (QP=22, 27, 32, 37) reportedly show around 0% average bit rate impact for luma. Almost all of the results of sequences for the low QP range (QP=1, 5, 9, 13) reportedly show gains for luma; and the peak gain is about 1.3% without any reported process time increase.

Does not have full-factorization implementation approach (roughly like JCTVC-G495 in concept).

(Higher precision; probably increased operations or wordlength or less flexible implementation opportunities)

JCTVC-G625 Cross-check of JCTVC-G333, "Accuracy improvement of HM's transform bases" [A. Fuldseth (Cisco)] [late]

JCTVC-G496 Core transform design for HEVC with 7 bit coefficients [A. Fuldseth, G. Bjøntegaard (Cisco), M. Budagavi, V. Sze (TI)]

This contribution proposes a set of 7 bit transform matrices for HEVC, covering all transform sizes from 4x4 to 32x32. The proposed transform matrices were asserted to have the same properties as the 8 bit transform matrices currently used in the HM transforms. The transform matrices and the associated transform operations described in this contribution are proposed for the core transform design in HEVC. The proposed transform design was reported to have the following properties: 16 bit data representation before and after each transform stage (independent of the internal bit depth), 16 bit multipliers for all internal multiplications, no need for correction of different norms of basis vectors during quantization/dequantization, all transform sizes above 4x4 can reuse arithmetic operations for smaller transform sizes, and implementations using either pure matrix multiplication or a combination of matrix multiplication and butterfly structures are reportedly possible. BD-rate results vary between −0.1% and 0.2% for the average across all sequences and all classes for the low (−1, 5, 9, 13), “normal” (22, 27, 32, 37) and high (36, 42, 47, 51) QP ranges. The 7 bit transform matrices reportedly offers between 9% and 23% reduction in hardware costs when compared to the 8 bit versions currently used in HM.

The contribution indicated that this should be considered an information contribution, pending conclusion on CE10 work.

A participant commented that in addition to the average results, the worst case is interesting.

Another participant indicated that the RDO does not actually function properly for low QP. It would be highly desirable to fix these issues. However, others commented that although the RDO is flawed in this range, the results seem to tend to be consistent with expectations based on knowledge of transform tradeoff characteristics.

JCTVC-G335 Cross-check on 7 bit transform matrices (JCTVC-G496) [Y. Sugito, A. Ichigaya (NHK)]

JCTVC-G628 Comparison of core transform proposals [A. Fuldseth, G. Bjøntegaard (Cisco), M. Budagavi (TI)]

Notes elsewhere.

JCTVC-G782 AhG7: Overflow Prevention in HEVC inverse transform [E. Alshina, A. Alshin, J.H. Park (Samsung)]

This contribution proposes a modification for the HEVC inverse transform framework which reportedly allows preventing overflow of 16 bits in 3 temporal buffers by using no more than 2 clipping operations. Proposed modification guarantees all temporal buffers within 16 bits even for random input for inverse transform (non-confirmed bit streams). Performance test show no change under common test conditions due to proposed modification.

Additionally 32 bit overflow in intermediate calculation for JCTVC-F251 core transform is studied here. The same solution with no more than 2 clipping operations per pixel guarantees no 32 bits overflow in register for JCTVC-F251. Performance of JCTVC-F251 doesn't change due to proposed modification.

Additional test results for 12 bits internal bit-depth show noise level change of BD rate (0.00% in average) due to proposed change for both HM4.0 and JCTVC-F251 inverse transforms.

It was proposed to specify to clip after the dequantization and after the first stage of the inverse transform. The described clipping range might not be a power of two.

It was commented that, especially in software, a non-power-of-two clipping would be more complex than a power-of-two clipping range.

It was commented that with some transform designs, there would be cases where the input data cannot be represented through the transform with some clipping ranges. For example, DC values above 140 would become distorted when using the scheme proposed for JCTVC-G737 (and other cases exist).

The proponent indicated that the JCTVC-G737 transform coefficients for the FF variation could be down-shifted by 1 bit to prevent this. It was asserted that this would not substantially degrade the performance of the modified transform and would reduce gate count.

Decision: It was agreed to put signed 16 b range clipping as a "normative" result requirement at the output of the first inverse transform.

It was remarked that column-inverse-first is likely to work better than row-inverse-first.

JCTVC-G719 Structured Level Limits [L. Kerofsky, A. Segall, K. Misra (Sharp), E. Alshina, A. Alshin (Samsung)]

This contribution proposes limits on the quantization levels. These levels vary with QP parameter and transform size. It is asserted that these limits ensure the dequantized coefficient do not exceed 16-signed bits in dynamic range. A formula defines the limits from 6 basic values using the QP and transform size parameters used in dequantization. The limits are proposed for use in clipping decoded levels to the range specified by the limits and removing the clipping following dequantization It is additionally proposed to place a limit on the maximum absolute value of level independent of QP and block size.

It appeared that the proposed pre-dequant clipping would not function properly when quantization weighting matrices are used.

Decision: It was agreed that we should normatively forbid level values outside of some range. The precise range should be 16 b (for now).

Note: Does the QP range in HEVC change with bit depth as in AVC? Should it? This should be studied.

Question: Why impose as a decoder operation rather than requiring the encoder to obey a constraint?

It was suggested that clipping in the decoder is more robust; probably decoders would do this anyway, in order to cope with badly-designed encoders that don't obey the specified limits.

Decision: We should specify clipping of the output of the dequant (i.e., the input to the inverse transform) to a signed 16 b range.

JCTVC-G856 AHG7: IDCT output range after T+Q+IQ+IT with valid residual inputs [M. Zhou (TI)]

Describes IDCT output range with "reasonable" quantization – 5 bits expansion for valid input.

JCTVC-G497 SIMD optimization of proposed HEVC core transforms [A. Fuldseth, L. P. Endresen, S. Selnes (Cisco), V. Arbatov, F. Franchetti (SpiralGen), M. Puschel (ETH Zurich)]

Effectively covered in CE 10 report.

JCTVC-G811 Crosscheck of JCTVC-G497 on SIMD optimization of core transforms [C. Auyeung (Sony)] [late]

JCTVC-G601 Cross verification of SIMD-optimized partial butterfly HM (JCTVC-G495) transforms [D. Flynn (BBC)] [late] [upload 2011-11-24 10:40:36]

Reports some SIMD analysis on Intel SSE2 (reportedly 2nd most common architecture), saying that PB approach was significantly faster for SIMD than other implementations and is identical for JCTVC-G495 and JCTVC-G737. The FF approach was reported as having characteristics that were unfriendly in several ways (e.g. ordering/shuffling and dependency chain effects preventing effective use of pipelining).

JCTVC-G132 Hardware analysis of transform and quantization [M. Budagavi (TI), V. Sze (TI), M. Sadafale]

Effectively covered in CE 10 report. Describes concept behind assertion of sharing of all multipliers and some adders between encoder and decoder, involving transform matrix symmetry.

JCTVC-G495 has this property, and in JCTVC-G628 it was asserted that JCTVC-G737 does not.

It was asserted by the proponent of JCTVC-G737 that a (somewhat different) form of sharing of multipliers was possible with the FF form of that transform.

Describes two hardware implementations based hard-wired and SIMD architecture (e.g. useful for multi-standard processors) and asserts that the JCTVC-G495 design is better for this.

The specifics of these implementations were not released for the hand-optimized designs of either JCTVC-G495 or JCTVC-G737.

JCTVC-G263 Hardware complexity analysis of spatial transform [X. Tian (Altera)]

Effectively covered in CE 10 report.

JCTVC-G265 Core Transform Property for Practical Throughput Hardware Design [M. Tikekar, C.-T. Huang, C. Juvekar, A. Chandrakasan (MIT)]

Summarized as follows:

- Implemented all transform sizes (and DST and non-square and control logic) for JCTVC-G495
- Emphasizes number of unique coefficients, for which a substantial decrease (25%) of complexity for JCTVC-G495 implementation was achievable by taking advantage of this property. (The proponent of JCTVC-G737 asserted that this could apply also to that proposal.)
- Throughput of 2 samples per cycle at 200 MHz (which would be enough for 30 fps 4kx2k). It was remarked that the CE10 plan requested input for a range of frequencies 150–500 MHz with up to 32 samples.

JCTVC-G857 SIMD Analysis of Some Core Spatial Transforms [S. Riabtsev (CSR)] [late] [uploaded 2011-11-24 15:41:16]

Some of the results in this had been made available in the CE 10 report prior to availability.

The contribution reports that both JCTVC-G737 and JCTVC-G495 can be implemented in real time and comments that the FF form of JCTVC-G737 is the preferred form for hardware.

JCTVC-G990 Cross check of inverse transfom complexity reported in JCTVC-G757 [A. Fuldseth (Cisco)] [late]

Effectively covered in CE 10 report.

JCTVC-G865 New Results for Guaranteeing 16-bit Transform Dynamic Range [K. Misra, L. Kerofsky, A. Segall (Sharp)] [late]

Requests action already taken as recorded above for JCTVC-G782 and JCTVC-G719 in regard to decoder clipping after dequant and after the first stage inverse transform (16 b clip in each place).

JCTVC-G977 Non-CE10: new 8-bits core spatial transform with fast algorithm [Hongbo Zhu] [late]

Not presented (and late) – the presenter was unavailable when presentation was requested. It may be studied as information.

Conclusions

Since JCTVC-G495 and JCTVC-G737 are the only candidate technologies that have been well-studied, other new proposals would not be appropriate for a decision at this meeting.

Both JCTVC-G495 and JCTVC-G737 seem like essentially good candidate designs.

Some submitted non-proponent analysis may indicate some preference for JCTVC-G737 in hardware (although another non-proponent indicated that their internal analysis had led to a different conclusion). No significant difference was observed between the two for software SIMD architecture.

JCTVC-G737 seems to need some modification as a bug fix, which would involve some loss of precision.

Given that scenario and the desire to try to close the topic and move on, the consensus was to select JCTVC-G495.

Decision: Adopted JCTVC-G495.

5.15.2 Alternative transforms

See also the relevant CE report.

JCTVC-G281 Non-CE7: Boundary Dependent Transform for Inter Predicted Residue [J. An, X. Zhao, X. Guo, S. Lei (MediaTek)]

An alternative transform for inter, with 0.2% benefit for RA and 0.5% for LD. For further study (along with JCTVC-G632).

JCTVC-G631 Cross-Check of JCTVC-G281: Boundary Dependent Transform for Inter Predicted Residue [A. Saxena, F. Fernandes (Samsung)] [late]

JCTVC-G632 Non CE 7: On secondary transforms for inter prediction residual [A. Saxena, F. Fernandes (Samsung)]

Supplements the JCTVC-G281 concept, only tested with length 4 and 8, with gain of 0.4% relative to HM for LD LC. For further study along with JCTVC-G281.

JCTVC-G282 Non-CE7: Mode Dependent DCT/DST for Chroma [X. Zhao, X. Guo, M. Guo, S. Lei (MediaTek), S. Ma, W. Gao (PKU)]

Application of DST to chroma, with 0.5% benefit for U and V components. JCTVC-G107 tested several cases, and this is one of them.

JCTVC-G879 Cross-Check of JCTVC-G282 [A. Saxena, F. Fernandes] [late]

JCTVC-G345 Non-CE7: Restricted mode-dependent 8x8 DST for Intra prediction [A. Ichigaya, Y. Sugito, S. Sakaida, (NHK)]

Introduces MDST 8x8 with restriction of combination of PU and TU size. Overall benefit (relative to HM anchor) is small (0.2%), but Class A showed more gain (0.6%).

JCTVC-G630 Cross Check of JCTVC-G345: Restricted Mode-Dependent 8x8 DST for Intra prediction [A. Saxena, F. Fernandes (Samsung)] [late]

JCTVC-G817 Non-CE7: Cross verification of JCTVC-G345, Restricted mode-dependent 8x8 DST for Intra prediction [R. Cohen (MERL)]

JCTVC-G591 Non-CE 7: Supplementary Results for the Rotational Transform [Zhan Ma, Felix Fernandes, Elena Alshina, Alexander Alshin (Samsung)]

Describes a fast search for use of the syntax-signal ROT, provide 0.5% rate benefit at 10% encoder time increase. (Without the fast search, the rate benefit is 0.9% at 29% encoder time increase.)

JCTVC-G735 Non-CE 7: Crosscheck of JCTVC-G597 Supplemental ROT Results [P. Topiwala (FastVDO)] [late]

JCTVC-G629 Non CE 7: Harmonization of SDIP and Mode-Dependent Secondary Transforms [A. Saxena (Samsung), Y. Shibahara (Panasonic), F. Fernandes (Samsung), T Nishi (Panasonic)]

Applies 8x8 MDST (non-signalled type selection, 0.7%) to SDIP non-square blocks. Shows that gain of MDST is additive to SDIP (0.8% additive gain on top of 1.3% SDIP gain). This supplements the information collected in CE 7. This indicates that these two features work properly in combination.

JCTVC-G937 Cross-check of JCTVC-G629: Harmonization of SDIP and Mode-Dependent Secondary Transforms [H. Yang (Huawei), C. Lai (Hisilicon)] [late]

5.16 IBDI and memory compression

JCTVC-G328 AHG8: Bit depth of output pictures [Y. Chen, Y. -K. Wang, X. Wang, I. S. Chong, M. Karczewicz (Qualcomm)]

(Track B.) Skepticism was expressed regarding this as a normative output definition behaviour. For further study.

JCTVC-G430 An experimental comparison of memory bandwidth between 8-bit and 10-bit coding [T. Chujoh (Toshiba), K. Chono (NEC)]

(Track A.) An experimental comparison between 8-bit and 10-bit coding is reported. Although the coding efficiency of 10-bit coding has been discussed at previous several meetings, the quantitative discussion of memory bandwidth has not been sufficient. By using the measurement module of memory bandwidth that has been developed by AHG8 of reference memory compression and has been distributed to CE3 of motion compensation, the numerical result of memory bandwidth is shown. As experimental results, the memory bandwidth increase of 10-bit coding compared to 8-bit coding is an average of 37% and a maximum of 47%. Since the reductions of memory bandwidth have been discussed in AHG8 and CE3, those discussions should be considered.

It was considered valuable to have quantification of the necessary memory bandwidth for the N-bit case.

Refers to plenary discussion on HM settings.

5.17 Complexity assessment

JCTVC-G095 Virtual motion compensation memory bandwidth verifier (VMBV) [M. Zhou (TI)]

This contribution proposes an virtual motion compensation memory bandwidth verifier (VMBV) aimed to lower the worst case motion compensation memory bandwidth requirements without harming coding efficiency or imposing significant burden on the encoder side. The proposed VMBV advocates: 1) to define virtual maximum memory access bandwidth rate for profile & levels, say Rmax, measured in unit of bytes per second; 2) to specify a virtual memory access bandwidth measurement tool which quantifies the memory access bandwidth consumed by a decoded frame, say d_n, measured in bytes; and 3) to impose the VMBV conformance on bitstreams: for any frame the consumed memory access bandwidth d_n shall be less than or equal to $R^* \Delta t_n$, where R ($R \leq Rmax$) is the virtual memory access bandwidth rate signaled in sequence parameter set, and Δt_n is time used for decoding the frame. It is recommended to conduct the further study on this topic to specify the proper VMBV memory bandwidth measurement tool, and to implement the VMBV constraint in the encoder motion estimation to investigate the practicality of the proposed VMBV model.

The idea behind this is "Forbidding too evil bitstreams" – e.g. random change of motion in neighboring CUs that would impose increase in memory bandwidth

It seems difficult to specify maximum memory bandwidth such as maximum bitrate. A problem is how to measure the memory bandwidth, as it is architecture dependent.

Other possibilities: Restrict PU block size, restrict deviations of MVs.

Further study (in the AHG on memory bandwidth issues).

JCTVC-G262 HM decoder complexity assessment on ARM [T. Anselmo, D. Alfonso (STM)]

This contribution presents the results of an assessment of the HM 4.0 decoder complexity on ARM architecture, in particular a Dual Cortex A9 CPU integrated in the ST-Ericsson Nova™ A9500 application processor. (based on current reference software)

E.g. in RAHE interpolation 26%, ALF 15%, SA 4%, transform 1%. (MD5 8% which should be disabled at the decoder)

The results reportedly show that the current complexity ratio between HE and LC configuration on ARM is on average 1.218, with minimum and maximum values 1.075 and 1.409 respectively.

JCTVC-G757 On software complexity [F. Bossen (Docomo Innovations)]

Complexity is a complicated topic. While the commonly-used run-time measurements obtained with the HM software may be indicative of complexity, they often remain a poor proxy of actual complexity. A software decoder was thus written from scratch with the goal of achieving real-time decoding on x86 and ARM devices, and thereby provide better estimations of run times in real-world environments. This contribution provided information regarding which tools significantly contribute to decoding time and also suggested some modifications to the draft HEVC specification.

The described decoder takes advantage of SIMD technology to improve decoding times (MMX/SSE on x86, and NEON on ARM). In its current state the following decoding rates are reportedly achieved:

- 1920x1080@50fps on a single core of a Core i5 processor (Arrandale) clocked at 2.53GHz
- 832x480@30fps on a single core of a Cortex A9 processor clocked at 1GHz

No support for ALF and NSQT was implemented.

MC and intra prediction, on both platforms, consumed roughly half of the processing time.

JCTVC-G988 HEVC software player demonstration on mobile devices [K. McCann, J. Choi, J. H. Park (Samsung)] [late]

Real-time decoding is the key feature for most applications. This document describes an HEVC software decoder running on commercial devices such as mobile phones and x86. The software decoder is implemented based on Samsung's commercial media player framework, which is already loaded on various PC and mobile devices. This HEVC software decoder on mobile devices, together with a file container and android media player, is reported to be capable of running on current commercial devices (the Galaxy Note and Galaxy S made by Samsung). The results were indicated to be broadly consistent with the complexity and profiling measurement using a low complexity decoder that is reported in JCTVC-G757, providing confidence that the current HEVC design using CABAC could be commercially implemented at an early date.

5.18 Encoder optimization

JCTVC-G156 CU Depth Pruning for Fast Coding Tree Block Decision [H. L. Tan, C. Yeo, Y. H. Tan (I2R)]

This contribution presents a CU Depth Pruning algorithm for fast coding tree block (CTB) decision. The proposed method attempts to terminate the CTB decision process by performing a one-level look-ahead for the last sub-CU where possible. It is reported that the proposed method reduces encoding time by about 8% with 0.1% Luma BD-Rate coding loss for the Random Access and Low Delay configurations.

It was remarked that we have a paramter "ECU" in the software that is also an encoding optimization trick.

It was remarked that this may introduce some sort of assymmetry in the search. The patch is in the contribution, which is available for further study.

JCTVC-G401 RDO with weighted distortion in HEVC [B. Li (USTC), G. J. Sullivan, J. Xu (Microsoft)]

For analysis of coding performance, situations are sometimes encountered where the rate-distortion behaviour is substantially different between the luma and chroma components. One approach that has recently been suggested for overall compression effect evaluation is to use a combined PSNR metric – e.g. $PSNRAVG_{YUV} = (6 * PSNRAVG_Y + PSNRAVG_U + PSNRAVG_V) /8$, as suggested at the Daegu meeting (and probably also previously) and as used in JCTVC-F386. This contribution suggested to consider this approach to be a useful step forward. However, it also advocated caution when considering experiments for which the chroma BD results are changing much more significantly and in the opposite direction with respect to the luma results – especially when chroma improves and luma degrades. Indeed, it is reported that bit allocation effects alone can cause apparent coding gain. To illustrate this issue, the contribution reports the results of some preliminary experiments in which the use of a weighting in the R-D mode decision criterion can reportedly result in significant apparent combined BD coding gain (0.8% in the HE LD case) when the luma BD fidelity is degrading (by 1.4%) and the chroma BD fidelity is improving (by about 11%). Furthermore, the chroma QP can be changed by the syntax element of chroma_qp_index_offset (although this syntax element is reported to be missing currently from the draft and HM software). According to the reported experimental results, if the chroma QP value is decreased by 3, up to 5.5% combined BD-Rate gain can reportedly be obtained for HE LD case. If the chroma QP is further decreased, more measured gain in terms of the combined BD-Rate measure may also be obtained.

Considers the metric of a weighted averaging (6+1+1)/8 of luma and chroma PSNR measurements. It is suggested that this metric changes less dramatically than single PSNR values when bits are shifted between luma and chroma. (Typically using more bits in chroma results in an apparent overall benefit, as chroma is easier to code).

Two types of tests were reported:

- Changing the weighting in the R-D optimization
- Changing the QP for the chroma

It was noted that JCTVC-G005 supports the inclusion of chroma step size control in HEVC (which we may assume is already intended to be inherited from AVC into HEVC).

It was noted that the ratio of chroma gain to luma loss is not always a constant.

Alternative ways of measuring overall fidelity were discussed. One was to combine the luma and chroma MSEs before converting to the PSNR domain.

As averaging PSNR means using a geometric mean, it was asked whether it would be better to use weighted MSE instead (such as RDO over different channels is doing). I.e. practically measuring PSNR based on Euclidean distance in YCbCr.

It was suggested to perform further study in an AHG on how to obtain an improved objective metric evaluation methodology.

JCTVC-G543 Early skip detection for HEVC [Jungyoup Yang, Jaehwan Kim, Kwanghyun Won, Hoyoung Lee, Byeungwoo Jeon (SKKU)]

In this contribution, an early detection of the "skip" mode is proposed to reduce the encoding complexity of HEVC. The proposed method is in the same spirit as the early skip detection scheme implemented in MPEG-4 Part 10 AVC/H.264 reference SW, but was slightly modified to address the different encoding scheme of HEVC. It was reported that the proposed method reduces the encoding time by about 33% with BD-bit rate loss of 0.45% compared to an HM4.0 encoder.

Previously, a fast mode decision JCTVC-F092 was previously adopted. That can be combined with this proposal. When combined together, the combination sped up the encoder by about a factor of two.

The modification was asserted to be less than 10 lines of code and to be feasible to be implemented in a switchable fashion. Decision (SW): Adopted (not high priority).

JCTVC-G573 Cross-check of Early skip detection for HEVC with Early CU Termination (JCTVC-G543, JCTVC-F092) [S. Lee, S. Cho, S. Park, N. Eum (ETRI)] [late]

JCTVC-G794 Cross-check of Early skip detection for HEVC (JCTVC-G543) [Kiho Choi, Sang-hyo Park, Euee S. Jang] [late]

JCTVC-G589 Encoder optimization: Reduced number of reference pictures for RA [P. Wennersten, R. Sjöberg, J. Samuelsson (Ericsson)]

This contribution consists of an alternative GOP structure for random access coding. Compared to the GOP structure currently in use for the random access JCT-VC common conditions test case, it requires fewer pictures to be kept in the decoded picture buffer. Only the encoder configuration is changed, and the average luma BD-rate result is reportedly −0.2% for random access high efficiency and −0.3% for random access low complexity. Calculating YUV BD-rate as (6*Y+U+V)/8, the change is −0.2% for RA HE and −0.4% for RA LC.

The AHG21 source code was used. Based on AHG21 software (otherwise, in HM software, the structure is hard coded).

In spirit, we would like to use this. However, the current implementation is tangled up with AHG21 work.

Comments: The suggested structure is similar to JM and KTA. It may also improve the latency.

Conclusion: Agreed that this is desirable, but it depends on the result of AHG21 related BoG. Not high priority in implementation.

It was suggested to discuss this again after AHG21 was resolved. Also see JCTVC-G157.

This topic was discussed again on Nov. 29. Decision (SW): Adopt and include in HM5 and common test conditions.

JCTVC-G687 Fast fractional motion search with adaptive searching point reduction [Wan-Chi Siu (HKPU), Yan-Ho Kam (HKPU), Wai-Lam Hui (HKPU), Yui-Lam Chan (HKPU), Yu Liu (ASTRI), Jenny Yan Huo (ASTRI)]

This contribution proposes an additional option of the approach of performing fractional motion search, aiming at reducing the computational complexity of the encoder of the current HEVC reference model. According to the simulation results, the proposed technique reportedly achieves 6% reduction in computational complexity with a 0.44% loss in luma BD-rate.

Half pixel search is applied with horizontal/vertical neighbors in the first step.

The change would require (probably a lot) “more than 10 lines of code”.

Not to be included.

It was commented that the speed-up is not so large, and we have other work to focus on. It may be nice to use in practice, but we do not consider it a sufficiently high priority to put this in our software at this time.

5.19 Withdrawn

JCTVC-G114 [withdrawn]

JCTVC-G160 [withdrawn]

JCTVC-G177 [withdrawn]

JCTVC-G356 [withdrawn]

JCTVC-G368 [withdrawn]

JCTVC-G538 [withdrawn]

JCTVC-G562 [withdrawn]

JCTVC-G594 [withdrawn]

JCTVC-G595 [withdrawn]

JCTVC-G602 [withdrawn]

JCTVC-G670 [withdrawn]

JCTVC-G701 [withdrawn]

JCTVC-G866 [withdrawn]

JCTVC-G903 [withdrawn]

JCTVC-G921 [withdrawn]

JCTVC-G964 [withdrawn]

JCTVC-G969 [withdrawn]

5.20 Not presented due to late arrival or lack of availability

JCTVC-G1043 20 years after MPEG-2 [J. Song] [late]

6 Plenary Discussions and BoG Reports

6.1 Project development

JCTVC-G061 HEVC issues (comments from USNB of WG11) [A. G. Tescher for USNB of WG11]

The USNB of WG 11 commented as follows:

- The USNB requests HEVC-based stereoscopic view scalability should be included in the first phase of HEVC scalability extension development. This work should take into account the relevant responses to the 3DV CfP and should be conducted by JCT-VC.
- Regarding the timeline for general HEVC scalability extension, the USNB suggests issuing a preliminary CfP in May 2012, and a final CfP in July 2012, with submissions prior to the October 2012 meeting of WG11.
- The USNB requests that the scope of the CfP on HEVC scalability extension includes HEVC enhancement with an AVC base layer.

- The USNB requests that the HEVC design be studied to determine whether there is adequate justification for retaining multiple entropy coding methods. Absent such justification, only one entropy coding method should be included in HEVC at the CD stage.
- The USNB welcomes the plan to conduct a subjective test of HEVC relative to AVC High profile to assess their relative coding performance. We suggest that the RA-HE and LB-HE configurations of HEVC be used for this test, configured for 8 bit-per-sample decoding precision. We suggest that if scheduling constraints require it, HM 4 rather than HM 5 be used for this testing.

Some aspects relevant to current phase of work were discussed as follows;

- regarding the entropy coding, affirmative
- regarding the plan to do a test, affirmative
- regarding the 8 b per sample in the test, affirmative
- regarding the RA HE and LB HE, affirmative
- regarding the HM 4 rather than HM 5 if necessary, affirmative (whichever works out)

Results of the test are planned to be available by the San Jose meeting.

JCTVC-G096 Items to be clarified in HEVC design [M. Zhou (TI), W. Wan (Broadcom), T. Suzuki (Sony), A. Tabatabai (Sony)]

Items to be clarified:

Max and min LCU size: the contribution recommended max LCU = 64x64, min LCU = 16x16. To be further discussed in AHG8 on profiles and levels.

Comment: LCU sizes beyond that range may currently not be properly supported in SW.

Comment: There may be no benefit in supporting LCU sizes larger than 64x64.

Comment: Should also consider limit on SCU.

Min slice granularity: the contribution recommended min slice granularity of 16x16 (luma). This should already be in the WD; to be checked. An additional limit may be imposed by level. Further discuss this in an AHG.

Max number of references frames: the contribution recommended to stick with AVC limits for frame pictures (16). We agreed to keep this limit in the WD, although this may be further discussed.

4x4 inter prediction support: the contribution recommended to not include it in initial profiles. Question: what is the coding efficiency impact, in particular at high bit rates? Question: can we consider this just a profile or level issue? We agreed to keep it in the specification. Inclusion in given profile is to be discussed in later work.

Regarding chroma deblocking: a mismatch between text (edges of size 4) and SW (edges of size 8) was noted. It was agreed that the intent was to align the text with the SW (edges of size 8). The group agreed that the intent is to filter chroma edges of size 8. Deblocking experts were requested to review deblocking-related text in general with WD editors.

JCTVC-G507 Syntax Issues [K. Sato (Sony)]

3 items were included in this contribution:

The relationship between log2_min_coding_block_size_minus3 and inter_4x4_enaled_flag in SPS

Inter_4x4_enabled_flag may be redundant in SPS under certain conditions. Suggestion to make coding of this flag conditional. Decision: Agreed.

The relationship between slice granularity and max_cu_qp_delta_depth in PPS:

Comment: max_cu_qp_delta_depth, pic_init_qp_minus26, and slice_qp_delta not [properly] implemented in software. This should be fixed. Chono-san volunteered.

Comment: Software is reported to not work if slice granularity is larger than delta qp granularity. For example when slices have 16x16 granularity and delta qp has 32x32 granularity.

Decision: Adopt solution A: the value of log2MinCUDQPSize shall be smaller than or equal to the CU size specified by the value of slice granularity.

Tile boundary processing was already discussed as part of JCTVC-G194 review.

JCTVC-G661 Parallel partition Profile & Level limits [Chad Fogg, Aaron Wells]

This contribution describes the need to define limits related to slices, entropy slices, tiles and wavefronts.

To be further discussed in AHG8.

JCTVC-G729 Proposal to start the discussion on HEVC profile/level [T. Suzuki (Sony)]

This contribution requested establishing an AHG to discuss profiles and levels. This was done.

It was suggested that we should “clean up” the level definitions from AVC instead of blindly copying it.

It was requested to thoroughly test profiles in their definition process (e.g., 4:2:2 10 bit).

JCTVC-G914 UKNB Comment on HEVC Extensions [UKNB of WG11] [late]

Not presented.

JCTVC-G1019 Samsung’s comments on HEVC Extension [K. McCann, C. Kim, B. Choi, J. H. Park] [late]

Not presented.

JCTVC-G1004 Proposed text for some features not yet integrated into JCTVC-F803 [M Horowitz (eBrisk)] [late]

Updated version of JCTVC-F803. This text will be incorporated into the next WD version released by editors.

JCTVC-G1000 Suggested revised common test conditions [F. Bossen] [late]

A discussion of this was held in preparation of establishing common test conditions (on the 2nd Wed).

Aspects discussed:

- Separating out class A 8 bit and 10 bit – agreed.
- Within class A, using 8 bit rounded version of 10 bit sequences – perhaps not.
- Including class F in overall averages? This is not to be included in overall averages, but class F is required to be reported separately.
- The JCTVC-G382 non-normative quantization feature is *disabled* in these configs.

It was strongly suggested that having a good (but not overly complex) rate control algorithm for the HM would be highly beneficial. This was agreed.

It was suggested to provide flags in the SPS to disable the features are currently switchable only using a #define, and for this to be a "software-only" feature. Decision (SW): Agreed.

6.2 BoGs

JCTVC-G1002 BoG report on reference picture buffering and list construction [J. Boyce, R. Sjoberg, Y.-K. Wang]

The BoG recommended adoption of the AHG21 working draft text modification, in JCTVC-G021. It was also recommended to have an AHG until the next meeting, and that contributions to next meeting be based upon the editors' WD version which includes the JCTVC-G021 modifications.

The BoG requested to meet again during this meeting to define test conditions with various picture coding structure patterns for evaluation of long term reference picture contributions, and for bit rate savings based contribution, based on a draft test conditions document prepared by Miska Hannuksela and circulated on the reflector by Saturday.

The BoG also recommended to further discuss contribution JCTVC-G198 with a larger group (this was later done in Track A).

Several contributions initially assigned to this BoG were considered to not be within its scope, so it is recommended that they be re-assigned: JCTVC-G717, JCTVC-G635, JCTVC-G157, and JCTVC-G549. Additionally, the BoG proposed postponing consideration of JCTVC-G715 until after the AHG18 discussion.

Questions and comments:

- Are long-term reference pictures (LTRP) supported?
    - Long-term pictures, in AVC, affect weighted prediction, temporal MV scaling, default list construction, list modification, sliding window, and explicit reference picture MMCO.
    - It was remarked that for high-level syntax and functionalities such as the above, although some things aren't reflected yet in the working draft, such aspects are understood to be generally inherited from AVC.
    - It was reported that the intention of the BoG was to intend to have LTRPs in the design, but that there was not yet a good understanding of how specifically to best support them. It was agreed that LTRPs should be supported in the (final) design.
    - It was suggested to adopt an intermediate interim draft shared within the AHG that included some form of LTRP.
- Some doubt was expressed regarding whether the reference picture set (RPS) proposed approach has been sufficiently well-studied, has sufficient merit, and is sufficiently mature.
    - It was noted that the RPS approach had been the subject of active AHG discussion.
    - Several participants expressed support for the proposal, in terms of loss resilience, design simplification, and temporal scalability handling.

The BoG was requested to find a way to address the LTRP support topic as part of its activities.

The BoG reported back after Nov 24 BoG meeting. (The following discussion was chaired by J. Boyce.) The BoG recommended adding the JCTVC-G788 proposal #7a long term reference picture solution to the JCTVC-G021 WD text. The revised JCTVC-G1002 document upload included revised draft text.

Some discussion was held about POC wrap handling for the JCTVC-G788. The JCTVC-G1002 draft was conservative about incorporating changes.

Several participants expressed support for the JCTVC-G1002 draft. After some more time was given to allow some participants to review the draft text, this was agreed to be adopted.

Decision: Adopt JCTVC-G021 as modified by JCTVC-G1002-v3, plus a bug fix of a sign error and some clarifications to be provided as -v4.

It was noted that this design does not support marking the current picture as an LTRP. This provides less flexibility than the AVC design and should be studied and potentially changed in the future.

An updated version of BoG report was discussed Nov. 29:

Suggested reference conditions were described in JCTVC-G1036 for alternate coding structures. To be further refined in AHG21.

Recommend to use it for proposals related to reference picture list construction and marking.

Recommendation to adopt additional restriction related to CRA pictures. Working draft text attached to BoG report. Restriction is already present in software developed by prior AHG21.

Decision: Adopt.

JCTVC-G1005 BoG report on review of non-CE deblocking filter proposals A. Norkin

This contribution summarizes activities of the break out group (BoG) on review of non-CE deblocking filter related proposals.

The proposals are sorted into categories (although some proposals can belong to more than 1 category).

1. Parallel deblocking

2. Modifications to deblocking filter description

3. Modifications to Bs calculation process

4. Line buffer reduction

5. Deblocking filter simplifications

6. Signaling deblocking filter parameters in slice header

7. Varying QP deblocking and deblocking for IPCM blocks

See under 5.5.1.

JCTVC-G1006 BoG report on Non-CE MV Coding Proposals [B. Bross, J. Jung, S. Oudin]

See under 5.8.1.

JCTVC-G1017 BoG report on intra mode [V. Sze]

The mandate of this break out group was to look into the details of JCTVC-G243, analyse "evaluate text, implementation complexity, destabilization, and amount of gain". Take note of any non-CE proposals which may be related to this contribution. Only contributions relating exclusively to entropy coding of intra mode were discussed; contributions which affected pixel values (e.g. JCTVC-G358 and part of JCTVC-G119) were not discussed. A BoG meeting session was held from 5pm–7pm on November 25, 2011.

Tools	Changes/Complexity	Coding Gains*	Alternative Tools		
			JCTVC-G153 −0.2Y	JCTVC-G359 −0.3Y	JCTVC-G423 0.2U/0.3V
+2 MPRM	-Compute four additional MPRM via LUT or operations & comparison for angle conversion -Additional 3(?) comparisons to select 2 MPRM -Additional bin (mprm_idx)	−0.3 (Y)	X**	X***	

Remainder coding with mode ranking	-variable registers that need to be updated for rank -rank mapped to exp-golomb rather than FLC -bypass coding of mprm_idx and remainder	−0.2 (Y)	X	X	
Chroma mode coding	- replace ver/hor/DC with luma+/−1 and perp (computed with LUT or operations & comparison for angle conversion)	−0.3 (U) −0.4 (V)			X
additional 19th mode Intra_4x4	Additional mode.	N/A	X	X	

* = estimated from Appendix B

** = treats first remaining mode as MPM; additional bin

*** = no additional MPM, but requires angle conversion

X = denotes that proposal provides an alternative to tool in JCTVC-G243.

Further CE work should be focused on cleanup/simplification, and forget about one or two tenths of a percent in coding gain.

Annex A contains a review of intra mode coding proposals (blue = exactly the same, yellow = basically the same as each other). Section 4.1 identifies overlapping ideas.

JCTVC-G145 proposes LCU boundary line buffer compression (0.0) or elimination (0.1 loss)

Decision: Eliminate the line buffer as proposed in JCTVC-G145

JCTVC-G184 proposes to change neighbors for consistency with how inter works

No action.

JCTVC-G423 on chroma coding

For further study

JCTVC-G707 = JCTVC-G767 (part of JCTVC-G153), increased us of bypass coding

Decision: Adopt JCTVC-G707 = JCTVC-G767.

Remark: Right now the bins for the remainder are coded starting from the LSB; let's start from the MSB. (Considering that it is coded in bypass mode, no effect on perf.) Decision: Agreed.

JCTVC-G418 & JCTVC-G109 & JCTVC-G144 (part of JCTVC-G119), simplifying the case when neighbour PU size differs

Decision: Adopted.

Additional further aspect of JCTVC-G119 to default to planar if neighbours not intra or unavailable

Question: Does it affect non-intra coding efficiency? Probably not – and verbally reported (by a non-proponent) not to (or to actually provide a little gain).

Decision: Adopted (part 2 of JCTVC-G119 as described above).

Suggestion: Note that currently at 64x64 level, only 4 modes are available, making the parsing different than at lower sizes, and the prediction actually operates at the 32x32 level, so there is no real benefit for the restriction (aside from trivial overhead reduction).

Decision: Agreed to support all 32x32 modes to be signalled at the 64x64 level.

This closed all of intra mode coding (in regard to contribs that only affect the coding of the modes, not the values of the samples).

JCTVC-G1016 BoG report on APS matters [S. Wenger]

A break-out group meeting was held Saturday, Nov. 26 2011 from 8:00 through 10:10. Approximately 20 delegates were present. The BoG reviewed and summarized input documents JCTVC-G122, JCTVC-G220, JCTVC-G295, JCTVC-G330, JCTVC-G332, JCTVC-G566, JCTVC-G658, and discussed related issues.

Based on contributions JCTVC-G122 and JCTVC-G220, the BoG recommended removing CABAC usage from the APS. The removal of any byte alignment syntax elements in the APS was also recommended, as they did not appear to be needed anymore. WD text is included in JCTVC-G122.

Decision: Adopted (adjusted as necessary to remove remaining byte alignment syntax and to include an extension flag and a while loop of extra data bits and RBSP trailing bits – as necessary in all three parameter sets).

The BoG further recommended to henceforth not include any CABAC coded syntax elements "above" the slice header (inclusive).

In further discussion in JCT-VC (Track B) this was agreed to be the plan (unless some exceptional justification arrives for something in the future) because header-level parsing may often be performed by software on low-capability processors.

The BoG reported that we have an issue that may be referred to as "partial update", that was asserted to need to be addressed at some point in time. "Partial update" refers to the idea that from one picture to another picture, parts of the information carried in APS would be able to change without transmission of a full APS carrying both the changed and unchanged information. There are two very similar proposals addressing this issue at this meeting (JCTVC-G295 and JCTVC-G332), both of which rely on multiple APS references in the slice header. The proponents of JCTVC-G295 and JCTVC-G332 agreed to prepare a combined proposal for consideration by JCT-VC. It was also remarked that document E309 addresses the same problem in a different way, avoiding multiple references to parameter sets in the slice header. It was further remarked that a solution according to JCTVC-G295 / JCTVC-G332 could co-exist with a solution based on E309, as they have different trade-offs in terms of where the bits are spent (slice header vs. additional NAL units). The BoG did not agree on a solution for this problem, but recommended the JCT-VC to consider a unified proposal at this meeting.

JCTVC-G1026 was uploaded in response to this. See notes above for JCTVC-G1026.

The BoG recommended to JCT-VC to include a tool that allows MTU size matching (akin to slices) for parameter sets and especially for the APS, if there is an expectation that a parameter set may become larger than commonly used MTU sizes. It was not clear to the BoG participants whether we have this problem at this point in time, and the BoG indicated that it would be good if this can be clarified by the larger group.

In subsequent discussion in JCT-VC (Track B), it was agreed that a large APS seems like a possibility, and further study was encouraged regarding how to address this. JCTVC-G658 was identified as a contribution on this subject that is available for such study and further work.

The group discussed the potentially different error resilience properties of APS and other parameter sets, and to what extent that should affect the selection of data to be carried in the APS. It was reported that, due to its strict timing requirements, APSs are likely to be conveyed in-band and synchronous to the rest of the bitstream (at least at picture and perhaps even at slice level), and, therefore, are less easily protectable than other parameters sets. Conceivably, this could be a reason to limit the data included into an APS to such data whose loss is not catastrophic to the decoding process. However, the BoG came to the conclusion that this argument is not very compelling. First, from a compliance viewpoint, the APS includes data that is required for the decoding process. Decoding data in the absence of the correct APS is a non-conforming operation, with all its consequences. Second, it is very hard to define "catastrophic". ALF parameters were claimed to be one example where a loss is not catastrophic—if you lose those, you

would still get a reasonably displayable picture from the decoder. However, it was reportedly probably not difficult to design an "evil" bitstream which includes ALF parameters that render that bitstream useless if ALF not applied properly. Accordingly, the BoG recommended to work under the assumption that an APS is available at the decoding time of a slice that references that APS, and to expect system layer support to ensure sufficiently reliable transport of the APS for the application in question.

It was agreed in the BoG and confirmed by the JCT-VC (Track B) that the APS is the right place for quantization matrices, as proposed in JCTVC-G295, JCTVC-G330, and JCTVC-G658, while keeping in mind the need to consider the "partial update" issue.

It was suggested by the BoG that, for the RPS related syntax elements, what has been planned to be in the PPS should stay in the PPS, and what is currently in the slice header should be moved to the APS. Y.-K. Wang agreed to write drop-in text for the larger group and the editors, which was included in the zip file of the BoG report (v2).

After discussion of the BoG report in the JCT-VC (Track B), it was agreed to not act immediately on this suggestion, but rather to study the subject further before taking this step.

So a summary of the content of the APS as planned is (at the time of this discussion at the meeting) to contain the following:

- ALF and SAO parameters (modified to remove CABAC encoding)
- Quantization weighting matrix data – Decision: Agreed.
- Reserved extension data and RBSP trailing bits

Text reflecting this will be uploaded in a -v3 of the BoG report.

After discussion of JCTVC-G566, the BoG recommended to reinserted enabling/disabling ALF and SAO flags in the slice header, in order to remove a parsing dependency between the APS and slice header. Decision: Agreed.

The BoG noted the possible consequence of allowing different values in the APS and slice header, with a suggested restriction that if the flag is "0" in APS, it cannot be "1" in the slice header.

The JCT-VC (Track B) discussed also the possibility of allowing different flag values in different slices of the same picture. This topic was initially left open for further discussion. Pending a decision otherwise, the slice-level flags must be static within a picture and must equal the APS flag and all slices of a picture must refer to the same APS.

In further discussion, it was noted that ALF, when enabled, flags in the slice header that can disable ALF on a fine level of granularity. Allowing the general enabling flag to be zero when the APS-level flag is 1 would be a shortcut with the same effect and better coding efficiency. Therefore, we should allow this.

For SAO, the map control does not in general allow alignment with the boundaries of a slice, and the map control is not sent within the slice header. Therefore, we should not (currently) try to move the control to the slice level.

Decision: Agreed to allow this flexibility of flag value for ALF but not SAO.

Regarding definition of nal_unit_type value for APS? Decision: Use 14 (previously reserved).

JCTVC-G1020 BoG report on loop-filtering (AHG6) [T. Yamakage] [late]

See under 5.5.2–5.5.4.

JCTVC-G1025 BoG report on tiles and wavefront parallel processing [M. Horowitz]

This report contains the summary of proceedings of the tiles and wavefront parallel processing BoG meeting. The BoG was created to review contributions related to tiles and wavefront parallel processing.

The meeting was held on Friday evening, 18:00 to 22:15 and Saturday morning, 10:00 to 12:15, November 25 and 26, respectively. Approximately 30 delegates attended.

The BoG reviewed and summarized input documents: JCTVC-G183, JCTVC-G968, JCTVC-G194, JCTVC-G802, JCTVC-G197, JCTVC-G961, JCTVC-G315, JCTVC-G317, JCTVC-G318, JCTVC-G453, JCTVC-G454, JCTVC-G618, JCTVC-G199, JCTVC-G627, JCTVC-G722, and JCTVC-G815 and prepared associated recommendations.

The BoG recommended adoption of JCTVC-G194, AHG4: Non-cross-tiles loop filtering for independent tiles. JCTVC-G194 proposes a flag to indicate enabling or disabling in-loop filtering across independent tile boundaries. The current HM design always filters across independent tile boundaries.

In Track B, this recommendation was accepted as noted above for JCTVC-G194.

The BoG recommended adoption of JCTVC-G197, AHG4: Low latency CABAC initialization for dependent tiles. To facilitate low-delay (in the wavefront sense from the decoder perspective), JCTVC-G197 proposes that the CABAC probabilities of the first LCU in each tile are inherited from those of the adjacent left LCU if it is within the same slice. In the current HM design, CABAC probabilities are always inherited from the last LCU, in tile scan order, in the same slice.

In Track B, this recommendation was accepted as noted above for JCTVC-G197.

In addition, the group recommended that the JCTVC-G197 be further tested to confirm that it has an advantage over the use of entropy slices that explicitly initialize CABAC (from the improved fixed initialization tables that resulted from CE 1).

The BoG recommended adoption of two elements of JCTVC-G315, AHG4: Unification of picture partitioning schemes.

The first of these recommendations is to move the slice address to the beginning of the slice header.

Decision: Adopted.

The second recommendation is to make the presence of cabac_init_idc syntax element independent of slice type. When the slice type is I, then the syntax element value was recommended to be required to be zero.

In discussion of this, it was noted that cabac_init_idc is not actually in the slice header of the WD 4 draft. This was apparently to initialize CABAC for decoding the ALF parameters. Now that there is no CABAC encoded content in the APS anymore, we can move cabac_init_idc back to the slice header.

Decision: Put slice_type and cabac_init_idc into the slice header and entropy slice header.

In addition to the above recommendations for adoption, the BoG recommends that the ideas in JCTVC-G618, “Line buffers problem in HEVC”, be considered in CE work similar to the prior CE 12.3 and 8.c (as an additional method to test). JCTVC-G618 proposes a tiles-based solution to reduce a line-buffer problem identified in in-loop filtering processes in the current HEVC design. In addition, level constraints on the maximum tile width are proposed.

The BoG recommended that if time permits, JCTVC-G722, "Harmonization of entry points for tiles and wavefront processing", be discussed after data becomes available (likely Monday) and that there is a related element of JCTVC-G315 "Unification of picture partitioning schemes".

This work was then planned for AHG activity.

Finally, the BoG reported that contribution JCTVC-G454, Parallel processing of ALF and SAO for tiles, identified a potential issue in the current HEVC design which allows one slice to reference only one APS. It was reported that in some cases, it may be advantageous to allow more than one APS to be referenced in a slice (e.g., a picture partitioned into 1 slice and 2 tiles and each tile would ideally reference a different APS). It was commented that the APS BoG is aware of this issue. See notes on this topic elsewhere.

JCTVC-G1032 BOG report on intra prediction complexity reduction and filtering [R. Joshi]

Break-out group meetings for intra prediction complexity and filtering were held on Saturday, Sunday and Monday, Nov. 24–26, 2011. Approximately 25 delegates were present.

Regarding prediction modes supported at the 64x64 level, this was resolved as recorded in notes for JCTVC-G1017.

The BoG recommended that some discussed modifications of DC prediction relating to JCTVC-G567 be studied in a CE. In Track B, this was discussed, but it did not seem worth pursuing as a CE.

The BoG recommended that part 3 of JCTVC-G119 be tested in a CE, and this was generally supported. It was commented that other proposals may address the same issue.

JCTVC-G1034 BoG report on chroma intra prediction [Ali Tabatabai]

The relevant contributions were reviewed.

The BoG recommended the following actions:

- A first element of JCTVC-G419, which is WD text modifications for harmonization of WD and HM5.0 SW for LM (text to be provided as part of the BoG report). Decision: Agreed.
- To further study in a CE, the coding efficiency improvement proposals JCTVC-G173, JCTVC-G244, JCTVC-G346, and JCTVC-G358.
- To also further study JCTVC-G245, and the issue that it raises regarding phase alignment for chroma. The study of this may involve investigation of workflows and collection of example source material. The contributor generated some example source material by phase-adjusted subsampling of some 4:4:4 video sequences. This should be studied in the AHG on chroma formats.

JCTVC-G1035 BoG report on resolving deblocking filter description [A. Norkin et al.]

Suggested changes on cleanup: OK.

Removing 4x4 block boundary: OK, as it is not likely that any proposal would be adopted that uses them.

Signalling of de-block parameters (beta, tc_offset, on/off) both in APS and slice header – slice can inherit from APS or use own parameters.

A desire was expressed to check with APS experts regarding whether the design of the APS parameters is appropriate.

Cleanup of source code: A plan exists, but can only be done after meeting.

Decision: Adopt (subject to checking of WD text and software by editor/coordinator)

Also see additional notes in above sections discussing deblocking filter.

JCTVC-G1038 JCT-VC break-out report: Harmonization of NSQT with residual coding [J. Sole (Qualcomm)]

A break-out group meeting was held Monday Nov. 28 2011 from 11:00 through 13:00. Approximately 20 delegates were present.

The BoG studied the interaction between the contexts for residual coding in JCTVC-G1015 and the sub-block scans in JCTVC-G323 with NSQT.

And analysed possible issues (including transpose blocks and remapping)

Four proposals on the topic were discussed: JCTVC-G123, JCTVC-G517, JCTVC-G724, JCTVC-G750.

NSQT is currently doing a remapping.

With respect to the current remapping, the BoG indicated that:

- Discussion of direct integration of JCTVC-G1015 with the current design HM4.0 indicated that it appears to have no additional issues with respect to NSQT (interaction with 8x8 and 16x16/32x32).
- Discussion of direct integration of JCTVC-G323 with the current design HM4.0 indicated that it appears to have no additional issues with respect to NSQT (no interaction with 16x4 and 4x16, interaction only in the 32x8 and 8x32 that map to the 16x16)
- There was agreement that the remapping from non-square to square blocks should be removed.
- It was reported that proposals (JCTVC-G123, JCTVC-G517, JCTVC-G724, JCTVC-G750) removing remapping have interaction with JCTVC-G1015 (interaction with 8x8 and 16x16/32x32) and JCTVC-G323.
- It was recommended that a CE be established on NSQT harmonization with entropy coding.
- Confirmation was requested of whether "bugfix 214" will be in HM 5.0.

It was remarked that "bugfix 214" is a technical change that may not really be a bug. Contribution JCTVC-G517 had commented on this aspect, and had not yet been reviewed. This aspect was discussed in the Track B review of the BoG output. It was described as a mismatch between the WD and software.

> The software currently performs and inverse transform of the longer direction first, regardless of whether that is within columns or within rows.
>
> The proposal is for the inverse transform to always apply to columns first and then rows.
>
> Decision: Agreed (columns first and then rows).

It was suggested that JCTVC-G269 and JCTVC-G354 have a relationship to this work.

It was suggested that we should put a "straw man" scheme in the draft now that is consistent with JCTVC-G323. A scheme was described verbally and was requested to be documented and uploaded in a revision of the BoG report. This was provided. Decision: Adopted.

JCTVC-G1039 BoG report on chroma formats [David Flynn (BBC)]

BoG recommendation: Adopt SPS syntax for chroma_format_idc (same as AVC). Further discuss separate_colour_plane_flag.

Decision: Agreed

The issue with subsample position of chroma (in particular w.r.t. LM chroma mode) is to be further discussed in relevant AHG (20?).

Recommending further study on native 4:4:4 coding vs 4:2:0 with normative upsampling filters.

The issue of 4:2:2 and 4:4:4 content availability is to be further discussed in AHG11. Offers were made verbally at meeting.

JCTVC-G1041 BoG report on subjective viewing test for deblocking filter proposals [A. Norkin, M. Narroschke, K. Andersson, D. Flynn, X. Guo, G. v. d. Auwera]

JCTVC-G1041 reports on informal subjective testing. The results reportedly indicate that there is no subjective quality difference that can be claimed between any of the proposals.

JCTVC-G1044 BoG report on Quantization M. Budagavi, L. Kerofsky

This contribution is a report on complexity analysis of dequantization proposals: JCTVC-G382, JCTVC-G773, JCTVC-G850.

An analysis was provided of the computations and complexity involved in the proposed quantization schemes, with specifics relating to operation with flat and non-flat quantization weighting matrices.

See additional notes in CE 4 summary section.

7 Project planning

7.1 WD drafting and software

JCTVC-G777 The Art of Writing Standards: Some Shalls and Shoulds for Better Quality Interop Specs [G. J. Sullivan (Microsoft)]

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 meeting was planned to be 20 Jan. 2012.

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 to be approved at the meeting at which the CE plan is established.

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-F900.

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.

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.

Non-final CE plan documents are preferably reviewed and given tentative approval during the meeting (in some cases with guidance expressed to suggest modifications to be made in a subsequent revision). In cases where review during the meeting is not possible, the document should be made available and discussed and refined immediately following the meeting.

The CE description for each planned CE is described in an associated output document JCTVC-F9xx for CExx, where "xx" is the CE number (xx = 01, 02, etc.). Final 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 the preceding 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-G1200.

7.6 Software development

The software coordinator had already started integrating bug fixes on top of HM 3.3 software, and had strongly recommended for proponents of adopted proposals to re-implement them in HM 3.3 and test in this environment before integrating them into HM 4.x. All tools were planned to again be thoroughly tested after integration in HM 4.x.

HM 4.0 should be available within 4 weeks after the meeting, and will be used for CEs. HM 4.1 is planned to be available 3 weeks later.

7.7 Subjective test plan for design

We plan a subjective test enabling results at the Feb meeting.

Plans for subjective testing: Preparation of visual comparison for the February meeting will need to be discussed in the next meeting. Initial idea: Use a set of rates e.g. as from CfP, and run HM and JM on same conditions. It may not be necessary to run all different constraint cases, RA may be sufficient.

The AHG needs to prepare JM & HM encodings, roughly as was done for the CfP.

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-G1102 HEVC Test Model 5 (HM 5) Encoder Description • Produce and finalize JCTVC-G1103 HEVC text specification Working Draft 5 • 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, S. Sekiguchi, 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 5.0 software version and the reference configuration encodings according to JCTVC-G1200 based on common conditions suitable for use in most core experiments (expected within 2.5 weeks after the meeting). • Prepare and deliver HM 5.1 software (and additional "dot" version software releases as appropriate) and appropriate software branches that include additional items not integrated into the 5.0 version (expected within three weeks after the 5.0 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

Picture Partitioning and LCU scan order (AHG4) (jct-vc@lists.rwth-aachen.de) • Study the interactions and combinations of picture partitioning and LCU scan order • Identify and work to resolve issues relating to the draft text description of picture partitioning and LCU scan order, and the associated HM functionality • Identify and discuss additional issues relating to picture partitioning and LCU scan order	R. Sjöberg (chair), Y. Chen, F. Henry, M. Horowitz, K. Kazui, A. Segall, W. Wan (vice chairs)	N
Spatial transforms (AHG5) (jct-vc@lists.rwth-aachen.de) • Study and discuss the "core" transforms. • Discuss the transform-related Core Experiment (CE7) along with additional transform-related proposals, and identify potential synergies or incompatibilities related to the core transform tools being investigated. • Report the results and conclusions of these studies, discussions and experiments to the JCT-VC.	P. Topiwala (chair), M. Budagavi, R. Cohen, R. Joshi (vice chairs)	N
In-loop filtering (AHG6) (jct-vc@lists.rwth-aachen.de) • Study simplification and harmonization of in-loop filtering technologies • Study the relationship between IPCM and deblocking filtering behavior • Clean up and stabilize the HM software, the WD text and the HM encoder description on non-deblocking 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 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.	T. Suzuki (chair)	N

Profile and level definitions (AHG8) (jct-vc@lists.rwth-aachen.de) • Study potential architectures of profiles that could be used to define operation points with trade-off between complexity and compression efficiency, facilitating maximum interoperability. • Study a potential set of levels to span the target range of applications with a reasonable degree of granularity • Investigate the feasibility of meeting the vast majority of industry requirements for complexity / compression efficiency trade-off in the target 8-bit 4:2:0 video applications with a single profile. • Identify potential clustering of coding tools and constraints in terms of coding efficiency vs. complexity trade-off for the majority of applications. • Evaluate the coding tools identified in the previous mandate to help assist profiling decisions by JCT-VC.	M. Horowitz, K. McCann (co-chairs), T. Suzuki, T. K. Tan, W. Wan, Y.-K. Wang (vice chairs)	N
Entropy coding architecture (AHG9) (jct-vc@lists.rwth-aachen.de) • Characterize entropy coding throughput, memory, silicon area, power requirements, etc. • Study interdependencies between entropy coding and other processes and the consequences of these interdependencies • Identify and discuss additional issues on entropy coding	K. McCann (primary), J. Lainema, D. Marpe, A. Segall, K. Sugimoto, V. Sze, W. Wan, X. Wang (vice chairs)	N
Parallel merge/skip (AHG10) (jct-vc@lists.rwth-aachen.de) • Develop common understanding of underlying motion estimation throughput issues due to sequential merge mode • Evaluate parallel merge/skip solutions including configurable and CU-based approaches • Work on alternative solutions that would narrow the performance gap between parallel and non-parallel merge • Report the results of these studies, discussions and experiments to the JCT-VC • Recommend a unified solution if available	M. Zhou (chair), H. Y. Kim, P. Onno, X. Wen (vice chairs)	N

Video test material selection (AHG11) (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
Objective quality metric and alternative methods for measuring coding efficiency (AHG12) (jct-vc@lists.rwth-aachen.de) • Study and report suggested methods for objective quality assessment of reconstructed video sequences (for purposes of HEVC coding experiment evaluations). • Identify problems and possible solutions for extending any proposed objective quality metrics to color spaces other than 4:2:0 YCbCr. (e.g. 4:4:4 RGB) • Study methods to compare and report the overall coding efficiency of coding tools as a single number which captures overall rate and overall quality (over all color components) of a sequence. • Identify associated changes for HM software and Excel template (used for reporting simulation results) to support the suggested methods.	K. Minoo, G. Sullivan (co-chairs)	N
Interlace indication (K. Chono) (AHG13) (jct-vc@lists.rwth-aachen.de) • Develop candidate text for an interlaced format indicator, starting from a VUI flag signaling the presence of an SEI message.	K. Chono (chair), C. Fogg, K. Sato, S. Sekiguchi, W. Wan (vice chairs)	N

Loss robustness (AHG14) (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 loss robustness • Discuss related Core Experiments, and identify potential synergies or incompatibilities related to the tools being tested in the CEs	S. Wenger (chair), M. Coban, Y. W. Huang, P. Onno, Y.-K. Wang (vice chairs)	N
High-level syntax (AHG15) (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, including the need and feasibility of sub-picture based HRD operations • 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
Unification of NSQT and SDIP (AHG16) (jct-vc@lists.rwth-aachen.de) • Implement and harmonize the non-square partitioning techniques in SDIP (JCTVC-G558 and JCTVC-G754) with the NSQT in HM5. • Study and investigate combinations of PU and TU sizes that lead to the best coding efficiency and complexity tradeoff • Provide the WD text that is entirely consistent with the unified software (HM5 + JCTVC-G558 + JCTVC-G754).	X. Zheng (chair), J. Xu, X. Wang, A. Tabatabai, J. Lim (vice chairs)	N

Hooks for scalable coding (AHG17) (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
Resolution adaption (AHG18) (jct-vc@lists.rwth-aachen.de) • Study methods of resolutions adaptation and their impact on complexity and compression performance • Investigate reasonable methods to assess the benefit in measurable compression performance • Investigate the impact of different filters (simple/more complex) for normative down- and up-sampling • Investigate subjective quality of resolution change e.g. limiting frequent switching • Determine the necessity of keeping both resolutions in buffer and suitable limitations on DPB for managing complexity • Investigate the relationship with alternatives such as pre- and post-filtering	T. Davies (chair), P. Topiwala, P. Wu (vice chair)	N
Lossless coding (AHG19) (jct-vc@lists.rwth-aachen.de) • Study and investigate techniques which enable lossless coding with minimum changes to the current design • Develop software for support of lossless coding modes • Produce a single candidate WD text specification with lossless coding capability for review at the next meeting • Examine the potential impact to the common test cases from the lossless coding modes	W. Gao (chair), K. Chono, J. Xu, M. Zhou, P. Topiwala(vice chairs)	N
Chroma format support (AHG20) (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, P. Topiwala (vice chairs)	N
Reference picture buffering and list construction (AHG21) (jct-vc@lists.rwth-aachen.de) • Finalize the test specification document for reference picture buffering and list construction proposals for the 8th JCT-VC meeting in a timely manner (JCTVC-G1036)	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-G1036 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 loss resilience AHG)		
HM subjective quality investigation (AHG22) (jct-vc@lists.rwth-aachen.de) • Establish a testing scenario for comparison of HM versus JM together with the test coordinator, Vittorio Baroncini • Perform encoding of HM and JM test cases. • Prepare the evaluation of test results as input to the February 2012 meeting.	G. Sullivan, J.-R. Ohm (co-chairs), F. Bossen, T. Wiegand (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-F634 HEVC Reference Software Manual [F. Bossen, D. Flynn, K. Sühring (AHG chairs)]

The intention is to provide this as part of the software package in the future.

JCTVC-F688 Revised HEVC Software Guidelines [K. Sühring, D. Flynn, F. Bossen (software coordinators)]

This version approved at the 6th meeting was approved to still be valid.

JCTVC-G1100 Meeting Report of 7th JCT-VC Meeting [G. J. Sullivan, J.-R. Ohm]

JCTVC-G1102 High Efficiency Video Coding (HEVC) Test Model 5 (HM 5) Encoder Description [K. McCann (primary), B. Bross, W.-J. Han, S. Sekiguchi, G. J. Sullivan] (WG 11 N 12345)

JCTVC-G1103 High Efficiency Video Coding (HEVC) text specification Working Draft 5 [B. Bross (primary), W.-J. Han, G. J. Sullivan, J.-R. Ohm, T. Wiegand] (WG 11 N 12346)

JCTVC-G1200 Common HM test conditions and software reference configurations [F. Bossen]

Based on update of JCTVC-G1000 as discussed in Wednesday closing plenary.

Software HM5.0 availability Dec. 19

Any adopted proposals where software is not delivered by the scheduled by the scheduled date will be rejected.

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

Document deadline of February 2012 meeting is likely to be Jan. 20th.

JCTVC-G1201 Core Experiment 1: Entropy Coding Investigation [R. Joshi (primary), E. Alshina, H. Kirchhoffer, J. Lainema, H. Sasai]

JCTVC-G1202 Core Experiment 2: Chroma RQT depth [K. Sugimoto]

JCTVC-G1203 Core Experiment 3: Chroma Interpolation Filter [T. Chujoh, E. Alshina]

Only JCTVC-G698, including subjective investigation.

Remaining issues to be investigated are related to memory bandwidth AHG

JCTVC-G1204 Core Experiment 4: Quantization [K. Sato (primary), H. Aoki, M. Budagavi, M. Coban, X. Li]

JCTVC-G1205 Core Experiment 5: Transform skipping [M.Mrak, J. Sole, J. Xu, A. Saxena]

JCTVC-G1206 Core Experiment 6: Intra coding improvements [A. Tabatabai (primary), E. François, K. Chono, R. Joshi, J. Lainema, H. Yu]

Includes all intra coding aspects (also chroma prediction, intra mode coding simplification, SDIP improvements over "reference" of AHG).

JCTVC-G1207 Core Experiment 7: Additional transforms [R. Cohen (primary), F. Fernandes, R. Joshi, C. Yeo]

JCTVC-G1208 Core Experiment 8: Non-deblocking loop filtering [T. Yamakage (primary), I. S. Chong, M. Narroschke, Y.-W. Huang]

JCTVC-G1209 Core Experiment 9: MV coding and skip/merge operation [I. K. Kim (primary), W. J. Chien, J. Jung, I. K. Kim, M. Zhou]

Combined with former CE13

JCTVC-G1210 Core Experiment 10: Deblocking filter [A. Norkin (primary), X. Guo, B. Jeon, M. Narroschke]

JCTVC-G1211 Core Experiment 11: Coefficient scanning and coding [V. Sze (primary), J. Chen, T. Nguyen, K. Panusopone, J. Sole]

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:

- 1–10 February 2012 under WG 11 auspices in San José, USA.
- 30 April – 8 May 2012 under ITU-T auspices in Geneva, CH.
- 11–20 July 2012 under WG 11 auspices in Stockholm, SE.
- 10–19 October 2012 under WG 11 auspices in Shanghai, CN.
- 16–23 January 2013 under ITU-T auspices in Geneva, CH.

ITU was thanked for its excellent hosting of the 7th meeting of the JCT-VC and for providing the viewing equipment used at the meeting. David Flynn and Kenneth Andersson were thanked for assisting with the setup and operation of the equipment.

The JCT-VC meeting was closed at approximately 1335 hours on Wednesday 30 Nov 2011.

Annex A to JCT-VC report:
List of documents

JCT-VC number	MPEG number	Created	First upload	Last upload	Title	Source
JCTVC-G001	m22345	2011-11-09 03:21:33	2011-11-21 03:08:39	2011-11-21 03:08:39	JCT-VC AHG Report: Project Management (AHG 1)	G. J. Sullivan, J.-R. Ohm (AHG chairs)
JCTVC-G002	m22604	2011-11-19 19:40:34	2011-11-20 15:14:46	2011-11-20 23:51:56	JCT-VC AHG report: HEVC Draft and Test Model editing (AHG 2)	B. Bross, K. McCann, W.-J. Han, J.-R. Ohm, S. Sekiguchi, G. J. Sullivan, T. Wiegand
JCTVC-G003	m22617	2011-11-20 10:59:22	2012-01-24 00:15:26	2012-01-24 00:15:26	JCT-VC AHG report: Software development and HM software technical evaluation (AHG 3)	F. Bossen, D. Flynn, K. Suehring
JCTVC-G004	m22505	2011-11-15 15:17:51	2011-11-21 00:43:05	2011-11-21 00:43:05	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 (vice chairs)
JCTVC-G005	m21828	2011-11-07 16:52:05	2011-11-20 23:24:44	2011-11-21 14:43:10	JCT-VC AHG Report: Spatial Transforms (AHG 5)	P. Topiwala (AHG Chair), M. Budagavi, R. Cohen, R. Joshi (vice chairs)
JCTVC-G006	m22510	2011-11-16 01:32:32	2011-11-19 06:42:18	2011-11-21 14:50:53	JCT-VC AHG report: In-loop and post-processing filtering (AHG 6)	T. Yamakage, K. Chono, Y. J. Chiu, I. S. Chong, M. Narroschke
JCTVC-G007	m22635	2011-11-21 03:32:02	2011-11-21 03:33:35	2011-11-21 03:33:35	JCT-VC AHG report: Transform dynamic range (AHG 7)	A. Segall (Sharp), E. Alshina (Samsung)
JCTVC-G008	m22543	2011-11-17 12:22:07	2011-11-17 12:26:37	2011-11-17 12:26:37	JCT-VC AHG report: Reference pictures memory compression (AHG 8)	K. Chono (chair), T. Chujoh, D. Hoang, C. S. Lim, A. Tabatabai, M. Zhou (vice-chairs)
JCTVC-G009	m22605	2011-11-19 19:59:33	2011-11-20 13:31:45	2011-11-20 13:31:45	JCT-VC AHG report: Entropy Coding Architecture (AHG 9)	K. McCann (chair), A. Fuldseth, D. Marpe, A. Segall, K. Sugimoto, V. Sze, W. Wan, X. Wang (vice chairs)
JCTVC-G010	m22545	2011-11-17 12:55:32	2011-11-18 12:23:05	2011-11-18 12:23:05	JCT-VC AHG report: Quantization (AHG 10)	M. Budagavi, M. Karczewicz, G. Martin-Cocher, K. Sato
JCTVC-G011	m22624	2011-11-20 22:33:06	2011-11-21 10:45:54	2011-11-21 19:00:53	JCT-VC AHG Report: Video test material selection (AHG 11)	T. Suzuki

JCTVC-G012	m21629	2011-11-04 17:28:30	2011-11-09 11:24:05	2011-11-09 11:24:05	JCT-VC AHG report: Complexity assessment (AHG 12)	D. Alfonso (AHG chair), J. Ridge, X. Wen (vice-chairs),
JCTVC-G013	m21680	2011-11-06 14:07:53	2011-11-23 18:30:12	2011-11-23 18:30:12	JCT-VC AHG report: Screen Content Coding (AHG 13)	O. Au, J. Xu, H. Yu (AHG chairs)
JCTVC-G014	m22644	2011-11-21 08:56:55	2011-11-21 08:57:53	2011-11-21 08:57:53	JCTVC AHG Report (AHG14)	S. Wenger
JCTVC-G015	m22539	2011-11-17 07:57:19	2011-11-18 21:25:35	2011-11-18 21:25:35	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 (vice chairs)
JCTVC-G016	m22587	2011-11-18 18:40:13	2011-11-19 03:56:54	2011-11-23 09:24:35	JCT-VC AHG report: Padding process (AHG 16)	V. Wahadaniah, K. Chono, Y. Lin
JCTVC-G017	m22457	2011-11-10 18:00:00	2011-11-16 18:03:49	2011-11-21 15:43:17	JCT-VC AHG Report: Scalable coding investigation (AHG 17)	J. Boyce, J. Kang, K. Minoo, W. Wan, Y.-K. Wang
JCTVC-G018	m21762	2011-11-07 09:33:13	2011-11-08 20:16:30	2011-11-18 10:45:38	JCT-VC AHG report: Resolution adaption (AHG 18)	T. Davies (AHG chair), P. Topiwala, P. Wu (Vice-chairs)
JCTVC-G019	m22544	2011-11-17 12:24:27	2011-11-19 22:09:49	2011-11-19 22:09:49	JCT-VC AHG Report: Transform Skipping (AHG19)	M. Mrak (AHG chair), J. Sole, I.-K. Kim, J. Xu, H. Yu (vice chairs)
JCTVC-G020	m22647	2011-11-21 10:16:43	2011-11-21 10:17:33	2011-11-21 10:17:33	JCT-VC AHG report: Chroma format support (AHG 20)	David Flynn, Dzung Hoang, Ken McCann
JCTVC-G021	m22506	2011-11-15 15:19:54	2011-11-21 00:44:38	2011-11-21 18:04:44	JCT-VC AHG report: Reference picture buffering and list construction (AHG21)	D. Flynn, R. Sjöberg (AHG chairs), Y. Chen, T. K. Tan, W. Wan, Y.-K. Wang (vice chairs)
JCTVC-G022	m22646	2011-11-21 10:08:51	2011-11-21 10:10:32	2011-11-21 10:10:32	JCT-VC AHG report: Lossless Coding (AHG22)	W. Gao (chair), K. Chono, J. Xu, M. Zhou (vice chairs)
JCTVC-G031	m22139	2011-11-08 15:56:09	2011-11-19 02:53:24	2011-11-19 02:53:24	CE1: Summary report of core experiment on entropy coding	R. Joshi, E. Alshina, H. Sasai, H. Kirchhoffer, J. Lainema (CE coordinators)
JCTVC-G032	m22431	2011-11-09 16:06:37	2011-11-21 08:07:08	2011-11-21 15:45:18	CE2: Summary report of core experiment on Motion Partitioning and OBMC	X. Zheng, I. S Chong, I.-K Kim
JCTVC-G033	m21795	2011-11-07 11:49:22	2011-11-19 10:49:15	2011-11-28 17:52:49	CE3: Summary report of Core Experiment on Motion Compensation	T. Chujoh, E. Alshina (CE coordinators)
JCTVC-G034	m22357	2011-11-09 03:40:42	2011-11-21 16:54:35	2011-11-21 16:54:35	CE4: Summary report of Core Experiment on Quantization	K. Sato, M. Budagavi, M. Coban, H. Aoki, X. Li (CE coordinators)
JCTVC-G035	m22233	2011-11-08 23:47:17	2011-11-20 16:49:02	2011-11-20 16:49:02	CE5: Summary report on CAVLC entropy coding improvements	X. Wang, P. Wu, C. Kim (CE Coordinators)

JCTVC-G036	m22309	2011-11-09 02:23:01	2011-11-18 20:03:48	2011-11-21 20:53:15	CE6: Summary Report on Intra Coding Improvements	A. Tabatabai, E. Francois, K. Chono, H. Yu, R. Joshi, J. Lainema
JCTVC-G037	m21611	2011-11-03 22:29:59	2011-11-20 16:02:44	2011-11-22 21:10:01	CE7: Summary report of Core Experiment on additional transforms	R. Cohen, C. Yeo, R. Joshi, F. Fernandes (CE coordinators)
JCTVC-G038	m22480	2011-11-14 06:27:06	2011-11-19 06:43:51	2011-11-28 09:11:03	CE8: Summary report of Core Experiment on non-deblocking loop filtering	T. Yamakage, I. S. Chong, M. Narroschke, Y.-W. Huang
JCTVC-G039	m22173	2011-11-08 19:33:38	2011-11-18 19:41:12	2011-11-18 19:41:12	CE9: Summary Report of Core Experiment on MV Coding and Skip/Merge Operations	B. Bross, J. Jung, W.-J. Chien, I.-K. Kim, M. Zhou (CE coordinators)
JCTVC-G040	m21829	2011-11-07 16:54:12	2011-11-10 22:49:58	2011-11-24 18:12:37	CE10: Summary Report of Core Experiment on Core Spatial Transforms	P. Topiwala, M. Budagavi, R. Joshi, E. Alshina (CE coordinators)
JCTVC-G041	m21679	2011-11-05 22:57:35	2011-11-20 21:07:37	2011-11-23 08:16:20	CE11: Summary report of Core Experiment on coefficient scanning and coding	V. Sze, J. Chen, T. Nguyen, K. Panusopone, J. Sole (CE coordinators)
JCTVC-G042	m22193	2011-11-08 20:22:22	2011-11-21 12:19:17	2011-11-22 10:52:36	CE12: Summary report of Core Experiment on deblocking filtering	A. Norkin, X. Guo, B. Jeon, M. Narroschke (CE coordinators)
JCTVC-G043	m22591	2011-11-18 21:26:06	2011-11-18 21:26:37	2011-11-18 21:26:37	CE13: Summary report of Core Experiment 13 on motion data parsing robustness and throughput	J. Jung, B. Bross, J. Chen, P. Onno (CE coordinators)
JCTVC-G051	m21502	2011-10-10 02:23:09	2011-10-10 08:30:49	2011-11-02 20:52:18	CE8 Subset 3: Cross-check of Panasonic's line memory reduction for in-loop filtering (JCTVC-G564)	S. Park, S. Lee, N. Eum (ETRI)
JCTVC-G052	m21505	2011-10-21 10:11:41	2011-10-21 10:19:28	2011-11-23 16:45:17	CE9: Results of MRG_MVD series	S. Fukushima, M. Ueda, K. Arakage, S. Sakazume (JVC Kenwood)
JCTVC-G053	m21508	2011-10-21 12:53:04	2011-10-21 13:17:17	2011-11-23 16:46:03	CE9: Results of AMVP_SEL01 and AMVP_SEL02	H. Nakamura, S. Fukushima, M. Nishitani, H. Takehara (JVC Kenwood)
JCTVC-G054	m21599	2011-10-28 09:45:24	2011-11-05 07:13:22	2011-11-14 09:08:30	CE4 Subtest 1.2.a: Study and cross-verification of Mitsubishi signalling of Max and Min QP in slice (JCTVC-G462)	K. Chono, H. Aoki (NEC)
JCTVC-G055	m21600	2011-10-28 09:46:31	2011-11-05 07:14:20	2011-11-05 07:14:20	CE4 Subtest 1.2.b: Cross-verification of Ericsson table-based delta QP coding method (JCTVC-G070)	K. Chono, H. Aoki (NEC)
JCTVC-G056	m21601	2011-10-29 15:46:13	2011-10-31 13:04:03	2011-11-22 15:30:07	CE8 Subtest G: Adaptive Loop Filtering of Chrominance Samples Using Luma Map	F. Kossentini, H. Guermazi, N. Mahdi, M. Horowitz (eBrisk Video Inc.)
JCTVC-G057	m21602	2011-10-29 16:38:53	2011-11-05 18:00:05	2011-11-21 16:36:37	CE3: An Adaptive Interpolation Filtering Technique	F. Kossentini, N. Mahdi, H. Guermazi, M. Horowitz (eBrisk Video Inc.)

JCTVC-G058	m21603	2011-10-29 18:05:26	2011-11-05 18:02:35	2011-11-22 15:27:37	CE3: Interpolation using different-length horizontal and vertical filters	F. Kossentini, N. Mahdi, H. Guermazi, M. Horowitz (eBrisk Video Inc.)
JCTVC-G059	m21604	2011-10-29 18:22:27	2011-11-05 18:09:21	2011-11-05 18:09:21	CE3: Cross-Verification of Samsung/Motorola's interpolation filter variant B (JCTVC-Gxxx)	F. Kossentini, N. Mahdi (eBrisk Video Inc.)
JCTVC-G060	m21605	2011-10-31 12:23:40	2011-10-31 12:36:05	2011-10-31 12:36:05	CE8 Subtest F: Verification results of Panasonic Proposal	F. Kossentini, H. Guermazi (eBrisk Video Inc.)
JCTVC-G061	m21544	2011-10-23 12:03:13	2011-10-23 12:04:59	2011-10-23 12:04:59	HEVC issues (comments from USNB of WG11)	A. G. Tescher for USNB of WG11
JCTVC-G062	m21606	2011-11-03 07:55:42	2011-11-03 21:33:13	2011-11-24 19:18:13	Non-CE3: 7-tap quarter-pel luma interpolation filter with accurate phase shift	H. Zhu
JCTVC-G063	m21607	2011-11-03 13:25:25	2011-11-05 18:05:10	2011-11-22 15:26:37	CE3: Adaptive interpolation using different-length horizontal and vertical filters	F. Kossentini, N. Mahdi, H. Guermazi, M. Horowitz (eBrisk Video Inc.)
JCTVC-G064	m21608	2011-11-03 22:03:02	2011-11-08 23:35:31	2011-11-08 23:35:31	Results of the PA-Coder	H. Zhu
JCTVC-G065	m21612	2011-11-04 06:22:01	2011-11-08 20:25:22	2011-11-22 20:16:47	Improved Weighted Prediction	Y. Ye, E. S. Ryu (InterDigital)
JCTVC-G066	m21613	2011-11-04 10:51:00	2011-11-07 10:31:11	2011-11-07 10:31:11	CE4 Subtest 1: Spatial QP prediction based on intra prediction (test 1.3.b)	H. Aoki, K. Chono (NEC), M. Kobayashi, M. Shima (Canon)
JCTVC-G067	m21614	2011-11-04 10:55:52	2011-11-08 11:42:04	2011-11-21 01:31:45	CE4 Subtest 1: Spatial QP prediction based on intra prediction and prediction mode (test 1.3.c)	H. Aoki, K. Chono (NEC), M. Kobayashi, M. Shima (Canon), K. Sato (Sony)
JCTVC-G068	m21615	2011-11-04 10:58:13	2011-11-07 10:31:51	2011-11-07 10:31:51	CE4 Subtest1: QP prediction based on intra/inter prediction (test 1.4)	H. Aoki, K. Chono (NEC), M. Coban, M. Karczewicz (Qualcomm)
JCTVC-G069	m21616	2011-11-04 11:29:02	2011-11-08 11:58:36	2011-11-08 11:58:36	Cross-verification of KDDI proposal on intra coding (JCTVC-G346)	M. Matsumura, S. Matsuo, S. Takamura, H. Jozawa (NTT)
JCTVC-G070	m21617	2011-11-04 13:45:23	2011-11-08 14:48:51	2011-11-08 14:48:51	CE4 Subset 1.2.b: Ericsson table-based delta QP coding method	R. Sjoberg, J. Sun (Ericsson)
JCTVC-G071	m21618	2011-11-04 13:46:40	2011-11-09 11:36:04	2011-11-17 13:32:41	CE4 Subset 1.1.a: Cross-verification of delta QP coding at sub_CU level from Motorola (JCTVC-F577)	R. Sjoberg, J. Sun (Ericsson)
JCTVC-G072	m21619	2011-11-04 16:07:45	2011-11-08 01:43:14	2011-11-08 01:43:14	CE1: Cross-check of Subtest C (Tests 1, 2, 4, 6, 17)	C. Yeo (I2R)
JCTVC-G073	m21620	2011-11-04 16:11:38	2011-11-07 05:04:20	2011-11-07 05:04:20	CE4: Cross-check of Subtest 1.3.e - Spatial QP prediction	C. Yeo (I2R)
JCTVC-G074	m21621	2011-11-04	2011-11-07	2011-11-18	CE4: Cross-check of Subtest 2 on de-quantization offset (2.1.a,	C. Yeo (I2R)

		16:14:26	05:05:02	05:39:12	2.3.d)	
JCTVC-G075	m21622	2011-11-04 16:17:12	2011-11-07 05:33:22	2011-11-07 05:33:22	CE7: Cross-check of Unified Tools 1 & 2 - Mode-Dependent Secondary Transform	C. Yeo, Y. H. Tan, Z. Li (I2R)
JCTVC-G076	m21623	2011-11-04 16:20:14	2011-11-07 05:33:57	2011-11-17 06:50:06	CE7: Cross-check of Tool 4 - DST for Intra Chroma Residual Coding	C. Yeo, Y. H. Tan, Z. Li (I2R)
JCTVC-G077	m21624	2011-11-04 16:21:33	2011-11-07 05:05:52	2011-11-07 05:05:52	CE11: Cross-check of CE.B1 - Scans for large blocks in CAVLC	C. Yeo (I2R)
JCTVC-G078	m21625	2011-11-04 16:26:40	2011-11-08 22:30:06	2011-11-08 22:53:37	Information for HEVC scalability extension	J. Boyce, D. Hong, W. Jang, A. Abbas (Vidyo)
JCTVC-G079	m21626	2011-11-04 16:26:42	2011-11-08 16:18:43	2011-11-24 17:38:42	SEI message for display orientation information	J. Boyce, D. Hong, S. Wenger (Vidyo)
JCTVC-G080	m21627	2011-11-04 16:34:13	2011-11-08 09:47:37	2011-11-08 09:47:37	CE6: Cross-check report for Subtest CE6b on Intra Mode Coding	H. L. Tan, C. Yeo, Y. H. Tan (I2R)
JCTVC-G081	m21628	2011-11-04 16:36:22	2011-11-08 09:48:12	2011-11-08 09:48:12	CE6: Cross-check report for Subtest CE6d on Intra prediction with secondary boundary (Test 7)	H. L. Tan, Y. H. Tan, C. Yeo (I2R)
JCTVC-G082	m21630	2011-11-04 18:35:52	2011-11-09 00:34:44	2011-12-29 18:31:15	Non-CE9: Modified H positions for memory bandwidth reduction in TMVP derivation	M. Zhou (TI)
JCTVC-G083	m21631	2011-11-04 18:37:22	2011-11-09 01:32:54	2011-11-21 04:24:05	CE4: Test results on compact representation of quantization matrices	M. Zhou, V. Sze (TI)
JCTVC-G084	m21632	2011-11-04 18:38:13	2011-11-09 00:40:53	2011-11-09 00:40:53	CE9: Test results on SP01, SP02, SP03 and SP04	M. Zhou (TI)
JCTVC-G085	m21633	2011-11-04 18:39:00	2011-11-09 01:30:44	2011-11-09 18:18:02	CE9: Test results on parallelized merge/skip mode	M. Zhou (TI)
JCTVC-G086	m21634	2011-11-04 18:40:33	2011-11-09 00:52:40	2011-11-18 05:35:41	CE12 subset 7.4: Test results on decreasing worst case complexity of deblocking filter	M. Zhou, O. Sezer, V. Sze (TI)
JCTVC-G087	m21635	2011-11-04 18:41:44	2011-11-09 00:15:06	2011-11-18 05:36:33	CE12 subset 4.10: Test results on unification of luma and chroma filtering	M. Zhou, O. Sezer, V. Sze (TI)
JCTVC-G088	m21636	2011-11-04 18:43:21	2011-11-09 00:14:30	2011-11-21 10:27:59	CE12 subset 2: Test results and architectural study on de-blocking filter without parallel on/off filter decision	M. Zhou, O. Sezer, V. Sze (TI)
JCTVC-G089	m21637	2011-11-04 18:44:55	2011-11-09 00:36:25	2011-11-18 18:13:06	Non-CE12: Enable low-complexity and fully parallelized de-blocking filter with minor changes	M. Zhou, O. Sezer, V. Sze (TI)
JCTVC-G090	m21638	2011-11-04 18:46:02	2011-11-09 00:15:50	2011-11-18 18:14:21	Non-CE12: Testing results on using HM3.0 delta calculation for luma weak filter	M. Zhou, O. Sezer, V. Sze (TI)
JCTVC-G091	m21639	2011-11-04 18:46:47	2011-11-09 00:12:58	2011-11-17 00:55:50	CE13: Test results on maxNumMergeCand signaling and simplification of merge MVP list pruning process	M. Zhou (TI)
JCTVC-G092	m21640	2011-11-04	2011-11-09	2011-11-24	AHG22: High-level signaling of lossless coding mode in HEVC	M. Zhou (TI)

		18:47:35	00:39:41	18:22:01		
JCTVC-G093	m21641	2011-11-04 18:48:38	2011-11-09 00:39:04	2011-11-09 00:39:04	AHG22: Sample-based angular prediction (SAP) for HEVC lossless coding	M. Zhou (TI)
JCTVC-G094	m21642	2011-11-04 18:49:30	2011-11-09 00:11:19	2011-11-09 00:11:19	Non-CE4: Carriage of large block size quantization matrices with up-sampling	M. Zhou, V. Sze (TI)
JCTVC-G095	m21643	2011-11-04 18:50:33	2011-11-09 00:16:38	2011-11-09 00:16:38	Virtual motion compensation memory bandwidth verifier (VMBV)	M. Zhou (TI)
JCTVC-G096	m21644	2011-11-04 18:51:14	2011-11-07 23:53:22	2011-11-21 04:09:38	Items to be clarified in HEVC design	M. Zhou (TI), W. Wan (Broadcom), T. Suzuki (Sony), A. Tabatabai (Sony)
JCTVC-G097	m21645	2011-11-04 18:55:33	2011-11-08 22:50:24	2011-11-08 22:50:24	Non-CE13: cross-verification of Broadcom's proposal JCTVC-G288 complexity reduction of MVP list construction	M. Zhou (TI)
JCTVC-G098	m21646	2011-11-04 18:56:15	2011-11-08 16:50:01	2011-11-08 16:50:01	Non-CE9: cross-verification of Canon's proposal JCTVC-G241 on parallel derivation of the temporal predictor for Merge/Skip modes	M. Zhou (TI)
JCTVC-G099	m21647	2011-11-04 18:57:03	2011-11-08 17:02:38	2011-11-12 00:20:33	Non-CE9: cross-verification of LGE's proposal JCTVC-G163 on simplification of merge/skip ref_idx derivation	M. Zhou (TI)
JCTVC-G100	m21648	2011-11-04 18:58:20	2011-11-08 16:58:57	2011-11-19 14:05:49	Non-CE9: cross-verification of LGE's proposal JCTVC-G164 on improvement on parallel merge/skip mode	M. Zhou (TI)
JCTVC-G101	m21649	2011-11-04 18:58:58	2011-11-09 00:56:11	2011-11-09 00:56:11	CE9 subset 2.3: cross-verification of MMI's proposal on AMVP simplification Sel03 & Sel04	M. Zhou (TI)
JCTVC-G102	m21650	2011-11-04 18:59:40	2011-11-08 16:46:04	2011-11-08 16:46:04	Non-CE9: cross-verification of Panasonic's proposal JCTVC-G541 simplified scaling calculation method for temporal/spatial MVP of AMVP/Merge	M. Zhou (TI)
JCTVC-G103	m21651	2011-11-04 19:00:36	2011-11-09 00:57:52	2011-11-09 00:57:52	CE12 subset 2: cross-verification of SONY's parallel de-blocking filtering proposals JCTVC-G255 and JCTVC-G256	M. Zhou, V. Sze (TI)
JCTVC-G104	m21652	2011-11-04 19:01:26	2011-11-08 17:07:23	2011-11-15 01:38:35	Non-CE9: cross-verification of LGE and MediaTek's proposal JCTVC-G165 on new MVP positions for merge/skip modes and its combination with replacing redundant MVPs	M. Zhou (TI)
JCTVC-G105	m21653	2011-11-04 19:02:00	2011-11-08 16:53:58	2011-11-08 16:53:58	Non-CE9: cross-verification of JVC's proposal JCTVC-G219 on construction of MVP list without using scaling operation	M. Zhou (TI)
JCTVC-G106	m21654	2011-11-04 19:21:26	2011-11-09 07:54:42	2011-11-09 18:09:27	Cross-Check for JCTVC-G153: On Intra Mode Coding	A. Saxena, F. Fernandes (Samsung)
JCTVC-G107	m21655	2011-11-04 19:22:15	2011-11-09 08:15:40	2011-11-20 23:05:01	CE 7: Mode-Dependent DCT/DST for 4x4 Chroma Blocks	A. Saxena, F. Fernandes, E. Alshina, J. Chen (Samsung)
JCTVC-G108	m21656	2011-11-04 19:22:52	2011-11-09 08:44:25	2011-11-25 09:52:31	CE 7 : On secondary transforms for intra prediction residual	A. Saxena (Samsung), Y. Shibahara (Panasonic), F. Fernandes (Samsung), T. Nishi

						(Panasonic)
JCTVC-G109	m21657	2011-11-04 20:01:57	2011-11-08 18:44:34	2011-11-08 18:44:34	On Intra Mode Mapping	X. Zhang, S. Liu, S. Lei (MediaTek)
JCTVC-G110	m21660	2011-11-05 01:17:36	2011-11-07 21:22:20	2011-11-23 15:40:54	Implication of parallelized bitstreams on single core decoder architectures	W. Wan, T. Hellman (Broadcom)
JCTVC-G111	m21661	2011-11-05 01:20:31	2011-11-07 23:29:29	2011-11-22 11:21:52	Common test conditions to specify 8-bit internal bit depth for all 8-bit source material	T. Hellman, Y. Yu, W. Wan (Broadcom)
JCTVC-G112	m21662	2011-11-05 01:21:52	2011-11-07 23:54:36	2011-11-24 17:15:38	Changing luma/chroma coefficient interleaving from CU to TU level	T. Hellman, Y. Yu (Broadcom)
JCTVC-G113	m21663	2011-11-05 07:17:00	2011-11-05 07:19:36	2011-11-14 05:37:40	CE4 Subtest 1.1.a: Cross-verification of Motorola's QP adaptation at sub_CU level (JCTVC-F577)	K. Chono, H. Aoki (NEC)
JCTVC-G114	m21664	2011-11-05 07:17:27			Withdrawn	
JCTVC-G115	m21665	2011-11-05 07:18:13	2011-11-07 07:44:00	2011-11-07 07:44:00	AHG22: Cross-verification of TI's Sample-based angular prediction (SAP) for HEVC lossless coding (JCTVC-G093)	K. Chono, H. Aoki (NEC)
JCTVC-G116	m21666	2011-11-05 08:59:37	2011-11-07 05:38:28	2011-11-20 09:04:58	On PCM memory usage reduction in HM software	K. Chono, H. Aoki (NEC),
JCTVC-G117	m21667	2011-11-05 09:37:20	2011-11-07 07:45:32	2011-11-07 07:45:32	Non-CE6: Cross-verification of Huawei Modifications to intra frame coding (JCTVC-G119)	K. Chono, H. Aoki (NEC),
JCTVC-G118	m21668	2011-11-05 10:14:50	2011-11-07 07:58:16	2011-11-20 10:11:41	Potential enhancement of signaling of I_PCM blocks	K. Chono, H. Aoki (NEC),
JCTVC-G119	m21669	2011-11-05 15:13:12	2011-11-08 15:22:15	2011-11-19 17:11:34	Modifications to Intra-frame coding	Y. Lin (Hisilicon), H. Yang (Huawei), L. Liu, J. Zheng (Hisilicon), H. Yu (Huawei)
JCTVC-G120	m21670	2011-11-05 15:19:25	2011-11-15 15:11:30	2011-11-15 15:11:30	Cross-verification of Samsung proposal on padding process (JCTVC-G791)	Y. Lin, C. Lai (HiSilicon)
JCTVC-G121	m21671	2011-11-05 22:50:00	2011-11-08 22:10:09	2011-11-08 22:10:09	CE11: Reduction in contexts used for coefficient level	V. Sze (TI)
JCTVC-G122	m21672	2011-11-05 22:50:44	2011-11-08 23:52:44	2011-11-24 14:29:32	VLC for high level syntax (ALF and SAO parameters)	V. Sze (TI)
JCTVC-G123	m21673	2011-11-05 22:51:04	2011-11-09 02:05:07	2011-11-25 21:08:50	Non-CE11: Simplified Coefficient Scans for NSQT	V. Sze (TI)
JCTVC-G124	m21674	2011-11-05 22:51:46	2011-11-09 00:36:41	2011-11-09 00:36:41	CE11: Cross-check of proposal on removal of the parsing dependency of residual coding on intra mode JCTVC-G321 (JCTVC-F550)	V. Sze (TI)
JCTVC-G125	m21675	2011-11-05 22:52:05	2011-11-19 01:49:52	2011-11-19 01:49:52	Cross-check of Samsung proposal on context reduction for coefficient levels (JCTVC-G783)	V. Sze (TI)

JCTVC-G126	m21676	2011-11-05 22:52:08	2011-11-20 21:22:46	2011-11-21 10:11:55	Cross-check of Panasonic proposal on context reduction for coefficient levels (JCTVC-G522)	V. Sze (TI)
JCTVC-G127	m21677	2011-11-05 22:52:55	2011-11-09 00:41:30	2011-11-16 23:48:43	Cross-check of Sony proposal on context reduction for significance map (JCTVC-G366)	V. Sze (TI)
JCTVC-G128	m21678	2011-11-05 22:54:42	2011-11-09 00:40:15	2011-11-09 00:40:15	Cross-check of proposal on context simplification for coefficients entropy coding JCTVC-G301 (JCTVC-F148)	V. Sze (TI)
JCTVC-G129	m21681	2011-11-06 16:55:10	2011-11-08 22:33:59	2011-11-08 22:33:59	CE6.a: Sub-sampling portion of neighboring pixels in calculation of LM parameters	M. Budagavi (TI), K. Sato (Sony)
JCTVC-G130	m21682	2011-11-06 17:01:22	2011-11-08 22:35:00	2011-11-08 22:35:00	CE8 Subtest d - Chroma ALF with reduced vertical filter size	M. Budagavi, V. Sze, M. Zhou (TI)
JCTVC-G131	m21683	2011-11-06 20:20:48	2011-11-08 22:52:46	2011-11-08 22:52:46	PU-size dependent motion compensation filtering order	M. Budagavi, R. R. Srinivasan (TI)
JCTVC-G132	m21684	2011-11-06 20:21:26	2011-11-09 02:27:40	2011-11-23 08:09:51	Hardware analysis of transform and quantization	M. Budagavi (TI), V. Sze (TI), M. Sadafale
JCTVC-G133	m21685	2011-11-06 20:22:02	2011-11-11 21:34:13	2011-11-11 21:34:13	CE8: Crosscheck of JCTVC-G208 - Snowflake5x5 and cross9x9 for luma and chroma ALF shapes	M. Budagavi (TI)
JCTVC-G134	m21686	2011-11-06 20:51:58	2011-11-09 02:15:23	2011-11-21 19:15:28	Motion Vector Predictor Candidate Clipping Removal	M. Coban, M. Karczewicz (Qualcomm)
JCTVC-G135	m21687	2011-11-06 22:23:51	2011-11-08 08:16:19	2011-11-24 19:13:36	Non-CE6: Rectangular (2NxN and Nx2N) Intra Prediction	S. Liu, X. Zhang, Z. Zhou, S. Lei (MediaTek)
JCTVC-G136	m21688	2011-11-06 22:30:21	2011-11-08 08:15:04	2011-11-08 08:15:04	Suggestion on picture quality hierarchy for Low Delay configurations	S. Liu, X. Zhang, S. Lei (MediaTek)
JCTVC-G137	m21690	2011-11-07 01:16:31	2011-11-07 05:58:01	2011-11-07 05:58:01	CE3 : Cross-check of Panasonic's Picture Adaptive 1/8-pel Motion Compensation: Test2-b (JCTVC-G535)	S. Park (ETRI)
JCTVC-G138	m21691	2011-11-07 01:47:24	2011-11-08 23:09:09	2011-11-18 07:29:28	Deblocking of IPCM Blocks Containing Reconstructed Samples	G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G139	m21692	2011-11-07 01:48:37	2011-11-09 02:52:23	2011-11-27 10:57:28	Non-CE6.d: Intra Prediction With Selective Secondary Boundary	G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G140	m21693	2011-11-07 03:09:20	2011-11-09 06:35:43	2011-11-09 06:35:43	CE4: Subtest 2.1.c Cross Check Report for Mediatek AQO CaseC by HKUST	F. Zou, O. C. Au (HKUST)
JCTVC-G141	m21694	2011-11-07 03:11:03	2011-11-09 06:38:16	2011-11-09 06:38:16	CE4: Subtest 2.2.d Cross Check Report for RIM ARL Case D by HKUST	F. Zou, O. C. Au (HKUST)
JCTVC-G142	m21695	2011-11-07 03:22:56	2011-11-08 09:08:51	2011-11-16 05:48:46	CE6.c: LM mode harmonization on SDIP	J. Lim, B. Jeon (LG)
JCTVC-G143	m21696	2011-11-07 03:23:33	2011-11-08 09:09:20	2011-11-16 05:50:21	CE6.c: VLC improvement for intra partitioning on SDIP	J. Lim, B. Jeon (LG)

JCTVC-G144	m21697	2011-11-07 03:25:05	2011-11-08 09:09:47	2011-11-16 05:51:04	Non-CE6: on MPM mapping	J. Lim, S. Park, B. Jeon (LG)
JCTVC-G145	m21698	2011-11-07 03:25:37	2011-11-08 09:10:10	2011-11-23 15:35:11	Non-CE6: Reducing Line Buffers for intra mode	J. Lim, Y. Jeon, S. Park, B. Jeon (LG)
JCTVC-G146	m21699	2011-11-07 03:26:57	2011-11-08 09:10:33	2011-11-22 15:25:14	Non-CE8: Information on CU-based ALF control re-design process	J. Lim, S. Park, B. Jeon (LG)
JCTVC-G147	m21700	2011-11-07 03:27:42	2011-11-08 09:10:56	2011-11-16 05:52:54	Non-CE8: Cross-check of MediaTek's limited number of ALF filter by LG (JCTVC-G215)	J. Lim, S. Park, B. Jeon (LG)
JCTVC-G148	m21701	2011-11-07 03:28:11	2011-11-08 09:11:42	2011-11-16 05:54:45	Non-CE6: Cross-check of MediaTek's MPM mapping by LG (JCTVC-G109)	J. Lim, S. Park, B. Jeon (LG)
JCTVC-G149	m21702	2011-11-07 03:45:43	2011-11-08 19:43:33	2011-11-08 19:43:33	Options for High-Level Syntax for Multistandard Scalability	S. Wenger (Vidyo)
JCTVC-G150	m21703	2011-11-07 03:48:32	2011-11-08 17:35:10	2011-11-08 17:35:10	Proposed Error Pattern Files for JCT-VC	S. Wenger (Vidyo)
JCTVC-G151	m21704	2011-11-07 04:30:43	2011-11-08 18:52:35	2011-11-08 18:52:35	Prediction and partition mode binarization for Low Delay P	X. Zhang, S. Liu, S. Lei (MediaTek)
JCTVC-G152	m21705	2011-11-07 04:33:25	2011-11-08 18:54:54	2011-11-09 19:13:38	Method and syntax for quantization matrices representation	X. Zhang, S. Liu, S. Lei (MediaTek)
JCTVC-G153	m21706	2011-11-07 04:35:26	2011-11-08 16:48:28	2011-11-21 21:39:15	Non-CE6: On intra prediction mode coding	C. Yeo, H. L. Tan, Y. H. Tan, Z. Li (I2R)
JCTVC-G154	m21707	2011-11-07 04:36:11	2011-11-08 18:47:56	2011-11-09 19:04:24	De-quantization without Rounding Offset	X. Zhang, S. Liu, S. Lei (MediaTek)
JCTVC-G155	m21708	2011-11-07 04:37:11	2011-11-08 16:52:28	2011-11-24 19:29:32	Non-CE1: On CABAC context initialization	C. Yeo, Y. H. Tan, Z. Li (I2R)
JCTVC-G156	m21709	2011-11-07 04:38:37	2011-11-08 01:55:53	2011-11-21 21:50:08	CU Depth Pruning for Fast Coding Tree Block Decision	H. L. Tan, C. Yeo, Y. H. Tan (I2R)
JCTVC-G157	m21710	2011-11-07 04:52:32	2011-11-08 10:26:53	2011-11-18 07:55:43	Reference List Construction for Random Access Settings	Hendry, S. Park, B. Jeon (LG)
JCTVC-G158	m21711	2011-11-07 05:06:12	2011-11-08 10:28:09	2011-11-21 15:05:22	Undiscardable Leading Picture for CRA	Hendry, S. Park, B. Jeon (LG)
JCTVC-G159	m21712	2011-11-07 05:10:14	2011-11-08 10:28:48	2011-11-18 07:57:20	Random Access Detection and Notification	Hendry, S. Park, Y. Jeon, B. Jeon (LG)
JCTVC-G160	m21713	2011-11-07 05:12:08	2011-11-08 10:07:46	2011-11-08 10:07:46	Withdrawn (duplicate registration)	
JCTVC-G161	m21714	2011-11-07 05:13:08	2011-11-08 10:08:09	2011-11-08 10:08:09	CE9: cross-verification of ETRI proposal JCTVC-G421 on merge/skip operations for identical motion (MRG_ID03 A, MRG_ID03 B)	Y. Jeon, B. Jeon (LG)

JCTVC-G162	m21715	2011-11-07 05:14:03	2011-11-08 10:08:31	2011-11-08 10:08:31	Non-CE12: cross-verification of JCTVC-G090 on testing results on using HM3.0 delta calculation for luma weak filter by TI	Y. Jeon, S. Park, B. Jeon (LG)
JCTVC-G163	m21716	2011-11-07 05:14:49	2011-11-08 10:08:56	2011-11-27 10:55:37	Non-CE9: simplification of merge/skip TMVP ref_idx derivation	Y. Jeon, S. Park, J. Park, B. Jeon (LG)
JCTVC-G164	m21717	2011-11-07 05:15:14	2011-11-08 10:09:20	2011-11-23 18:04:01	Non-CE9: improvement on parallelized merge/skip mode	Y. Jeon, S. Park, J. Park, B. Jeon (LG)
JCTVC-G165	m21718	2011-11-07 05:17:59	2011-11-08 10:09:45	2011-11-23 18:04:30	Non-CE9/Non-CE13: new MVP positions for merge/skip modes and its combination with replacing redundant MVPs	Y. Jeon, S. Park, B. Jeon (LG), J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G166	m21719	2011-11-07 05:19:30	2011-11-08 10:29:21	2011-11-21 15:07:05	AHG21: Explicit Reference Pictures Signaling with Output Latency Count Scheme	Hendry, S. Park, B. Jeon (LG)
JCTVC-G167	m21720	2011-11-07 05:36:42	2011-11-11 03:10:02	2011-11-11 08:56:36	CE6b: Cross-check report of intra mode coding with 4 MPMs and mode ranking (JCTVC-G243)	S. Cho, S. Lee, N. Eum (ETRI),
JCTVC-G168	m21721	2011-11-07 05:38:55	2011-11-11 08:55:30	2011-11-11 08:55:30	CE6a: Cross-check report of modified down-sampling filter for LM mode of intra chroma prediction (JCTVC-G172)	S. Cho, S. Lee, N. Eum (ETRI)
JCTVC-G169	m21722	2011-11-07 05:40:03	2011-11-11 08:58:41	2011-11-11 08:58:41	CE6a: Cross-check report of modified down-sampling filter for LM mode of intra chroma prediction (JCTVC-G455)	S. Cho, S. Lee, N. Eum (ETRI)
JCTVC-G170	m21723	2011-11-07 05:40:25	2011-11-08 01:48:14	2011-11-21 09:17:33	On issues for interlaced format support in HEVC standard	K. Chono, H. Aoki (NEC)
JCTVC-G171	m21724	2011-11-07 05:49:17	2011-11-07 07:07:08	2011-11-23 09:11:58	Parallel deblocking filter	Jeyun Yu, Seulki Yang, Juwon Byun, Youngjo Kim, Jaeseok Kim
JCTVC-G172	m21725	2011-11-07 06:22:24	2011-11-09 04:13:57	2011-11-19 11:54:51	CE6a: Modified down-sampling filter for LM mode of intra chroma prediction	Y. Chiu, Y. Han, L. Xu, W. zhang, H. Jiang (Intel)
JCTVC-G173	m21726	2011-11-07 06:23:55	2011-11-09 06:33:27	2011-11-27 02:38:14	Cross-channel intra chroma residual prediction	Y. Chiu, Y. Han, L. Xu, W. Zhang, H. Jiang (Intel)
JCTVC-G174	m21727	2011-11-07 06:29:20	2011-11-08 06:09:16	2011-11-08 06:09:16	CE12: Deblocking filter parameter adjustment in slice level	T. Yamakage, S. Asaka, T. Chujoh (Toshiba), M. Karczewicz, I. S. Chong (Qualcomm)
JCTVC-G175	m21731	2011-11-07 07:26:33	2011-11-08 02:16:39	2011-11-22 10:48:59	Non-CE12: BS Decision Tree Simplification	S. Park, N. Park, B. Jeon (LG), X. Guo, J. An, C. Hsu, Y.-W. Huang, S. Lei (MediaTek), G. Auwera, M. Karczewicz (Qualcomm)
JCTVC-G176	m21733	2011-11-07 08:00:29	2011-11-08 02:17:05	2011-11-22 10:49:34	Non-CE12: Simplified BS calculation process	S. Park, B. Jeon (LG)
JCTVC-G177	m21734	2011-11-07	2011-11-08	2011-11-08	Withdrawn	

		08:01:49	02:17:30	02:17:30		
JCTVC-G178	m21735	2011-11-07 08:04:33	2011-11-08 02:17:51	2011-11-16 01:33:59	CE3: Cross-check report for Tool 10 on Progressive Motion Vector Resolution (JCTVC-G277)	S. Park, B. Jeon (LG)
JCTVC-G179	m21736	2011-11-07 08:07:16	2011-11-08 02:18:22	2011-11-16 01:34:51	CE9: Cross-check report of MRG_PAR03 and 04 on parallelized merge/skip mode (JCTVC-G085)	S. Park, B. Jeon (LG)
JCTVC-G180	m21737	2011-11-07 08:09:01	2011-11-08 02:18:42	2011-11-16 01:35:36	CE12.3.2: Cross-check report of Reducing pixel line buffers by modifying DF for horizontal LCU edges (JCTVC-G228)	S. Park, B. Jeon (LG)
JCTVC-G181	m21738	2011-11-07 08:32:39	2011-11-09 02:27:30	2011-11-22 08:42:28	Non-CE9: Merging candidate reordering	H. Takehara, S. Fukushima (JVC Kenwood)
JCTVC-G182	m21739	2011-11-07 08:33:37	2011-11-09 02:29:12	2011-11-22 08:43:27	Non-CE9: AMVP syntax for bi-prediction	H. Takehara, S. Fukushima (JVC Kenwood)
JCTVC-G183	m21740	2011-11-07 08:34:29	2011-11-08 12:43:07	2011-11-23 14:35:34	Test result of low delay tile	K. Kazui, S. Shimada, J. Koyama, A. Nakagawa (Fujitsu)
JCTVC-G184	m21741	2011-11-07 08:34:41	2011-11-09 02:30:28	2011-11-23 08:17:35	Non-CE6: Unified neighboring positions for intra mode coding	S. Fukushima, H. Nakamura (JVC Kenwood)
JCTVC-G185	m21742	2011-11-07 08:35:33	2011-11-09 02:31:39	2011-11-23 16:46:01	Non-CE6: On intra chroma mode coding	T. Kumakura, S. Fukushima (JVC Kenwood)
JCTVC-G186	m21743	2011-11-07 08:36:43	2011-11-09 02:33:10	2011-11-09 02:33:10	CE6: Cross-verification of MediaTek and Qualcomm proposal (JCTVC-G203) by JVC KENWOOD	T. Kumakura, S. Fukushima (JVC Kenwood)
JCTVC-G187	m21744	2011-11-07 08:37:23	2011-11-09 02:34:33	2011-11-09 02:34:33	Non-CE11: Cross-verification of MediaTek proposal (JCTVC-G226) by JVC KENWOOD	S. Fukushima (JVC Kenwood)
JCTVC-G188	m21745	2011-11-07 08:37:50	2011-11-08 12:43:49	2011-11-23 14:39:07	Enhancement on operation of coded picture buffer	K. Kazui, S. Shimada, J. Koyama, A. Nakagawa (Fujitsu)
JCTVC-G189	m21746	2011-11-07 08:41:01	2011-11-08 12:44:33	2011-11-08 12:44:33	CE3: Cross-verification result of Tool 10	K. Kazui (Fujitsu)
JCTVC-G190	m21747	2011-11-07 08:44:42	2011-11-08 12:45:06	2011-11-08 12:45:06	CE9: Cross-verification result of MRG_MVD01	K. Kazui (Fujitsu)
JCTVC-G191	m21748	2011-11-07 08:46:07	2011-11-08 12:45:37	2011-11-18 07:39:29	CE13: Cross-verification result of JCTVC-F402 Test3	K. Kazui (Fujitsu)
JCTVC-G192	m21749	2011-11-07 08:46:44	2011-11-08 07:05:12	2011-11-08 07:05:12	CE6b: Intra remaining mode coding with mode ranking	J. Park, B. Jeon (LG)
JCTVC-G193	m21750	2011-11-07 08:47:27	2011-11-08 12:46:12	2011-11-08 12:46:12	Cross-verification result of JCTVC-G447 on reduced number of intra 64x64 prediction mode	K. Kazui (Fujitsu)
JCTVC-G194	m21751	2011-11-07 08:47:47	2011-11-07 17:12:32	2011-11-26 19:34:40	AHG4: Non-cross-tiles loop filtering for independent tiles	C.-Y. Tsai, C.-W. Hsu, C.-Y. Chen, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek), A. Fuldseth (Cisco)

JCTVC-G195	m21752	2011-11-07 08:50:53	2011-11-08 12:46:57	2011-11-22 20:17:38	Non-CE9/Non-CE13: Averaged merge candidate	S. Shimada, K. Kazui, J. Koyama, A. Nakagawa (Fujitsu)
JCTVC-G196	m21753	2011-11-07 08:52:34	2011-11-08 12:47:45	2011-11-23 07:52:06	Modification of derivation process of motion vector information for interlace format	J. Koyama, A. Yamori, K. Kazui, S. Shimada, A. Nakagawa (Fujitsu)
JCTVC-G197	m21754	2011-11-07 08:54:31	2011-11-07 17:15:34	2011-11-21 02:42:03	AHG4: Low latency CABAC initialization for dependent tiles	C.-W. Hsu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G198	m21755	2011-11-07 08:56:35	2011-11-08 03:51:11	2011-11-24 06:31:13	AHG21: Inter reference picture set prediction syntax and semantics.	T. K. Tan, C. S. Boon (NTT Docomo)
JCTVC-G199	m21756	2011-11-07 08:58:49	2011-11-07 17:18:40	2011-11-27 10:27:46	AHG4: Wavefront tile parallel processing	C.-W. Hsu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G200	m21757	2011-11-07 09:03:18	2011-11-07 17:20:41	2011-11-21 02:46:01	CE1.A.3: Reducing line buffers for CABAC	T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G201	m21758	2011-11-07 09:12:53	2011-11-07 17:22:50	2011-11-21 02:50:05	Non-CE1: Codeword reordering for last_significant_coeff_x and last_significant_coeff_y	T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G202	m21759	2011-11-07 09:21:33	2011-11-08 14:01:10	2011-11-21 02:51:44	Non-CE2: Modified NSQT coefficient scan for CAVLC	C.-W. Hsu, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G203	m21761	2011-11-07 09:27:17	2011-11-07 17:25:13	2011-11-22 07:40:57	CE6b: Intra prediction mode coding	T.-D. Chuang, C.-Y. Chen, M. Guo, X. Guo, Y.-W. Huang, S. Lei (MediaTek), W.-J. Chien, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G204	m21763	2011-11-07 09:40:21	2011-11-07 17:28:00	2011-11-21 02:58:04	CE8.c.2: Single-source SAO and ALF virtual boundary processing	C.-M. Fu, C.-Y. Chen, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G205	m21764	2011-11-07 09:43:05	2011-11-07 17:31:25	2011-11-21 03:00:26	CE8.c.3: Multi-source SAO and ALF virtual boundary processing	C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), S. Esenlik, M. Narroschke, T. Wedi (Panasonic)
JCTVC-G206	m21765	2011-11-07 09:45:32	2011-11-07 17:34:54	2011-11-21 03:02:39	CE8.c.4: SAO and ALF virtual boundary processing with cross9x9	C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), S. Esenlik, M. Narroschke, T. Wedi (Panasonic)
JCTVC-G207	m21766	2011-11-07 09:54:25	2011-11-07 17:37:04	2011-11-21 03:06:21	CE8.c.5: Non-cross-slices SAO	C.-M. Fu, C.-Y. Tsai, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek), M. Budagavi (TI)

JCTVC-G208	m21767	2011-11-07 09:57:54	2011-11-07 17:39:58	2011-11-21 03:08:05	CE8.d.1: Snowflake5x5 and cross9x9 for luma and chroma ALF shapes	C.-Y. Tsai, C.-Y. Chen, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek), I. S. Chong, M. Karczewicz (Qualcomm), T. Yamakage, T. Watanabe, T. Chujoh (Toshiba)
JCTVC-G209	m21768	2011-11-07 10:01:44	2011-11-07 17:42:08	2011-11-23 09:50:17	Modified method for coding mvd in the CABAC mode	S.-T. Hsiang, S. Lei (MediaTek)
JCTVC-G210	m21769	2011-11-07 10:03:38	2011-11-07 10:58:56	2011-11-14 21:40:13	CE1: Subtest 12, Entropy coding comparisons with simplified RDO	T. Davies (Cisco)
JCTVC-G211	m21770	2011-11-07 10:03:42	2011-11-08 14:06:36	2011-11-21 03:12:41	Non-CE8.c.6: Multi-source SAO and ALF virtual boundary processing with cross9x9	C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), S. Esenlik, M. Narroschke, T. Wedi (Panasonic), I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-G212	m21771	2011-11-07 10:09:36	2011-11-08 14:08:59	2011-11-29 08:30:44	Non-CE8.c.7: Single-source SAO and ALF virtual boundary processing with cross9x9	C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), S. Esenlik, M. Narroschke, T. Wedi (Panasonic), I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-G213	m21772	2011-11-07 10:11:27	2011-11-08 12:40:48	2011-11-08 12:40:48	Non-CE4: Performance comparison between temporal QP prediction and temporal MV prediction	H. Aoki, K. Chono (NEC)
JCTVC-G214	m21773	2011-11-07 10:15:20	2011-11-08 14:10:09	2011-11-21 03:16:07	Non-CE8: Constrained ALF coefficients	C.-Y. Chen, C.-Y. Tsai, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G215	m21774	2011-11-07 10:18:19	2011-11-08 14:12:56	2011-11-24 09:04:27	Non-CE8: Limited number of filters per picture for ALF	C.-Y. Chen, C.-Y. Tsai, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G216	m21775	2011-11-07 10:21:01	2011-11-08 14:15:07	2011-11-21 03:19:29	Non-CE8: Removing the 15th merge flag for BA mode in ALF	C.-Y. Chen, C.-Y. Tsai, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G217	m21776	2011-11-07 10:22:24	2011-11-09 05:55:24	2011-11-23 18:08:48	Non-CE9: Derivation process of reference indices for temporal merge candidates	H. Nakamura, S. Fukushima (JVC Kenwood)
JCTVC-G218	m21777	2011-11-07 10:23:24	2011-11-08 15:23:28	2011-11-21 03:24:03	Non-CE8: One-stage non-deblocking loop filtering	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-G219	m21778	2011-11-07 10:25:30	2011-11-09 06:00:18	2011-11-23 19:22:09	Non-CE9: Construction of MVP list without using scaling	H. Nakamura, S. Fukushima (JVC Kenwood)
JCTVC-G220	m21779	2011-11-07 10:25:40	2011-11-08 14:17:30	2011-11-21 03:36:29	Non-CE8: Pure VLC for SAO and ALF	C.-Y. Tsai, C.-M. Fu, C.-Y. Chen, C.-W. Hsu, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G221	m21780	2011-11-07 10:27:46	2011-11-09 06:05:24	2011-11-09 06:05:24	Non-CE13: The maximum number of merging candidates in P-slice	H. Nakamura, S. Fukushima, H. Takehara, M. Ueda (JVC Kenwood)
JCTVC-G222	m21781	2011-11-07 10:28:11	2011-11-08 14:19:40	2011-11-21 03:38:10	Non-CE8: Offset coding in SAO	C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek), I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-G223	m21782	2011-11-07 10:29:59	2011-11-08 14:21:49	2011-11-22 21:23:01	Non-CE9: Division-free MV scaling	T.-D. Chuang, Y.-W. Chen, J.-L. Lin, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G224	m21783	2011-11-07 10:31:20	2011-11-09 06:17:14	2011-11-09 06:17:14	Non-CE13: Multiple-scaled merging candidates	H. Nakamura, S. Fukushima (JVC Kenwood)
JCTVC-G225	m21784	2011-11-07 10:32:08	2011-11-08 14:23:59	2011-11-22 07:42:48	Non-CE9: Simplified AMVP derivation for Inter mode	J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G226	m21785	2011-11-07 10:33:54	2011-11-08 14:25:58	2011-11-21 03:46:17	Non-CE11: Extending MDCS to 16x16 and 32x32 TUs	C.-W. Hsu, X. Zhao, X. Guo, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G227	m21786	2011-11-07 10:35:41	2011-11-09 06:27:55	2011-11-16 07:30:40	Non-CE9: Cross-check for Samsung proposals JCTVC-G552 by JVC Kenwood	H. Nakamura, S. Fukushima (JVC Kenwood)
JCTVC-G228	m21787	2011-11-07 10:36:24	2011-11-08 14:28:45	2011-11-21 03:48:22	CE12.3.2: Reducing pixel line buffers by modifying DF for horizontal LCU boundaries	C.-W. Hsu, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G229	m21788	2011-11-07 10:39:12	2011-11-08 14:30:56	2011-11-21 03:49:48	CE12.3.3: Reducing motion data line buffers	T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G230	m21789	2011-11-07 10:42:14	2011-11-08 15:29:54	2011-11-21 03:51:47	Non-CE12.3: Reducing pixel line buffers by modifying DF to R3W2 for horizontal LCU boundaries	C.-W. Hsu, Y.-W. Huang, S. Lei (MediaTek), M. Ikeda, T. Suzuki (Sony), S. Park, B. Jeon (LG)
JCTVC-G231	m21790	2011-11-07 10:44:31	2011-11-08 14:34:14	2011-11-22 07:45:33	CE13: Results of tests 1, 3d, and 3e in section 3.1 on replacing redundant MVPs and its combination with adaptive MVP list size	J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G232	m21791	2011-11-07 10:46:31	2011-11-08 14:36:35	2011-11-22 07:50:00	CE13: Results of tests 2d and 2e in section 3.1 on adaptive MVP list size	J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G233	m21792	2011-11-07 11:00:44	2011-11-07 15:22:32	2011-11-07 15:22:32	CE1: Subtest 13, Disabling CABAC PMU	T. Davies (Cisco)

JCTVC-G234	m21793	2011-11-07 11:22:59	2011-11-08 11:59:23	2011-11-08 11:59:23	CE8.c.3: Cross-verification of MediaTek and Panasonic proposal on multi-source SAO and ALF virtual boundary processing (JCTVC-G205)	M. Matsumura, S. Takamura, H. Jozawa (NTT)
JCTVC-G235	m21794	2011-11-07 11:47:54	2011-11-08 12:00:46	2011-11-08 12:00:46	CE8.h: CU-based ALF with non-local means filter	M. Matsumura, S. Takamura, H. Jozawa (NTT)
JCTVC-G236	m21796	2011-11-07 11:49:46	2011-11-10 12:04:57	2011-11-18 18:15:59	CE13: Cross-check of Mediatek results section 3.1 (JCTVC-G231) by Canon	P. Onno, G. Laroche (Canon)
JCTVC-G237	m21799	2011-11-07 11:52:18	2011-11-08 09:40:50	2011-11-08 09:40:50	CE12 Subtest 5: Cross-verification of Panasonic's proposal JCTVC-G574	S. Lu, M. Ikeda, T. Suzuki (Sony),
JCTVC-G238	m21807	2011-11-07 12:08:27	2011-11-08 12:40:11	2011-11-18 12:48:43	CE12 Subtest1: Cross-verification of Panasonic proposal JCTVC-G590	M. Ikeda, T. Suzuki (Sony)
JCTVC-G239	m21808	2011-11-07 12:08:56	2011-11-08 15:30:25	2011-11-24 18:08:39	Non-CE11: Modified method for coding the positions of last significant coefficients in the CABAC mode	S.-T. Hsiang, S. Lei (MediaTek)
JCTVC-G240	m21800	2011-11-07 11:53:38	2011-11-08 20:19:10	2011-11-20 23:05:20	CE13: Experiment regarding section 3.5	G. Laroche, T. Poirier, P. Onno (Canon)
JCTVC-G241	m21797	2011-11-07 11:50:46	2011-11-08 19:24:02	2011-11-23 10:00:06	Non-CE9: On parallel derivation of the temporal predictor for Merge/Skip modes	G. Laroche, T. Poirier, P. Onno (Canon)
JCTVC-G242	m21798	2011-11-07 11:51:49	2011-11-08 18:07:32	2011-11-21 17:27:30	CE6b: Mode ranking for remaining mode coding with 2 or 3 MPMs	E. François, S. Pautet, C. Gisquet (Canon),
JCTVC-G243	m21801	2011-11-07 11:56:23	2011-11-08 18:10:44	2011-11-21 19:49:33	CE6b: Intra mode coding with 4 MPMs and mode ranking	E. François, S. Pautet (Canon), Joonyoung Park, Byeongmoon Jeon (LG), Tzu-Der Chuang, Ching-Yeh Chen, Mei Guo, Xun Guo, Yu-Wen Huang, Shawmin Lei (MediaTek), Wei-Jung Chien (Qualcomm), Ehsan Maani, Ali Tabatabai (Sony)
JCTVC-G244	m21802	2011-11-07 11:57:26	2011-11-08 18:23:04	2011-11-21 19:42:37	Non-CE6a: Luma-based chroma prediction - Model correction	C. Gisquet, E. François (Canon)
JCTVC-G245	m21803	2011-11-07 11:58:13	2011-11-08 18:12:08	2011-11-23 16:29:11	Non-CE6a: Use of chroma phase in LM mode	E. François, C. Gisquet, S. Pautet (Canon)
JCTVC-G246	m21804	2011-11-07 11:59:00	2011-11-08 23:33:41	2011-11-24 11:54:48	On additional SAO Band Offset classifications	G. Laroche, T. Poirier, P. Onno (Canon),
JCTVC-G247	m21805	2011-11-07 12:00:25	2011-11-08 18:13:05	2011-11-21 17:32:49	Non-CE5: CAVLC counters normalization per LCU	E. François, S. Pautet, C. Gisquet (Canon)
JCTVC-G248	m21806	2011-11-07 12:02:41	2011-11-08 18:01:06	2011-11-21 10:06:24	Low Complexity Scalable Extension of HEVC intra pictures	S. Lasserre, F. Le Léannec, E. Nassor (Canon)
JCTVC-G249	m21809	2011-11-07	2011-11-08	2011-11-18	CE12 Subtest1: Cross-verification of TI proposal JCTVC-G087	M. Ikeda, T. Suzuki (Sony)

		12:15:33	12:41:37	12:54:47		
JCTVC-G250	m21810	2011-11-07 12:17:18	2011-11-14 14:34:30	2011-11-14 14:34:30	CE3: Cross-check of JCTVC-G391 on MC memory band-width reduction (tool8) from Sony and Nokia	E. François (Canon)
JCTVC-G251	m21811	2011-11-07 12:17:21	2011-11-08 12:43:26	2011-11-18 12:56:20	CE12 Subtest4: Cross-verification of TI proposal JCTVC-G086	M. Ikeda, T. Suzuki (Sony)
JCTVC-G252	m21812	2011-11-07 12:19:37	2011-11-14 14:37:39	2011-11-14 14:37:39	CE6b: Cross-check of JCTVC-G203 on intra mode coding from Qualcomm and MediaTek	E. François (Canon)
JCTVC-G253	m21813	2011-11-07 12:19:55	2011-11-08 12:46:17	2011-11-18 12:58:52	CE12 Subtest3: Cross-verification of MediaTek proposal JCTVC-G228	M. Ikeda, T. Suzuki (Sony)
JCTVC-G254	m21814	2011-11-07 12:20:00	2011-11-09 14:00:05	2011-11-09 14:00:05	Non-CE6b: Cross-check of JCTVC-G153 on MPM index bypass coding from I2R	E. François (Canon)
JCTVC-G255	m21815	2011-11-07 12:25:37	2011-11-08 12:54:47	2011-11-14 12:41:02	CE12 Subtest2: Parallel deblocking improvement based on JCTVC-F214 tool1	M. Ikeda, J. Tanaka, T. Suzuki (Sony)
JCTVC-G256	m21816	2011-11-07 12:27:27	2011-11-08 12:55:23	2011-11-08 12:55:23	CE12 Subtest2: Parallel decision improvement and reduction based on JCTVC-F214 tool2	M. Ikeda, J. Tanaka, T. Suzuki (Sony)
JCTVC-G257	m21817	2011-11-07 12:30:19	2011-11-08 12:52:53	2011-11-08 12:52:53	CE12 Subtest3: Deblocking vertical tap reduction for line buffer based on JCTVC-F215	M. Ikeda, T. Suzuki (Sony)
JCTVC-G258	m21818	2011-11-07 12:40:05	2011-11-08 16:09:03	2011-11-15 12:15:55	CE3: LCU-based adaptive interpolation filter	S. Matsuo, S. Takamura, H. Jozawa (NTT)
JCTVC-G259	m21819	2011-11-07 12:43:00	2011-11-08 16:10:15	2011-11-17 07:33:13	Non-CE3: Modifications of LCU-based adaptive interpolation filter	S. Matsuo, S. Takamura, H. Jozawa (NTT)
JCTVC-G260	m21820	2011-11-07 13:57:51	2011-11-20 10:07:24	2011-11-20 10:07:24	CE6.c: cross-check of case 1, 2 and 3 (Huawei JCTVC-Gxxx)	J. Jung (Orange Labs)
JCTVC-G261	m21821	2011-11-07 14:33:16	2011-11-08 09:47:01	2011-11-08 09:47:01	CE9: cross-check of experiment SP01 – Remove TMVP center position (JCTVC-G084)	J. Jung (Orange Labs)
JCTVC-G262	m21822	2011-11-07 14:46:55	2011-11-09 11:22:45	2011-11-25 11:50:17	HM decoder complexity assessment on ARM	T. Anselmo, D. Alfonso (STM)
JCTVC-G263	m21823	2011-11-07 15:48:33	2011-11-07 15:50:03	2011-11-07 15:50:03	Hardware complexity analysis of spatial transform	X. Tian (Altera)
JCTVC-G264	m21824	2011-11-07 16:18:15	2011-11-08 20:10:47	2011-11-25 09:22:53	AHG18: Adaptive Resolution Coding (ARC)	T. Davies (Cisco), P. Topiwala (FastVDO)
JCTVC-G265	m21825	2011-11-07 16:35:19	2011-11-09 07:13:18	2011-11-22 16:42:32	Core Transform Property for Practical Throughput Hardware Design	M. Tikekar, C.-T. Huang, C. Juvekar, A. Chandrakasan (MIT)
JCTVC-G266	m21826	2011-11-07 16:45:07	2011-11-09 15:34:21	2011-11-22 09:29:57	CE10: Lossless Core Transforms for HEVC	W. Dai, M. Krishnan, J. Topiwala, P. Topiwala (FastVDO), E. Alshina (Samsung)

JCTVC-G267	m21827	2011-11-07 16:49:31	2011-11-07 17:18:58	2011-11-22 12:50:42	CE6.c Report on SDIP chroma extension scheme	J. Song, C. Lai, H. Yang, H. Yu (Huawei)
JCTVC-G268	m21830	2011-11-07 17:06:55	2011-11-09 17:47:29	2011-11-13 02:28:16	AHG22: Lossless Transforms for Lossless Coding	W. Dai, M. Krishnan, J. Topiwala, P. Topiwala (FastVDO)
JCTVC-G269	m21831	2011-11-07 17:13:29	2011-11-07 17:16:18	2011-11-22 12:49:19	CE11 Report on Prediction Unit Dependent Coefficient Scanning For Inter Frame	J. Song, X. Zheng, H. Yang, H. Yu (Huawei)
JCTVC-G270	m21832	2011-11-07 17:23:57	2011-11-17 17:31:40	2011-11-17 17:31:40	Non-CE6a: Cross-checking of JCTVC-G244 - Luma-based chroma prediction - Model correction	P. Bordes, P. Salmon (Technicolor)
JCTVC-G271	m21833	2011-11-07 17:55:41	2011-11-08 16:30:27	2011-11-24 18:11:57	Sign Data Hiding	G. Clare (Orange Labs), F. Henry (Orange Labs), J. Jung (Orange Labs)
JCTVC-G272	m21834	2011-11-07 19:14:12	2011-11-08 20:47:06	2011-11-22 20:35:15	Non-CE10: Core Transform Design for HEVC	J. Dong, Y. Ye (InterDigital)
JCTVC-G273	m21835	2011-11-07 19:47:04	2011-11-23 10:28:48	2011-11-23 10:28:48	Crosscheck for JCTVC-G358 new modes for chroma intra prediction	J. Dong (InterDigital)
JCTVC-G274	m21836	2011-11-07 20:37:56	2011-11-09 19:05:40	2011-11-09 19:05:40	Non-CE9: cross-check of contribution JCTVC-G082 (TI) on modified H TMVP position	J. Jung (Orange Labs)
JCTVC-G275	m21837	2011-11-07 20:46:31	2011-11-16 15:37:56	2011-11-16 15:37:56	CE13: cross-check of experiments T1 (JCTVC-G091), S1 (JCTVC-G776) and C2 (JCTVC-G240)	J. Jung (Orange Labs)
JCTVC-G276	m21838	2011-11-07 22:05:08	2011-11-09 05:35:25	2011-11-09 05:35:25	CE6: Cross-Check report for CE6b subtests of Intra Mode Coding (F062, F459, F091, F106, F269))	G. Li, N. Ling (Santa Clara Univ.), L. Liu, J. Zheng, P. Zhang (HiSilicon)
JCTVC-G277	m21839	2011-11-07 23:00:22	2011-11-08 16:53:51	2011-11-22 09:42:55	CE3: Progressive Motion Vector Resolution	J. An, X. Li, X. Guo, S. Lei (MediaTek)
JCTVC-G278	m21840	2011-11-07 23:03:03	2011-11-08 16:08:05	2011-11-20 20:25:33	CE4 Subtest 2: Adaptive-Dequantization Offset	X. Li, X. Guo, S. Lei (MediaTek)
JCTVC-G279	m21841	2011-11-07 23:04:12	2011-11-19 21:32:16	2011-11-28 08:18:10	CE6 Subtest d: Direction based Angular Intra Prediction	M. Guo, X. Zhao, X. Guo, S. Lei (MediaTek)
JCTVC-G280	m21842	2011-11-07 23:07:10	2011-11-08 16:55:15	2011-11-22 16:49:21	CE6 Subtest d: Intra Prediction with Secondary Boundary	M. Guo, X. Guo, X. Zhao, S. Lei (MediaTek), J. Lainema, K. Ugur (Nokia), K. Sugimoto, S. Sekiguchi, A. Minezawa (Mitsubishi), J. Lee, S.-C. Lim, H. Y. Kim, J. S. Choi (ETRI)
JCTVC-G281	m21843	2011-11-07 23:10:26	2011-11-08 16:57:02	2011-11-22 16:57:12	Non-CE7: Boundary Dependent Transform for Inter Predicted Residue	J. An, X. Zhao, X. Guo, S. Lei (MediaTek)
JCTVC-G282	m21844	2011-11-07	2011-11-08	2011-11-22	Non-CE7: Mode Dependent DCT/DST for Chroma	X. Zhao, X. Guo, M. Guo, S. Lei

		23:13:12	16:58:19	16:58:38		(MediaTek), S. Ma, W. Gao (PKU)
JCTVC-G283	m21845	2011-11-07 23:14:31	2011-11-08 16:59:12	2011-11-24 14:43:40	Residue Quad Tree Depth for Chroma in Intra Coding	X. Zhao, X. Guo, X. Li, S. Lei (MediaTek), S. Ma, W. Gao (PKU)
JCTVC-G284	m21846	2011-11-07 23:15:20	2011-11-08 17:03:22	2011-11-22 17:01:37	CE11: Extended Mode Dependent Coefficient Scanning	X. Zhao, X. Guo, S. Lei (MediaTek), S. Ma, W. Gao (PKU)
JCTVC-G285	m21847	2011-11-07 23:17:52	2011-11-08 17:04:59	2011-11-26 16:56:18	Non-CE11: Methods for Solving the Parsing Issue of MDCS	X. Zhao, X. Guo, C.-W. Hsu, T.-D. Chuang, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G286	m21848	2011-11-07 23:19:14	2011-11-08 17:11:33	2011-11-23 17:09:19	CE12 Subtest 1: Chroma Deblocking Filter	Q. Huang, J. An, X. Guo, S. Lei (MediaTek), A. Norkin, K. Andersson, R. Sjöberg (Ericsson)
JCTVC-G287	m21849	2011-11-07 23:20:08	2011-11-08 17:12:37	2011-11-23 17:10:11	CE12 Subtest 1: Simplified Chroma Deblocking Filter in JCTVC-G286	Q. Huang, J. An, X. Guo, S. Lei (MediaTek), A. Norkin, K. Andersson, R. Sjöberg (Ericsson)
JCTVC-G288	m21850	2011-11-07 23:27:40	2011-11-09 01:32:49	2011-11-09 03:55:03	Non-CE13: Complexity Reduction of MVP List Contruction	Y. Yu, T. Hellman (Broadcom)
JCTVC-G289	m21851	2011-11-07 23:49:32	2011-11-08 23:09:53	2011-11-08 23:09:53	Cross-verification of Sharp's proposal JCTVC-G307 on Bi-prediction restriction in small PUs	M. Zhou (TI)
JCTVC-G290	m21852	2011-11-07 23:59:50	2011-11-09 03:37:54	2011-11-18 06:55:14	Deblocking Filter Simplifications	G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G291	m21853	2011-11-08 00:02:15	2011-11-09 04:51:18	2011-11-18 20:04:08	Non-CE12 Subtest 5: Transform Dependent Deblocking Filter Parameter Adjustment in Slice Level	G. Van der Auwera, R. Joshi, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G292	m21854	2011-11-08 00:04:29	2011-11-09 06:36:38	2011-11-17 23:34:56	CE12 Subtest3: Cross Check of Mediatek's Motion Data Line Buffer Reduction Proposal JCTVC-G229	G. Van der Auwera (Qualcomm)
JCTVC-G293	m21855	2011-11-08 00:07:01	2011-11-09 06:04:17	2011-11-18 21:32:16	CE6.d: Cross Check of Category 4 on Tool Combinations for Intra Prediction with Secondary Boundary	G. Van der Auwera (Qualcomm)
JCTVC-G294	m21856	2011-11-08 00:48:00	2011-11-08 16:15:02	2011-11-08 16:15:02	CE6: Cross-check report for CE6a Sony proposal on improvement to chroma intra prediction from luma	H. Sasai, T. Matsunobu, T. Nishi (Panasonic)
JCTVC-G295	m21857	2011-11-08 00:48:54	2011-11-08 01:10:04	2011-11-08 01:10:04	Non-CE4 Subtest3 : Extension of Adaptation Parameter Sets syntax for Quantization matrix	J. Tanaka, Y. Morigami, T. Suzuki (Sony)
JCTVC-G296	m21858	2011-11-08 00:50:29	2011-11-08 01:04:44	2011-11-08 21:36:28	Picture-adaptive Field/Frame Coding: support for legacy video	O. Bar-Nir (Harmonic)

JCTVC-G297	m21859	2011-11-08 00:52:40	2011-11-08 16:15:42	2011-11-08 16:15:42	CE6: Cross-check report for CE6a TI & Sony proposal on sub-sampling portion of neighboring pixels in calculation of LM parameters	H. Sasai, T. Matsunobu, T. Nishi (Panasonic)
JCTVC-G298	m21860	2011-11-08 00:57:25	2011-11-08 16:17:16	2011-11-08 16:17:16	CE1: Cross-check report for CE1 Subset A MediaTek proposal on Reducing Line Buffers for CABAC	H. Sasai, T. Nishi (Panasonic)
JCTVC-G299	m21861	2011-11-08 00:57:36	2011-11-09 04:27:44	2011-11-09 04:27:44	CE8 Subtest h: Cross verification of NTT's CU-based ALF with NLM filter (JCTVC-G235) by Intel	Y. Chiu, L. Xu (Intel)
JCTVC-G300	m21862	2011-11-08 01:01:32	2011-11-08 16:18:03	2011-11-08 16:18:03	CE1: Cross-check report for CE1 Subset C Test 7	H. Sasai, T. Nishi (Panasonic)
JCTVC-G301	m21863	2011-11-08 01:01:35	2011-11-08 01:06:37	2011-11-21 10:50:14	Test Results On Context simplification for coefficients entropy coding	W. Ding (Beijing Univ. Tech.), J. Xu (Microsoft), X. Che, Y. Shi, B. Yin (Beijing Univ. Tech.)
JCTVC-G302	m21864	2011-11-08 01:05:00	2011-11-08 16:18:43	2011-11-08 16:18:43	CE11: Cross-check report for CE11 B2 Qualcomm proposal on Removal of the parsing dependency of residual coding on intra mode	H. Sasai, T. Nishi (Panasonic)
JCTVC-G303	m21865	2011-11-08 01:06:31	2011-11-08 19:51:20	2011-11-08 19:51:20	CE-4 Subset-3: Cross-check for Sony Proposal (JCTVC-G434) on Quantization Matrix	Z. Zhou, X. Zhang (MediaTek)
JCTVC-G304	m21866	2011-11-08 01:07:51	2011-11-09 06:08:26	2011-11-22 12:39:26	CE7: Experimental Results for the ROT	Z. Ma, F. Fernandes, E. Alshina, A. Alshin (Samsung)
JCTVC-G305	m21867	2011-11-08 01:08:36	2011-11-08 10:36:41	2011-11-22 21:41:18	Non-CE9: Bi-prediction for low delay coding	Y. Suzuki, A. Fujibayashi (NTT DOCOMO)
JCTVC-G306	m21868	2011-11-08 01:08:38	2011-11-08 19:55:14	2011-11-08 19:55:14	CE-4 Subset-3: Cross-check for TI Proposal (JCTVC-G083) on Quantization Matrix	Z. Zhou, X. Zhang (MediaTek)
JCTVC-G307	m21869	2011-11-08 01:28:28	2011-11-08 07:03:48	2011-11-22 21:49:47	Bi-prediction restriction in small PU	T. Ikai (Sharp)
JCTVC-G308	m21870	2011-11-08 01:29:06	2011-11-08 07:05:43	2011-11-18 08:24:03	Complexity reduction of significant map coding	T. Ikai (Sharp)
JCTVC-G309	m21871	2011-11-08 01:29:44	2011-11-08 09:36:46	2011-11-08 09:36:46	Modifications of offset classifications in SAO	Y. Yasugi, T. Ikai (Sharp)
JCTVC-G310	m21872	2011-11-08 01:30:25	2011-11-08 09:14:34	2011-11-08 09:14:34	CE5: CAVLC Adaptation using Difference Counter	T. Yamamoto (Sharp)
JCTVC-G311	m21873	2011-11-08 01:31:09	2011-11-08 09:17:47	2011-11-08 09:17:47	CE6b: Cross-check of Intra Mode Coding (JCTVC-G242 and JCTVC-G243)	T. Yamamoto (Sharp)
JCTVC-G312	m21874	2011-11-08 01:31:48	2011-11-08 09:15:15	2011-11-08 09:15:15	Non-Square Partition Mode Grouping for CAVLC	T. Yamamoto (Sharp)
JCTVC-G313	m21875	2011-11-08	2011-11-08	2011-12-01	CE4 Subtest 1.3.c: cross-verification of JCTVC-G067	Y. Yasugi (Sharp)

		01:36:43	09:29:29	05:51:17		
JCTVC-G314	m21876	2011-11-08 01:37:40	2011-11-09 01:01:12	2011-11-23 10:22:54	AHG21: On DPB management	Y. -K. Wang, Y. Chen (Qualcomm)
JCTVC-G315	m21877	2011-11-08 01:42:53	2011-11-09 01:03:11	2011-11-23 12:25:24	AHG4: Unification of picture partitioning schemes	M. Coban, Y. -K. Wang, M. Karczewicz, Y. Chen, I. S. Chong (Qualcomm)
JCTVC-G316	m21878	2011-11-08 01:44:13	2011-11-08 07:07:59	2011-11-22 23:50:19	CE8.a.1: 2-D mergeable syntax	T. Ikai (Sharp), I. S. Chong, M. Karczewicz (Qualcomm), T. Yamakage, T. Watanabe, T. Chujoh (Toshiba), C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G317	m21879	2011-11-08 01:46:15	2011-11-09 01:03:52	2011-11-23 10:24:17	AHG4: Dependency and loop filtering control over tile boundaries	Y. -K. Wang, Y. Chen, I. S. Chong, M. Coban, M. Karczewicz (Qualcomm)
JCTVC-G318	m21880	2011-11-08 01:49:51	2011-11-09 01:04:19	2011-11-23 10:24:43	AHG4: Tile groups	Y. -K. Wang, Y. Chen, M. Coban, M. Karczewicz (Qualcomm)
JCTVC-G319	m21881	2011-11-08 01:53:27	2011-11-09 01:04:46	2011-11-23 10:27:45	AHG15: Conforming bitstreams starting with CRA pictures	Y. Chen, Y. -K. Wang, M. Karczewicz (Qualcomm)
JCTVC-G320	m21882	2011-11-08 01:55:03	2011-11-09 08:11:11	2011-11-21 14:48:25	CE11: Scanning Passes of Residual Data in HE	J. Sole, R. Joshi, M. Karczewicz (Qualcomm)
JCTVC-G321	m21883	2011-11-08 01:55:06	2011-11-09 08:16:36	2011-11-19 02:40:32	CE11: Removal of the parsing dependency of residual coding on intra mode	J. Sole, Y. Zheng, W.-J. Chien, R. Joshi, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G322	m21884	2011-11-08 01:55:09	2011-11-09 09:03:52	2011-11-21 15:00:51	CE6.c: Harmonization of HE residual coding with non-square block transforms	J. Sole, R. Joshi, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G323	m21885	2011-11-08 01:55:22	2011-11-09 11:27:05	2011-11-29 08:50:28	Non-CE11: Diagonal sub-block scan for HE residual coding	J. Sole, R. Joshi, M. Karczewicz (Qualcomm)
JCTVC-G324	m21886	2011-11-08 01:55:27	2011-11-09 10:28:13	2011-11-22 15:35:18	Modified LPS range and state transition tables for BAC	J. Sole, M. Karczewicz (Qualcomm)
JCTVC-G325	m21887	2011-11-08 01:55:32	2011-11-09 01:05:11	2011-11-23 10:29:08	AHG15: Picture size signaling	Y. Chen, Y. -K. Wang, M. Karczewicz (Qualcomm)
JCTVC-G326	m21888	2011-11-08 01:55:32	2011-11-09 09:09:39	2011-11-21 17:03:02	Non-CE1.b: On the exponential memory decay probability update	J. Sole, M. Karczewicz (Qualcomm)
JCTVC-G327	m21889	2011-11-08 01:55:38	2011-11-09 09:12:28	2011-11-09 09:12:28	CE11: Cross-check of TI's reduction in contexts used for coefficient level (JCTVC-G121)	J. Sole (Qualcomm)
JCTVC-G328	m21890	2011-11-08	2011-11-09	2011-11-23	AHG8: Bit depth of output pictures	Y. Chen, Y. -K. Wang, X.

		01:59:02	01:05:41	10:30:35		Wang, I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-G329	m21891	2011-11-08 02:01:00	2011-11-08 11:50:22	2011-11-08 11:50:22	AHG18: Comments on the Implementations of Resolution Adaption on HEVC	M. LI, P. WU (ZTE)
JCTVC-G330	m21892	2011-11-08 02:01:48	2011-11-09 01:06:21	2011-11-23 10:31:11	AHG15: Syntax elements in adaptation parameter set	Y. Chen, Y. -K. Wang, M. Karczewicz (Qualcomm)
JCTVC-G331	m21893	2011-11-08 02:03:56	2011-11-09 01:06:50	2011-11-09 01:06:50	AHG15: On NAL unit types and slice types	Y. -K. Wang, Y. Chen (Qualcomm)
JCTVC-G332	m21894	2011-11-08 02:03:59	2011-11-08 11:54:51	2011-11-15 14:11:12	Multiple Adaptation Parameter Sets Referring	M. LI, P. WU (ZTE)
JCTVC-G333	m21895	2011-11-08 02:06:40	2011-11-08 12:58:25	2011-11-08 12:58:25	Accuracy improvement of HM transform bases	Y. Sugito, A. Ichigaya, S. Sakaida (NHK)
JCTVC-G334	m21896	2011-11-08 02:06:56	2011-11-09 01:07:26	2011-11-23 10:31:54	AHG15: On sequence parameter set and picture parameter set	Y. -K. Wang, Y. Chen, Y. Zheng, W. -J. Chien (Qualcomm)
JCTVC-G335	m21897	2011-11-08 02:08:23	2011-11-08 12:57:44	2011-11-14 05:17:47	Cross-check on 7 bit transform matrices (JCTVC-G496)	Y. Sugito, A. Ichigaya (NHK)
JCTVC-G336	m21898	2011-11-08 02:08:41	2011-11-09 03:05:59	2011-11-23 10:33:24	AHG 17: Unified NAL unit header design for HEVC and its extensions	Y. Chen, Y. -K. Wang, M. Karczewicz (Qualcomm)
JCTVC-G337	m21899	2011-11-08 02:09:00	2011-11-08 07:34:41	2011-11-08 07:34:41	Non-CE8.c.7: Crosscheck of Single-source SAO and ALF virtual boundary processing (JCTVC-G212)	T. Ikai (Sharp)
JCTVC-G338	m21900	2011-11-08 02:09:22	2011-11-10 07:51:15	2011-11-10 07:51:15	Non-CE8.a: Crosscheck of Non-CE8 Subtest a: Harmonization of CE8a Tool 2(SDBA) and Tool 3(HV8) (JCTVC-G656)	T. Ikai (Sharp)
JCTVC-G339	m21901	2011-11-08 02:09:43	2011-11-11 03:10:16	2011-11-16 06:40:24	Crosscheck of LG ALF (JCTVC-G146)	T. Ikai (Sharp)
JCTVC-G340	m21902	2011-11-08 02:11:18	2011-11-09 01:49:59	2011-11-17 08:17:32	CE5: Cross-check of CAVLC coefficients coding (JCTVC-G674)	T. Yamamoto (Sharp)
JCTVC-G341	m21903	2011-11-08 02:28:25	2011-11-08 06:29:52	2011-11-08 06:29:52	Crosscheck of MediaTek AMVP simplification JCTVC-G225	J. Park, S. Park, B. Jeon (LG)
JCTVC-G342	m21904	2011-11-08 02:52:44	2011-11-09 04:31:14	2011-11-09 04:31:14	CE3: Cross-verification of Qualcomm's adaptive motion vector resolution (JCTVC-G727) by Intel	Y. Chiu, W. Zhang, L. Xu, Y. Han (Intel)
JCTVC-G343	m21905	2011-11-08 02:54:24	2011-11-08 14:15:37	2011-11-22 12:23:35	Non-CE9: Improvement in temporal candidate of merge mode and AMVP	N. Zhang, X. Fan, S. Ma, D. Zhao (Harbin Inst. Tech.)
JCTVC-G344	m21906	2011-11-08 03:17:34	2011-11-10 01:10:08	2011-11-10 03:46:49	Cross-verification report for motion vector predictor candidate clipping removal (JCTVC-G134)	H. Aoki, K. Chono (NEC)
JCTVC-G345	m21907	2011-11-08 03:19:45	2011-11-08 12:29:31	2011-11-18 05:00:28	Non-CE7: Restricted mode-dependent 8x8 DST for Intra prediction	A. Ichigaya, Y. Sugito, S. Sakaida (NHK)

JCTVC-G346	m21908	2011-11-08 03:34:07	2011-11-08 14:18:43	2011-11-28 17:18:47	Chroma intra prediction based on residual luma samples	K. Kawamura, T. Yoshino, H. Kato, S. Naito (KDDI)
JCTVC-G347	m21909	2011-11-08 03:36:10	2011-11-08 06:41:58	2011-11-08 06:41:58	Cross-check report of NTT interpolation filter approach JCTVC-G259	T. Yoshino, S. Naito (KDDI)
JCTVC-G348	m21910	2011-11-08 03:37:33	2011-11-08 06:42:57	2011-11-08 06:42:57	Cross-check report of NTT intra prediction approach JCTVC-G350	T. Yoshino, S. Naito (KDDI)
JCTVC-G349	m21911	2011-11-08 03:39:53	2011-11-08 16:19:50	2011-11-21 10:16:41	CE1: SubtestA: Parallel context processing for coefficient coding using block-based context updates	H. Sasai, T. Nishi (Panasonic)
JCTVC-G350	m21912	2011-11-08 03:42:16	2011-11-08 21:08:09	2011-11-25 06:36:18	Modification of angular intra prediction	S. Matsuo, S. Takamura, H. Jozawa (NTT)
JCTVC-G351	m21913	2011-11-08 03:45:18	2011-11-09 04:27:14	2011-11-19 00:42:50	Modification of ALF classification	E. Maani, M. Ikeda (Sony)
JCTVC-G352	m21914	2011-11-08 03:47:19	2011-11-09 04:15:40	2011-11-19 00:45:58	Parameterization of Default Quantization Matrices	E. Maani, M. Haque, A. Tabatabai (Sony)
JCTVC-G353	m21915	2011-11-08 03:59:30	2011-11-09 02:36:03	2011-11-23 16:43:07	Non-CE4: QP prediction using spatial QP	H. Nakamura, M. Nishitani, S. Fukushima, T. Kumakura (JVC Kenwood)
JCTVC-G354	m21916	2011-11-08 04:31:56	2011-11-09 04:44:32	2011-11-19 01:08:07	Non-CE6: Improvements for SDIP	J. Xu, E. Maani, A. Tabatabai (Sony)
JCTVC-G355	m21917	2011-11-08 04:32:01	2011-11-09 10:24:48	2011-11-19 09:08:53	Non-CE5: joint coding of splitting flag and inter modes	W. Zhang, P. Wu,
JCTVC-G356	m21918	2011-11-08 04:32:24			Withdrawn	
JCTVC-G357	m21919	2011-11-08 04:33:16	2011-11-09 04:48:42	2011-11-19 01:05:22	Non-CE4: Improvement of Intra prediction based QP prediction	J. Xu, A. Tabatabai, K. Sato (Sony)
JCTVC-G358	m21920	2011-11-08 04:33:42	2011-11-10 04:31:43	2011-11-27 09:42:26	New modes for chroma intra prediction	X. Zhang, O. C. Au, J. Dai, F. Zou, C. Pang, X. Wen (HKUST)
JCTVC-G359	m21921	2011-11-08 04:34:26	2011-11-09 06:25:14	2011-11-30 09:09:46	Non-CE6: Coding of luma intra prediction modes that are not in the MPM set	R. Cohen, X. Xu, A. Vetro, H. Sun (MERL)
JCTVC-G360	m21922	2011-11-08 04:34:46	2011-11-09 04:50:34	2011-11-19 01:00:26	CE5: Redundancy removal for Run-mode in CAVLC (JCTVC-F286)	J. Xu, A. Tabatabai (Sony)
JCTVC-G361	m21923	2011-11-08 04:34:51	2011-11-09 04:46:43	2011-11-09 04:46:43	CE6.d: Crosscheck of JCTVC-F122 on gradient based intra prediction for vertical and horizontal set secondary boundary intra prediction from MediaTek	C. Auyeung (Sony)
JCTVC-G362	m21924	2011-11-08 04:36:11	2011-11-09 04:59:24	2011-11-19 06:58:16	Non-CE4: Efficient binarization of delta_QP in CABAC with signaling of Max and Min QP	J. Xu, K. Kondo, K. Sato, A. Tabatabai (Sony)
JCTVC-G363	m21925	2011-11-08	2011-11-09	2011-11-20	CE4: Improvement of delta-QP coding (1.3.a)	J. Xu, K. Kondo, K. Sato, A.

		04:37:31	05:03:12	23:29:46		Tabatabai (Sony)
JCTVC-G364	m21926	2011-11-08 04:37:32	2011-11-09 04:47:56	2011-11-09 04:47:56	CE11: Crosscheck of JCTVC-F124 on Extended Mode-Dependent Coefficient Scanning from MediaTek	C. Auyeung (Sony)
JCTVC-G365	m21927	2011-11-08 04:38:28	2011-11-09 05:08:58	2011-11-19 00:58:52	Non-CE5: Redefined contexts for last nonzero coefficient coding of 4x4 TU in CAVLC	J. Xu, A. Tabatabai (Sony)
JCTVC-G366	m21928	2011-11-08 04:39:55	2011-11-09 04:49:48	2011-11-18 23:55:18	Non-CE11: Context reduction of significance map coding with CABAC	C. Auyeung, J. Xu (Sony)
JCTVC-G367	m21929	2011-11-08 04:40:18	2011-11-09 03:06:20	2011-11-09 03:06:20	CE5: cross-check for Samsung's CAVLC (JCTVC-G532)	J. Xu, M. Haque (Sony)
JCTVC-G368	m21930	2011-11-08 04:41:08			Withdrawn	
JCTVC-G369	m21931	2011-11-08 04:41:14	2011-11-09 03:07:59	2011-11-19 00:57:40	CE6.c: cross-check for SDIP (JCTVC-G556)	J. Xu, A. Tabatabai (Sony)
JCTVC-G370	m21932	2011-11-08 04:41:56	2011-11-09 04:54:17	2011-11-19 00:00:10	Binarisation of last position for higher throughput	C. Auyeung (Sony)
JCTVC-G371	m21933	2011-11-08 04:42:11	2011-11-09 03:09:33	2011-11-09 03:09:33	CE8 Subset b: cross-check for Cisco's ALF (JCTVC-G498)	J. Xu, A. Tabatabai (Sony)
JCTVC-G372	m21934	2011-11-08 04:46:01	2011-11-09 04:58:21	2011-11-19 00:04:31	Coding order of sign and level minus 3 with CABAC	C. Auyeung, T. Suzuki (Sony)
JCTVC-G373	m21935	2011-11-08 04:47:08	2011-11-09 05:09:56	2011-11-19 00:29:02	Non-CE6: Performance of secondary boundary DC intra prediction	C. Auyeung (Sony)
JCTVC-G374	m21936	2011-11-08 05:03:43	2011-11-08 07:47:27	2011-11-22 13:02:40	Improving the Intra Prediction Based on a Uniform Probability Model	L. Liu (HiSilicon)
JCTVC-G375	m21937	2011-11-08 05:04:30	2011-11-08 16:29:13	2011-11-24 10:05:16	CE7: Cross Check Report for CE7 Tool 3, Rotational Only Transform	Y. Shibahara, T. Nishi (Panasonic)
JCTVC-G376	m21938	2011-11-08 05:05:02	2011-11-08 16:20:32	2011-11-18 14:00:02	Cross-check report of CE7 Tool 4, Mode-Dependent DCT/DST for 4x4 Chroma Blocks (JCTVC-G107)	Y. Shibahara, T. Nishi (Panasonic)
JCTVC-G377	m21939	2011-11-08 05:05:19	2011-11-08 21:52:13	2011-11-15 10:12:42	Non-CE6: Cross-check report of proposal on coding of luma intra prediction modes that are not in the MPM set (JCTVC-G359)	Y. Shibahara, T. Nishi (Panasonic)
JCTVC-G378	m21940	2011-11-08 05:05:44	2011-11-08 21:54:10	2011-11-16 11:51:36	Cross Check Report for Improvement to chroma TU specification (JCTVC-G442)	Y. Shibahara, T. Nishi (Panasonic)
JCTVC-G379	m21941	2011-11-08 05:05:51	2011-11-08 14:36:10	2011-11-08 14:36:10	CE3:Cross-check report of LCU-based adaptive interpolation filter (JCTVC-G258)	T. Yoshino, S. Naito (KDDI)
JCTVC-G380	m21942	2011-11-08 05:06:28	2011-11-08 14:07:12	2011-11-23 06:45:27	Non-CE8: Coding tree level signaling of alf_cu_flag	T. Nishi, K. Uchibayashi (Panasonic)
JCTVC-G381	m21943	2011-11-08	2011-11-08	2011-11-29	Nearest placement of Y/Cb/Cr transform coefficients locating at	Y. Shibahara, K. Uchibayashi,

		05:06:49	21:48:42	20:35:25	same spatial position	T. Nishi (Panasonic)
JCTVC-G382	m21944	2011-11-08 05:07:06	2011-11-09 01:22:51	2011-11-29 14:13:15	CE4 Subtest-2 Adaptive Reconstruction Levels	X. Yu, J. Wang, D. He, G. Martin-Cocher, E. Yang (RIM)
JCTVC-G383	m21945	2011-11-08 05:20:34	2011-11-09 04:01:22	2011-11-19 02:00:18	CE12 Subtest1: Deblocking of New Non-Square Blocks: Edge Shift for AMP	G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G384	m21946	2011-11-08 05:21:59	2011-11-08 22:49:15	2011-11-18 08:15:21	Varying QP Deblocking	G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G385	m21947	2011-11-08 05:23:43	2011-11-12 01:57:46	2011-11-18 21:34:51	Cross check of Panasonic JCTVC-G638 and JCTVC-G639 on Deblocking	G. Van der Auwera (Qualcomm)
JCTVC-G386	m21948	2011-11-08 05:30:58	2011-11-21 03:54:41	2011-11-25 12:49:22	Non-CE10: Cross Check Report for JCTVC-G272 Core Transform Design for HEVC.	K. Tang, X. Zhang, O. C. Au, X. Wen (HKUST)
JCTVC-G387	m21949	2011-11-08 05:41:34	2011-11-10 04:40:21	2011-11-29 15:18:43	Non-CE9 Parallel Merge/skip Mode for HEVC	X. Wen, O. Au, W. Dai, C. Pang, J. Dai, F. Zou, X. Zhan (HKUST)
JCTVC-G388	m21951	2011-11-08 06:19:59	2011-11-08 06:22:42	2011-11-21 06:46:03	CE12: Cross-check of Mitsubishi deblocking filter JCTVC-G466	T. Yamakage, S. Asaka (Toshiba)
JCTVC-G389	m21952	2011-11-08 06:51:10	2011-11-08 06:56:23	2011-11-08 06:56:23	CE5: CAVLC coding table modification	S. Kim, J. Lee, S. Lee (Yonsei Univ.), C. Kim, Y. Park, J. Park (Samsung)
JCTVC-G390	m21953	2011-11-08 06:55:19	2011-11-08 13:39:46	2011-11-22 15:46:16	CE3: MC boundary filter (tool 7)	K. Kondo, T. Suzuki (Sony)
JCTVC-G391	m21954	2011-11-08 06:55:57	2011-11-08 13:40:36	2011-11-22 15:58:04	CE3: Tap length reduction for small block (tool 8)	K. Kondo, T. Suzuki (Sony), K. Ugur (Nokia)
JCTVC-G392	m21955	2011-11-08 06:56:43	2011-11-08 13:41:01	2011-11-24 18:05:38	Non-CE3: Report on a restriction for small block	K. Kondo, T. Suzuki (Sony)
JCTVC-G393	m21956	2011-11-08 06:57:22	2011-11-08 13:41:30	2011-11-19 12:49:18	CE3: Cross check for Toshiba proposal JCTVC-G427 (tool 2)	K. Kondo, T. Suzuki (Sony)
JCTVC-G394	m21957	2011-11-08 06:57:56	2011-11-08 13:42:01	2011-11-19 12:59:04	CE3: Cross check for Samsung proposal (tool 1)	K. Kondo, T. Suzuki (Sony)
JCTVC-G395	m21958	2011-11-08 06:58:32	2011-11-08 13:42:43	2011-11-19 13:12:15	CE3: Cross check for eBrisk proposal JCTVC-G057 (tool 6)	K. Kondo, T. Suzuki (Sony)
JCTVC-G396	m21959	2011-11-08 07:11:11	2011-11-08 10:10:21	2011-11-23 18:05:09	Non-CE9: reordering of merge candidate	C. Kim, Y. Jeon, B. Jeon (LG)
JCTVC-G397	m21961	2011-11-08 07:31:32	2011-11-08 13:51:00	2011-11-22 02:19:46	Non-CE9/Non-CE13: Simplification of adding new merge candidates	B. Li (USTC), J. Xu (Microsoft), H. Li (USTC)
JCTVC-G398	m21962	2011-11-08 07:32:30	2011-11-08 13:51:49	2011-11-22 02:36:28	High-level Syntax: Marking process for non-TMVP pictures	B. Li (USTC), J. Xu (Microsoft), H. Li (USTC)

JCTVC-G399	m21963	2011-11-08 07:32:54	2011-11-08 13:58:04	2011-11-22 02:47:23	Comparison of Compression Performance of HEVC Working Draft 4 with AVC High Profile	B. Li (USTC), G. J. Sullivan, J. Xu (Microsoft)
JCTVC-G400	m21964	2011-11-08 07:33:38	2011-11-09 00:09:11	2011-11-22 02:50:33	CE4: Equal expected magnitude (EEM) encoder-only adaptive quantization rule for HEVC	B. Li (USTC), J. Xu, G. J. Sullivan (Microsoft)
JCTVC-G401	m21965	2011-11-08 07:34:12	2011-11-09 02:10:18	2011-11-22 03:01:38	RDO with weighted distortion in HEVC	B. Li (USTC), G. J. Sullivan, J. Xu (Microsoft)
JCTVC-G402	m21966	2011-11-08 07:34:41	2011-11-08 14:05:52	2011-11-08 14:05:52	CE5: Cross-check of CAVLC Adaptation using Difference Counter (JCTVC-G310)	B. Li (USTC), J. Xu (Microsoft)
JCTVC-G403	m21967	2011-11-08 07:35:12	2011-11-09 00:10:52	2011-11-28 12:17:06	CE4-Subtest-2 Cross-check of Adaptive Reconstruction Levels for Quantization Design (JCTVC-G382)	B. Li (USTC), J. Xu, G. J. Sullivan (Microsoft)
JCTVC-G404	m21968	2011-11-08 07:35:30	2011-11-08 14:07:05	2011-11-08 14:07:05	CE9: Cross-check of parallelized merge/skip mode (JCTVC-G085)	B. Li (USTC), J. Xu (Microsoft)
JCTVC-G405	m21969	2011-11-08 07:35:52	2011-11-08 14:07:59	2011-11-08 14:07:59	Non-CE5: Cross-check of CAVLC counters normalization per LCU (JCTVC-G247)	B. Li (USTC), J. Xu (Microsoft)
JCTVC-G406	m21970	2011-11-08 07:36:11	2011-11-09 00:22:18	2011-11-09 00:22:18	Non-CE9: Improvement in temporal candidate of merge mode and AMVP (JCTVC-G343)	B. Li (USTC), J. Xu (Microsoft)
JCTVC-G407	m21971	2011-11-08 07:36:33	2011-11-08 14:09:08	2011-11-08 14:09:08	Non-CE9: Cross-check of parallelized merge/skip mode for HEVC (JCTVC-G387)	B. Li (USTC), J. Xu (Microsoft)
JCTVC-G408	m21972	2011-11-08 07:36:50	2011-11-08 14:10:26	2011-11-08 14:10:26	Non-CE6: Cross-check of Remove potential duplicate modes from the candidate mode list for chroma intra prediction (JCTVC-G423)	B. Li (USTC), J. Xu (Microsoft)
JCTVC-G409	m21973	2011-11-08 07:42:19	2011-11-08 14:13:14	2011-11-08 14:13:14	CE12, Subset 1: Report of Deblocking for Large Size Blocks	Z. Shi (USTC), X. Sun, J. Xu (Microsoft)
JCTVC-G410	m21974	2011-11-08 07:43:02	2011-11-08 14:14:21	2011-11-08 14:14:21	CE12, Subset 1: Cross-verification report for MediaTek and Ericsson proposal JCTVC-G286	Z. Shi (USTC), J. Xu (Microsoft)
JCTVC-G411	m21975	2011-11-08 07:44:00	2011-11-08 14:15:13	2011-11-08 14:15:13	CE12, Subset 1: Cross-verification report for MediaTek and Ericsson proposal JCTVC-G287	Z. Shi (USTC), J. Xu (Microsoft)
JCTVC-G412	m21976	2011-11-08 07:46:13	2011-11-09 02:26:02	2011-11-09 02:26:02	CE11: Cross-check result of Significance Map interleaving part of Qualcomm proposal on Parallel Processing of Residual data in HE (JCTVC-G320)	C. Rosewarne, M. Maeda (Canon)
JCTVC-G413	m21977	2011-11-08 07:51:05	2011-11-09 02:29:54	2011-11-24 12:54:18	Modified probability update and table removal for multi-parameter CABAC update (JCTVC-F254)	C. Rosewarne, M. Maeda (Canon)
JCTVC-G414	m21978	2011-11-08 07:55:25	2011-11-08 08:59:21	2011-11-08 08:59:21	CE8.c.5: Cross-check of MediaTek/TI non-cross-slices SAO JCTVC-G207	T. Yamakage, T. Watanabe (Toshiba)
JCTVC-G415	m21979	2011-11-08 08:01:55	2011-11-08 23:46:07	2011-11-22 12:42:44	MC Complexity Reduction for Bi-prediction	H. Y. Kim (ETRI), K. Y. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee, J. S. Choi (ETRI)
JCTVC-G416	m21980	2011-11-08	2011-11-08	2011-11-21	CU-based Merge Candidate List Construction	H. Y. Kim (ETRI), K. Y. Kim,

		08:02:06	23:52:14	20:56:32		S. M. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee, J. S. Choi (ETRI)
JCTVC-G417	m21981	2011-11-08 08:02:14	2011-11-08 11:14:58	2011-11-08 11:14:58	Improved coding of CU-level information in CAVLC	S. Y. Yi (KAU), H. Choi (Hanbat Univ.), S.-C. Lim (ETRI), J.-G. Kim (KAU), H. Y. Kim, J. Lee, J. S. Choi (ETRI)
JCTVC-G418	m21982	2011-11-08 08:02:22	2011-11-08 14:15:06	2011-11-17 11:35:39	Simplification of intra prediction mode mapping method	J. Lee, S.-C. Lim, H. Y. Kim, J. S. Choi (ETRI)
JCTVC-G419	m21983	2011-11-08 08:02:36	2011-11-08 15:04:05	2011-11-28 14:25:11	Inconsistency of intra LM mode between HM and WD	J. Lee, S.-C. Lim, H. Y. Kim, J. S. Choi (ETRI)
JCTVC-G420	m21984	2011-11-08 08:02:43	2011-11-08 14:13:13	2011-11-08 14:13:13	CE6.d: Results of experiment 4.4.3	J. Lee, S.-C. Lim, H. Y. Kim (ETRI)
JCTVC-G421	m21985	2011-11-08 08:02:52	2011-11-08 23:57:41	2011-11-08 23:57:41	CE9: Results of Experiments MRG_ID02, MRG_ID03, and MRG_ID04	H. Y. Kim (ETRI), K. Y. Kim, S. M. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee (ETRI)
JCTVC-G422	m21986	2011-11-08 08:02:59	2011-11-08 23:59:29	2011-11-08 23:59:29	CE9: Cross-check for MRG_ID01 (JCTVC-G439)	H. Y. Kim (ETRI), K. Y. Kim, S. M. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee (ETRI)
JCTVC-G423	m21987	2011-11-08 08:03:00	2011-11-08 08:29:15	2011-11-23 08:59:12	Non-CE6: Remove potential duplicate modes from the candidate mode list for chroma intra prediction	H. Yang, J. Zhou, H. Yu (Huawei)
JCTVC-G424	m21988	2011-11-08 08:03:06	2011-11-08 11:17:32	2011-11-08 11:17:32	CE13: Cross-check report of JCTVC-G240 (section 3.5 test 1 and test 4)	S.-C. Lim, J. Lee, H. Y. Kim (ETRI)
JCTVC-G425	m21989	2011-11-08 08:04:13	2011-11-08 08:29:42	2011-11-08 08:29:42	CE7: Cross-check of the unified design on mode-dependent secondary transform (JCTVC-G108) by Huawei	H. Yang, H. Yu (Huawei)
JCTVC-G426	m21990	2011-11-08 08:05:07	2011-11-08 08:30:14	2011-11-20 16:56:00	Cross-check of Microsoft's proposal on simplification of adding new merge candidates (JCTVC-G397) by Huawei	H. Yang, H. Yu (Huawei)
JCTVC-G427	m21991	2011-11-08 08:06:51	2011-11-08 09:57:42	2011-11-19 12:29:26	CE3: Non-uniform tap length filtering (tool 2)	T. Chujoh, T. Yamakage (Toshiba)
JCTVC-G428	m21992	2011-11-08 08:07:41	2011-11-08 09:36:05	2011-11-25 12:02:47	CE3: Cross-check report for Sony tool 7 (JCTVC-G390)	T. Chujoh (Toshiba)
JCTVC-G429	m21993	2011-11-08 08:08:00	2011-11-08 09:38:26	2011-11-19 12:22:07	Non-CE3: Cross-check report of Sony proposal on restriction for small block (JCTVC-G392)	T.Chujoh (Toshiba)
JCTVC-G430	m21994	2011-11-08 08:08:18	2011-11-08 13:50:04	2011-11-24 17:48:52	An experimental comparison of memory bandwidth between 8-bit and 10-bit coding	T. Chujoh (Toshiba), K. Chono (NEC)
JCTVC-G431	m21995	2011-11-08 08:08:38	2011-11-08 08:43:40	2011-11-08 08:43:40	Non-CE9: Cross-verification of JVC Kenwood proposal on AMVP syntax for bi-prediction (JCTVC-G182)	T. Chujoh (Toshiba)

JCTVC-G432	m21996	2011-11-08 08:28:22	2011-11-09 05:00:37	2011-11-18 17:24:06	CE2: Cross verification of Qualcomm's Overlapped Block Motion Compensation (JCTVC-G749)	S. Lee, S. Cho, N. Eum (ETRI)
JCTVC-G433	m21997	2011-11-08 09:02:39	2011-11-08 09:36:29	2011-11-08 09:36:29	CE8.c.4: Cross-check of MediaTek/Panasonic's SAO and ALF virtual boundary processing with cross9x9 JCTVC-G206	T. Yamakage, T. Watanabe (Toshiba)
JCTVC-G434	m21998	2011-11-08 09:16:40	2011-11-08 13:54:39	2011-11-26 08:20:45	CE4 subtest 3: Quantization matrix for HEVC based on JCTVC-F362 and F475	Y. Morigami, J. Tanaka, T. Suzuki (Sony)
JCTVC-G435	m21999	2011-11-08 09:26:16	2011-11-08 12:18:34	2011-11-08 12:18:34	CE1 subtest C: Cross-checking reports of PIPE/V2F for low complexity entropy coding (JCTVC-F176)	A. Tanizawa, T. Shiodera, T. Yamakage (Toshiba)
JCTVC-G436	m22000	2011-11-08 09:26:37	2011-11-08 12:19:07	2011-11-08 12:19:07	CE6.d category 2: Cross-checking reports of intra prediction with secondary boundary (JCTVC-F172 and JCTVC-F456)	A. Tanizawa, T. Shiodera (Toshiba)
JCTVC-G437	m22001	2011-11-08 09:26:52	2011-11-08 12:19:35	2011-11-08 12:19:35	CE9 subtest 2.6: Cross-checking reports of MRG_ID04 (ETRI/KHU's proposal)	A. Tanizawa, T. Shiodera (Toshiba)
JCTVC-G438	m22002	2011-11-08 09:27:05	2011-11-08 12:20:16	2011-11-28 12:20:24	On complexity reduction of bi-prediction for identical motion	A. Tanizawa, T. Shiodera, T. Chujoh, T. Yamakage (Toshiba)
JCTVC-G439	m22003	2011-11-08 09:27:19	2011-11-08 12:20:46	2011-11-08 12:20:46	CE9 subtest 2.6: Results of MRG_ID01 in Merge/Skip operations for identical motion	A. Tanizawa, T. Shiodera, T. Chujoh, T. Yamakage (Toshiba)
JCTVC-G440	m22004	2011-11-08 09:27:34	2011-11-08 12:21:24	2011-11-22 18:32:15	Non-CE1: Modified probability model update for complexity reduction	A. Tanizawa, T. Shiodera, T. Yamakage (Toshiba)
JCTVC-G441	m22005	2011-11-08 09:28:44	2011-11-08 13:28:24	2011-11-26 17:55:14	Redundancy removal of explicit weighted prediction syntax	A. Tanizawa, T. Chujoh, T. Yamakage (Toshiba)
JCTVC-G442	m22006	2011-11-08 09:39:31	2011-11-08 13:40:33	2011-11-23 12:40:18	Improvement to chroma TU specification	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi), A. Ichigaya, S. Sakaida (NHK)
JCTVC-G443	m22007	2011-11-08 09:40:06	2011-11-08 13:42:04	2011-11-22 15:57:32	Improved directional intra prediction smoothing	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-G444	m22008	2011-11-08 09:40:29	2011-11-08 13:43:00	2011-11-28 08:57:11	Proposed fix on cbf flag signaling	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi), B. Li (USTC), J. Xu (Microsoft)
JCTVC-G445	m22009	2011-11-08 09:41:02	2011-11-08 13:48:37	2011-11-21 09:23:10	Removing DC component of ALF filter coefficients	A. Minezawa, K. Sugimoto, K. Miyazawa, S. Sekiguchi (Mitsubishi)
JCTVC-G446	m22010	2011-11-08 09:41:29	2011-11-08 14:09:51	2011-11-18 12:41:09	Reduction of the number of pixels used in Adaptive Loop Filter	K. Miyazawa, K. Sugimoto, A. Minezawa, S. Sekiguchi, T. Murakami (Mitsubishi)
JCTVC-G447	m22011	2011-11-08 09:41:59	2011-11-08 14:10:24	2011-11-26 08:56:00	Reduced number of intra 64x64 prediction mode	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G448	m22012	2011-11-08	2011-11-08	2011-11-22	Non-CE11: Context reduction for coding transform coefficients	S.-T. Hsiang, S. Lei (MediaTek)

		09:42:20	15:31:19	12:56:34		
JCTVC-G449	m22013	2011-11-08 09:42:29	2011-11-08 14:11:49	2011-11-26 09:00:26	Reduced number of intra chroma prediction mode	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G450	m22014	2011-11-08 09:42:52	2011-11-08 14:12:35	2011-11-08 14:12:35	High level syntax to support interlace format	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G451	m22015	2011-11-08 09:43:20	2011-11-08 14:13:05	2011-11-08 14:13:05	Qp offset for intra block	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G452	m22016	2011-11-08 09:43:46	2011-11-08 14:13:40	2011-11-08 14:13:40	SABAC - Scalable-complexity Adaptive Binary Arithmetic Coding	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G453	m22017	2011-11-08 09:44:13	2011-11-08 14:15:00	2011-11-26 09:39:58	New definition for Tile/slice boundary	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G454	m22018	2011-11-08 09:44:36	2011-11-08 14:15:27	2011-11-26 09:40:44	Parallel processing of ALF and SAO for tiles	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G455	m22019	2011-11-08 09:45:13	2011-11-08 13:38:02	2011-11-08 13:38:02	CE6: results of filtering for LM_mode	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-G456	m22020	2011-11-08 09:45:23	2011-11-08 13:12:47	2011-11-08 13:12:47	Non-CE6: Cross check report of MERL intra prediction mode coding (JCTVC-G359)	A. Ichigaya (NHK)
JCTVC-G457	m22021	2011-11-08 09:45:37	2011-11-08 13:39:36	2011-11-08 13:39:36	CE6: results of intra vertical and horizontal prediction	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-G458	m22022	2011-11-08 09:45:58	2011-11-08 14:35:58	2011-11-22 11:00:37	CE1c: results of PIPE/V2F	K. Sugimoto, R. Hattori, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G459	m22023	2011-11-08 09:46:31	2011-11-08 17:57:56	2011-11-21 05:40:06	CE1c: crosscheck of PIPE/V2V, CABAC	K. Sugimoto, R. Hattori, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G460	m22024	2011-11-08 09:46:52	2011-11-08 17:31:13	2011-11-08 17:31:13	CE4 subset 1.3.b: crosscheck of QP prediction based on intra prediction	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G461	m22025	2011-11-08 09:47:15	2011-11-08 17:40:41	2011-11-08 17:40:41	CE4 subset 1.4: crosscheck of QP prediction based on intra/inter prediction with QP buffer compression	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G462	m22026	2011-11-08 09:47:38	2011-11-08 14:39:06	2011-11-08 14:39:06	CE4 subset 1.2.a: results of Max/Min QP signaling	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G463	m22027	2011-11-08 09:47:58	2011-11-08 10:24:38	2011-11-28 09:46:35	Non-CE8: Block-based filter adaptation with intra prediction mode and CU depth information	S. Wang, S. Ma, J. Jia, J. Park (LG)
JCTVC-G464	m22028	2011-11-08 09:48:03	2011-11-08 17:50:28	2011-11-21 09:39:20	CE8 subtest a tool 2: crosscheck of Directional feature calculation on subset of pixels	K. Sugimoto, K. Miyazawa, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G465	m22029	2011-11-08	2011-11-08	2011-11-16	CE12: crosscheck of deblocking filter parameter adjustment in	K. Sugimoto, A. Minezawa, S.

		09:48:20	17:18:09	02:26:37	slice level	Sekiguchi (Mitsubishi)
JCTVC-G466	m22030	2011-11-08 09:48:40	2011-11-08 16:54:27	2011-11-16 02:29:36	CE12: results on signaling of boundary filtering strength	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G467	m22031	2011-11-08 09:48:52	2011-11-21 05:11:00	2011-11-21 05:11:00	Non-CE9/13: cross-verification of Fujitsu's proposal on Merge (JCTVC-G195)	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G468	m22032	2011-11-08 09:49:12	2011-11-21 05:11:29	2011-11-21 05:11:29	Non-CE9: cross-verification of JVC Kenwood proposal on Merge candidate reordering (JCTVC-G181)	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G469	m22033	2011-11-08 09:49:23	2011-11-21 05:12:04	2011-11-21 05:12:04	CE6a: Cross-check on LM mode of intra chroma prediction (JCTVC-G172)	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G470	m22034	2011-11-08 09:49:31	2011-11-21 05:12:38	2011-11-21 05:12:38	Non-CE1: Cross-check on HHI proposal (JCTVC-G547)	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G471	m22035	2011-11-08 09:52:18	2011-11-08 15:42:42	2011-11-12 18:00:29	CE1.A.2: Crosscheck for Panasonic's parallel context processing for coefficient coding using block-based context updates in JCTVC-G349	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-G472	m22036	2011-11-08 09:56:13	2011-11-09 16:03:48	2011-11-12 18:03:09	CE1.A.4: Crosscheck for Samsung's line buffer removal for CU split flag context model in JCTVC-G769	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-G473	m22037	2011-11-08 10:05:07	2011-11-08 15:47:48	2011-11-12 18:06:37	CE6b: Crosscheck for LG's MPM mapping modification in JCTVC-G144	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-G474	m22038	2011-11-08 10:08:51	2011-11-08 15:50:05	2011-11-12 18:08:55	Non-CE6b: Crosscheck for LG's intra mode line buffer reduction in JCTVC-G145	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-G475	m22039	2011-11-08 10:11:48	2011-11-08 15:54:09	2011-11-12 18:10:46	Non-CE6b: Crosscheck for JVC KENWOOD's unified neighboring positions for intra mode coding in JCTVC-G184	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-G476	m22040	2011-11-08 10:13:19	2011-11-09 16:05:30	2011-11-12 18:12:41	CE6.c: Crosscheck for LG's LM mode harmonization on SDIP in JCTVC-G142	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-G477	m22041	2011-11-08 10:16:25	2011-11-08 10:20:00	2011-11-08 10:20:00	Non-CE8.c.6: Cross-check of MediaTek/Panasonic/Qualcomm's multi-source SAO and ALF virtual boundary processing with cross9x9 JCTVC-G211	T. Yamakage, T. Watanabe (Toshiba)
JCTVC-G478	m22042	2011-11-08 10:17:08	2011-11-09 16:07:20	2011-11-12 18:15:57	CE6.c: Crosscheck for LG's VLC improvement for intra partitioning on SDIP in JCTVC-G143	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-G479	m22043	2011-11-08 10:20:06	2011-11-08 15:59:46	2011-11-12 18:17:40	CE8.c.1: Crosscheck for Panasonic's line memory reduction for ALF and SAO decoding in JCTVC-G564	C.-Y. Chen, Y.-W. Huang (MediaTek)
JCTVC-G480	m22044	2011-11-08 10:23:13	2011-11-09 16:10:32	2011-11-12 18:19:13	CE8.g.1: Crosscheck for eBrisk's adaptive loop filtering of chrominance samples using luma map in JCTVC-G056	C.-Y. Tsai, Y.-W. Huang (MediaTek)
JCTVC-G481	m22045	2011-11-08 10:23:24	2011-11-13 04:50:09	2011-11-13 04:50:09	Cross verification of Huawei's intra prediction improvement based on a uniform probability model (JCTVC-G374) by Intel	Y. Chiu, L. Xu (Intel)
JCTVC-G482	m22046	2011-11-08 10:29:13	2011-11-09 16:12:01	2011-11-12 18:21:17	CE8.h.1: Crosscheck for NTT's CU-based ALF with non-local means filter in JCTVC-G235	C.-Y. Tsai, Y.-W. Huang (MediaTek)

JCTVC-G483	m22047	2011-11-08 10:39:15	2011-11-16 14:55:01	2011-11-16 14:55:01	Non-CE8: Crosscheck for SHARP's modifications of offset classifications in SAO in JCTVC-G309	C.-M. Fu, Y.-W. Huang (MediaTek)
JCTVC-G484	m22048	2011-11-08 10:41:55	2011-11-23 08:55:13	2011-11-23 08:55:13	Non-CE9: Crosscheck for LG's reordering of merge candidate in JCTVC-G396	J.-L. Lin, Y.-W. Huang (MediaTek)
JCTVC-G485	m22049	2011-11-08 10:45:13	2011-11-08 16:09:21	2011-11-12 18:26:14	CE12.1.5: Crosscheck for Qualcomm's deblocking of new non-square blocks: edge shift for AMP in JCTVC-G383	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-G486	m22050	2011-11-08 10:49:56	2011-11-10 14:47:30	2011-11-12 18:27:20	CE12.3.1: Crosscheck for Sony's deblocking vertical tap reduction for line buffer in JCTVC-G257	C.-W. Hsu, Y.-W. Huang (MediaTek)
JCTVC-G487	m22051	2011-11-08 11:05:00	2011-11-09 16:13:40	2011-11-12 18:30:07	CE13: Crosscheck for Samsung's section 3.4 test 5' on adaptive list size and additional MVP candidates in JCTVC-G776	J.-L. Lin, Y.-W. Huang (MediaTek)
JCTVC-G488	m22052	2011-11-08 11:05:17	2011-11-08 18:06:45	2011-11-18 14:14:29	Non-CE6a : Cross check on use of chroma phase in LM mode (JCTVC-G245)	T. Guionnet, L. Guillo (INRIA)
JCTVC-G489	m22053	2011-11-08 11:08:10	2011-11-08 16:43:33	2011-11-12 18:32:33	CE13: Crosscheck for Canon's section 3.5 tests 5 and 6 on additional MVP candidates in JCTVC-G240	J.-L. Lin, Y.-W. Huang (MediaTek)
JCTVC-G490	m22054	2011-11-08 11:15:13	2011-11-08 23:27:41	2011-11-23 18:58:21	Modified SAO edge offsets	K. Andersson, P. Wennersten, R. Sjöberg (Ericsson)
JCTVC-G491	m22055	2011-11-08 11:39:56	2011-11-08 12:30:06	2011-11-18 19:23:25	Hybrid Horizontal/Vertical with Diagonal Mode Dependent Coefficient Scan	K. Sharman, J. Gamei, N. Saunders, P. Silcock (Sony)
JCTVC-G492	m22056	2011-11-08 11:43:16	2011-11-08 12:32:41	2011-11-18 19:23:52	Maximum VLC Limits in CABAC Escape Coding	K. Sharman, J. Gamei, N. Saunders, P. Silcock (Sony)
JCTVC-G493	m22057	2011-11-08 11:44:42	2011-11-08 12:33:25	2011-11-18 19:24:18	CABAC Stream Termination	K. Sharman, J. Gamei, N. Saunders, P. Silcock (Sony)
JCTVC-G494	m22058	2011-11-08 11:47:09	2011-11-08 12:31:16	2011-11-18 19:24:40	CABAC Packet-based Stream	K. Sharman, J. Gamei, N. Saunders, P. Silcock (Sony)
JCTVC-G495	m22059	2011-11-08 11:47:15	2011-11-08 19:46:36	2011-11-21 20:43:58	CE10: Core transform design for HEVC	A. Fuldseth, G. Bjøntegaard (Cisco), M. Budagavi (TI)
JCTVC-G496	m22060	2011-11-08 11:47:29	2011-11-08 19:47:03	2011-11-21 20:52:31	Core transform design for HEVC with 7 bit coefficients	A. Fuldseth, G. Bjøntegaard (Cisco), M. Budagavi, V. Sze (TI)
JCTVC-G497	m22061	2011-11-08 11:47:40	2011-11-08 19:47:51	2011-11-21 21:05:12	SIMD optimization of proposed HEVC core transforms	A. Fuldseth, L. P. Endresen, S. Selnes (Cisco), V. Arbatov, F. Franchetti (SpiralGen), M. Puschel (ETH Zurich)
JCTVC-G498	m22062	2011-11-08 11:47:54	2011-11-08 19:48:34	2011-11-15 15:39:08	CE8: ALF with low latency and reduced complexity	A. Fuldseth, G. Bjøntegaard (Cisco)
JCTVC-G499	m22063	2011-11-08 11:48:06	2011-11-08 19:49:10	2011-11-22 00:01:43	Improved ALF with low latency and reduced complexity	A. Fuldseth, G. Bjøntegaard (Cisco)

JCTVC-G500	m22064	2011-11-08 11:49:25	2011-11-09 03:01:38	2011-11-09 03:01:38	Cross-verification of LG's Reference List Construction for Random Access Settings (JCTVC-G157) by Panasonic	C. S. Lim, S. M. T. Naing, V. Wahadaniah (Panasonic)
JCTVC-G501	m22065	2011-11-08 11:49:32	2011-11-08 12:34:26	2011-11-18 19:25:01	CABAC with Arithmetic Context Variables	K. Sharman, J. Gamei, N. Saunders, P. Silcock (Sony)
JCTVC-G502	m22066	2011-11-08 11:51:08	2011-11-08 13:31:51	2011-11-08 13:31:51	CE4 Subtest 3.1: Crosscheck report of AVC based quantization matrix support (JCTVC-G434)	M. Shima (Canon)
JCTVC-G503	m22067	2011-11-08 11:51:43	2011-11-08 13:32:34	2011-11-08 13:32:34	CE4 Subtest 3.2: Crosscheck report of compact representation of quantization matrices proposed by TI (JCTVC-G083)	M. Shima (Canon)
JCTVC-G504	m22068	2011-11-08 11:52:11	2011-11-08 12:36:57	2011-11-18 19:25:23	CABAC with Combined Context Variables	K. Sharman, J. Gamei, N. Saunders, P. Silcock (Sony)
JCTVC-G505	m22069	2011-11-08 11:52:15	2011-11-08 13:35:48	2011-12-08 05:37:22	CE4 Subtest 3.3: Crosscheck report of Enhancement of quantization matrix coding of HEVC proposed by Sony (JCTVC-G434)	M. Shima (Canon)
JCTVC-G506	m22070	2011-11-08 11:52:47	2011-11-08 13:37:25	2011-11-08 13:37:25	Non-CE4: Crosscheck report of carriage of large block size quantization matrices with up-sampling proposed by TI (JCTVC-G094)	M. Shima (Canon)
JCTVC-G507	m22071	2011-11-08 12:01:56	2011-11-09 05:43:15	2011-11-09 05:43:15	Syntax Issues	K. Sato (Sony)
JCTVC-G508	m22072	2011-11-08 12:04:13	2011-11-09 06:10:07	2011-11-09 06:10:07	CE4: cross-check result of subtest 1.2.c	K. Sato (Sony)
JCTVC-G509	m22073	2011-11-08 12:06:04	2011-11-09 06:26:23	2011-11-23 08:56:07	Support of ChromaQPOffset in HEVC	S. Liu (MediaTek), K. Sato (Sony)
JCTVC-G510	m22074	2011-11-08 12:08:25	2011-11-09 07:00:15	2011-11-09 07:00:15	CE6.a: Result of Subtest 4.1.2.2	K. Sato (Sony)
JCTVC-G511	m22075	2011-11-08 12:10:53	2011-11-09 08:27:02	2011-11-09 08:27:02	Performance Evaluation of Luma-based Chroma Intra Prediction	K. Sato (Sony)
JCTVC-G512	m22076	2011-11-08 12:12:40	2011-11-09 09:17:33	2011-11-11 08:03:25	CE6: combination of subtest 4.1.2.1 & 4.1.2.2	K. Sato (Sony)
JCTVC-G513	m22077	2011-11-08 12:14:24	2011-11-09 05:38:50	2011-11-09 05:38:50	CE9: Cross-check result of Sel01&02	K. Sato (Sony)
JCTVC-G514	m22078	2011-11-08 12:16:08	2011-11-09 05:49:31	2011-11-09 05:49:31	CE13: Cross-Check Result of Test3b&4b	K. Sato (Sony)
JCTVC-G515	m22079	2011-11-08 12:18:38	2011-11-11 11:06:03	2011-11-11 11:06:03	Cross-check of JCTVC-G552: Simplification of temporal motion vector (TMVP) candidate derivation for Merge and AMVP	K. Sato (Sony)
JCTVC-G516	m22080	2011-11-08 12:20:23	2011-11-18 12:25:37	2011-11-23 09:20:54	On Spatial MV Prediction	K. Sato (Sony)
JCTVC-G517	m22081	2011-11-08	2011-11-09	2011-11-28	CE2 subtest C.1: Harmonization of unified scan and NSQT	X. Zheng (HiSilicon), Y. Yuan,

		12:54:00	03:22:29	09:51:16		Y. He (Tsinghua)
JCTVC-G518	m22082	2011-11-08 12:55:39	2011-11-09 03:33:23	2011-11-21 16:08:18	CE2 subtest C.1: Non-square quadtree (NSQT) with 2x8 and 8x2 transform	Y. Yuan (Tsinghua), X. Zheng (HiSilicon), Y. He (Tsinghua)
JCTVC-G519	m22083	2011-11-08 12:56:44	2011-11-09 04:36:57	2011-11-30 00:12:38	Non-CE2: Harmonization of implicit TU, AMP and NSQT	X. Zheng (HiSilicon), Y. Yuan, Y. He (Tsinghua)
JCTVC-G520	m22084	2011-11-08 12:56:57	2011-11-08 16:14:03	2011-11-25 12:44:12	Non-CE11: Modified Context Derivation for last coefficient flag	H. Sasai, T. Nishi (Panasonic)
JCTVC-G521	m22085	2011-11-08 12:57:23	2011-11-09 07:36:17	2011-11-30 00:06:20	Non-CE2: Non-square hadamard transform for motion estimation and merge estimation	X. Zheng, L. Liu (HiSilicon), Y. Yuan, Y. He (Tsinghua)
JCTVC-G522	m22086	2011-11-08 13:18:40	2011-11-08 14:10:28	2011-11-28 03:22:34	Non-CE11:Context reduction for coefficient level	K. Terada, H. Sasai, T. Nishi (Panasonic)
JCTVC-G523	m22087	2011-11-08 13:25:40	2011-11-18 16:49:42	2011-11-18 16:49:42	Cross-check of Non-CE9: Division-free MV scaling (JCTVC-G223) from Mediatek	P. Onno (Canon)
JCTVC-G524	m22088	2011-11-08 13:29:29	2011-11-11 12:32:28	2011-11-11 12:32:28	Cross-checking reports of improved weighted prediction (JCTVC-G065)	A. Tanizawa, T. Chujoh, T. Yamakage (Toshiba)
JCTVC-G525	m22089	2011-11-08 13:29:44	2011-11-18 15:15:37	2011-11-27 11:22:48	Cross-check of JCTVC-G441: Redundancy removal of explicit weighted prediction syntax	P. Bordes, P. Salmon (Technicolor)
JCTVC-G526	m22090	2011-11-08 13:41:58	2011-11-08 13:43:31	2011-11-22 15:06:11	AHG21: Combined signaling for reference picture set	Y. Park, I.-K. Kim, C. Kim (Samsung)
JCTVC-G527	m22091	2011-11-08 13:42:39	2011-11-09 02:26:37	2011-11-09 02:26:37	CE4: Cross-Check report for CE4 subset3 of Sony proposal on Quantization matrix for HEVC (JCTVC-G434)	J. Zheng (HiSilicon)
JCTVC-G528	m22092	2011-11-08 13:43:31	2011-11-09 02:27:11	2011-11-09 02:27:11	CE4: Cross-Check report for CE4 subset3 of TI compact representation of quantization matrices (JCTVC-G083)	J. Zheng (HiSilicon)
JCTVC-G529	m22093	2011-11-08 13:44:14	2011-11-18 21:03:38	2011-11-18 21:03:38	Non-CE4: Cross-Check for MediaTek quantization matrices representation (JCTVC-G152)	J. Zheng (HiSilicon)
JCTVC-G530	m22094	2011-11-08 13:46:02	2011-11-09 02:27:05	2011-11-23 16:07:13	Non-CE4: Layered quantization matrices compression	Y. Wang (Tsinghua), J. Zheng, X. Zheng (HiSilicon), Y. He (Tsinghua)
JCTVC-G531	m22095	2011-11-08 13:46:23	2011-11-11 04:23:06	2011-11-18 01:49:15	Cross verification of MediaTek's proposed methods for solving the parsing issue of MDCS (JCTVC-G285)	Y. Chiu, L. Xu (Intel)
JCTVC-G532	m22096	2011-11-08 13:50:22	2011-11-08 14:00:42	2011-11-08 14:00:42	CE5 2.1 : Improvement of CAVLC run- coding by prediction mode	C. Kim, Y. Park, K. P. Choi (Samsung)
JCTVC-G533	m22097	2011-11-08 13:57:09	2011-11-08 14:00:08	2011-11-25 17:37:03	On informing the discrepancy between HM software and WD at IDR picture and proposal for syntax of clean random access pictures	Y. Park, H. Yang, C. Kim (Samsung)
JCTVC-G534	m22098	2011-11-08 14:01:11	2011-11-08 15:13:13	2011-11-08 15:13:13	CE3: Cross-check report of Tool 10 (Progressive MV resolution) by Panasonic	T. Sugio, T. Nishi (Panasonic)

JCTVC-G535	m22099	2011-11-08 14:04:49	2011-11-08 15:15:34	2011-11-09 09:25:53	CE3: Experimental Result on Tool 9 (Picture Adaptive 1/8-pel Motion Compensation Method)	T. Sugio, T. Nishi (Panasonic)
JCTVC-G536	m22100	2011-11-08 14:06:07	2011-11-08 15:16:31	2011-11-08 15:16:31	CE9: Cross-check report of MRG_MVD02 by Panasonic	T. Sugio, T. Nishi (Panasonic)
JCTVC-G537	m22101	2011-11-08 14:06:10	2011-11-08 14:15:22	2011-11-18 00:52:58	Table reduction and Improvement of last position coding in CAVLC	C. Kim, Y. Park, J. H. Park (Samsung)
JCTVC-G538	m22102	2011-11-08 14:07:06	2011-11-08 14:14:28	2011-11-08 14:14:28	Withdrawn	
JCTVC-G539	m22103	2011-11-08 14:07:13	2011-11-08 15:20:22	2011-11-22 17:30:58	Non-CE13: Cross-check report of JCTVC-G288 subset 3.3 (test2a, 3a, 4a) by Panasonic	T. Sugio, T. Nishi (Panasonic)
JCTVC-G540	m22104	2011-11-08 14:09:24	2011-11-08 15:23:17	2011-11-08 15:23:17	CE13: Cross-check report of subset 3.2 series by Panasonic	T. Sugio, T. Nishi (Panasonic)
JCTVC-G541	m22105	2011-11-08 14:11:02	2011-11-08 15:24:30	2011-11-22 20:31:28	Non-CE9: Simplified scaling calculation method for temporal/spatial MVP of AMVP/Merge	T. Sugio, T. Nishi (Panasonic)
JCTVC-G542	m22106	2011-11-08 14:12:07	2011-11-08 15:25:34	2011-11-28 00:29:25	Non-CE9/Non-CE13: Simplification on AMVP/Merge	T. Sugio, T. Nishi (Panasonic)
JCTVC-G543	m22107	2011-11-08 14:12:33	2011-11-08 18:20:06	2011-11-19 09:32:44	Early skip detection for HEVC	J. Yang, J. Kim, K. Won, H. Lee, B. Jeon (SKKU)
JCTVC-G544	m22108	2011-11-08 14:14:05	2011-11-14 06:39:46	2011-11-14 06:39:46	Non-CE13: Cross check report of JCTVC-G224 by panasonic	T. Sugio, T. Nishi (Panasonic)
JCTVC-G545	m22109	2011-11-08 14:17:48	2011-11-08 14:24:23	2011-11-18 00:57:49	Improvement of level coding in CAVLC	C. Kim, Y. Park, J. H. Park (Samsung)
JCTVC-G546	m22110	2011-11-08 14:21:44	2011-11-08 14:23:05	2011-11-25 20:53:50	On high-level syntax for maximum DPB size and frame latency	Y. Park, K. P. Choi, C. Kim (Samsung)
JCTVC-G547	m22111	2011-11-08 14:21:47	2011-11-08 20:44:51	2011-11-23 20:06:03	Non-CE1: Counter-based probability model update with adapted arithmetic coding engine	J. Stegemann, H. Kirchhoffer, D. Marpe, T. Wiegand (Fraunhofer HHI)
JCTVC-G548	m22112	2011-11-08 14:26:57	2011-11-08 18:51:05	2011-11-23 11:04:25	AHG21: Construction and modification of predefined reference picture sets and reference picture lists	V. Wahadaniah, C. S. Lim, S. M. T. Naing (Panasonic)
JCTVC-G549	m22113	2011-11-08 14:27:55	2011-11-08 14:30:12	2011-11-16 02:06:21	Syntax rearrangement for list combination	Y. Park, S. Jeong, C. Kim (Samsung)
JCTVC-G550	m22114	2011-11-08 14:28:43	2011-11-08 14:37:42	2011-11-18 01:06:06	TU_size based dQP	C. Kim, Y. Park, K. P. Choi, J. H. Park (Samsung)
JCTVC-G551	m22115	2011-11-08 14:34:23	2011-11-08 15:27:09	2011-11-22 19:32:48	Restriction on motion vector scaling for Merge and AMVP	I.-K. Kim, Y. Park, N. Shlyakhov, J. H. Park (Samsung)
JCTVC-G552	m22116	2011-11-08	2011-11-08	2011-11-22	Simplification of temporal motion vector (TMVP) candidate	I.-K. Kim, N. Shlyakhov, J. H.

		14:35:48	15:27:51	19:33:31	derivation for Merge and AMVP	Park (Samsung)
JCTVC-G553	m22117	2011-11-08 14:36:34	2011-11-08 20:46:52	2011-11-08 20:46:52	CE1: Cross-check of Samsung's Multi-parameter probability model up-date for CABAC (JCTVC-F254)	J. Stegemann (HHI)
JCTVC-G554	m22118	2011-11-08 14:36:49	2011-11-08 15:28:31	2011-11-23 14:29:55	Grouping of bypass bins for last position coding of transform coefficients	I.-K. Kim, J. H. Park (Samsung)
JCTVC-G555	m22119	2011-11-08 14:38:06	2011-11-08 15:29:08	2011-11-23 17:40:11	One-addition dequantization	N. Shlyakhov, I.-K. Kim, J. H. Park (Samsung)
JCTVC-G556	m22120	2011-11-08 14:40:02	2011-11-08 16:39:43	2011-11-29 14:41:01	CE6.c Report on Simplification of Short Distance Intra Prediction (SDIP) Method	X. Cao, Y. He (Tsinghua), X. Peng (USTC), C. Lai, L. Liu, J. Zheng (HiSilicon), J. Xu (Microsoft), H. Yang, H. Yu (Huawei)
JCTVC-G557	m22121	2011-11-08 14:40:57	2011-11-14 14:41:25	2011-11-14 14:41:25	CE4.2.A: Cross-check of RIM ARL	X. Li, X. Guo (MediaTek)
JCTVC-G558	m22122	2011-11-08 14:41:39	2011-11-09 05:40:49	2011-11-24 15:41:17	CE6.c Report on Combination of SDIP and Its Improvements	X. Cao, Y. He (Tsinghua), X. Peng (USTC), C. Lai, L. Liu, J. Zheng (HiSilicon), J. Xu (Microsoft), H. Yang, J. Song, H. Yu (Huawei), J. Lim, B. Jeon (LGE), J. Sole, R. Joshi, X. Wang, M. Karczewicz (Qualcomm), J. Xu, E. Maani, A. Tabatabai (Sony)
JCTVC-G559	m22123	2011-11-08 14:45:20	2011-11-08 17:24:26	2011-11-08 17:24:26	CE8 Subtest c: Cross-Check report for JCTVC-G204	S. Esenlik, A. Kotra, M. Narroschke (Panasonic)
JCTVC-G560	m22124	2011-11-08 14:47:14	2011-11-14 14:43:22	2011-11-14 14:43:22	CE4.3.A: Cross-check of Qualcomm's fine-QP	X. Li, X. Guo (MediaTek)
JCTVC-G561	m22125	2011-11-08 14:49:14	2011-11-08 21:05:37	2011-11-09 10:30:07	CE6d: Cross-check report on Intra prediction with secondary boundary (Test 7) (JCTVC-F456)	T Guionnet, L Guillo
JCTVC-G562	m22126	2011-11-08 15:04:10	2011-11-09 12:33:49	2011-11-09 12:50:24	Withdrawn	
JCTVC-G563	m22127	2011-11-08 15:12:13	2011-11-08 15:17:14	2011-11-16 04:13:30	CE5 2.2 : Handling for exception cases longer than 32bit code-word in CAVLC	C. Kim, Y. Park, K. P. Choi (Samsung), M. Karczewicz, X. Wang, W.-J. Chien, L. Guo (Qualcomm)
JCTVC-G564	m22128	2011-11-08 15:14:46	2011-11-08 17:25:03	2011-11-08 17:25:03	CE8 subtest c tool 1: Line memory reduction for ALF and SAO decoding	S. Esenlik, M. Narroschke, T. Wedi (Panasonic)
JCTVC-G565	m22129	2011-11-08	2011-11-08	2011-11-23	CE6.d: Nokia report on intra prediction with secondary boundary	J. Lainema, K. Ugur (Nokia)

		15:16:31	15:43:26	16:27:14		
JCTVC-G566	m22130	2011-11-08 15:16:34	2011-11-08 17:25:41	2011-11-25 08:18:49	Syntax refinements for SAO and ALF	S. Esenlik, M. Narroschke, T. Wedi (Panasonic)
JCTVC-G567	m22131	2011-11-08 15:16:47	2011-11-08 15:44:41	2011-11-08 15:44:41	Simplified DC prediction	J. Lainema, K. Ugur (Nokia)
JCTVC-G568	m22132	2011-11-08 15:17:03	2011-11-08 15:45:24	2011-11-26 17:57:25	HM 4.0 entropy coding complexity study and software improvements	M. Viitanen, J. Vanne, T. D. Hämäläinen (TUT), J. Lainema, K. Ugur (Nokia)
JCTVC-G569	m22133	2011-11-08 15:17:18	2011-11-08 15:53:11	2011-11-28 19:24:06	Single entropy coder for HEVC with a high throughput binarization mode	J. Lainema, K. Ugur, A. Hallapuro (Nokia)
JCTVC-G570	m22134	2011-11-08 15:17:22	2011-11-08 17:26:06	2011-11-23 16:42:12	Byte alignment overhead reduction	S. Esenlik, M. Narroschke, T. Wedi (Panasonic)
JCTVC-G571	m22135	2011-11-08 15:19:39	2011-11-08 18:37:52	2011-11-25 10:24:56	CE2: Cross-check of Non-Square Quadtree Transform (NSQT) JCTVC-G517 & JCTVC-G518	S. Oudin, B. Bross (Fraunhofer HHI)
JCTVC-G572	m22136	2011-11-08 15:20:29	2011-11-09 08:25:04	2011-11-23 11:13:15	AHG16: Reference sample padding harmonization for intra DC mode	V. Wahadaniah, C. S. Lim (Panasonic)
JCTVC-G573	m22137	2011-11-08 15:23:28	2011-11-14 01:10:35	2011-11-14 01:10:35	Cross-check of Early skip detection for HEVC with Early CU Termination (JCTVC-G543, JCTVC-F092)	S. Lee, S. Cho, S. Park, N. Eum (ETRI)
JCTVC-G574	m22138	2011-11-08 15:28:26	2011-11-08 17:59:14	2011-11-22 09:57:02	CE12 Subtest 5: Deblocking filter using adaptive weighting factors	M. Narroschke, A.-K. Seifert (Panasonic)
JCTVC-G575	m22140	2011-11-08 16:06:25	2011-11-08 23:46:18	2011-11-26 09:50:48	Transform skip mode	Marta Mrak, Andrea Gabriellini, David Flynn (BBC)
JCTVC-G576	m22141	2011-11-08 16:12:39	2011-11-09 07:31:18	2011-11-24 11:51:55	CE1: Delayed state update for CABAC	R. Joshi, J. Sole, M. Karczewicz (Qualcomm)
JCTVC-G577	m22142	2011-11-08 16:14:53	2011-11-08 20:54:03	2011-11-25 10:46:33	Transform skipping dependent on block parameters	Glenn Van Wallendael, Jan De Cock, Rik Van de Walle (Ghent Univ.), Marta Mrak (BBC)
JCTVC-G578	m22143	2011-11-08 16:18:46	2011-11-09 07:32:58	2011-11-23 16:37:49	Non-CE4: Quantization matrix compression and signaling	R. Joshi, J. Sole, M. Karczewicz (Qualcomm)
JCTVC-G579	m22144	2011-11-08 16:21:32	2011-11-09 08:08:39	2011-11-09 08:08:39	CE10: Scaled integer transforms supporting recursive factorization structure	R. Joshi, J. Sole, M. Karczewicz (Qualcomm)
JCTVC-G580	m22145	2011-11-08 16:25:16	2011-11-09 15:21:59	2011-11-09 15:21:59	CE7: Crosscheck of rotational transform (JCTVC-G304)	R. Joshi (Qualcomm)
JCTVC-G581	m22146	2011-11-08 16:27:44	2011-11-09 15:22:52	2011-11-09 15:22:52	CE7: Crosscheck of combination of tool 1 and tool 2 for mode dependent secondary transform sizes 3x3 and 4x4 (JCTVC-G108)	R. Joshi (Qualcomm)
JCTVC-G582	m22147	2011-11-08 16:36:27	2011-11-08 17:17:47	2011-11-18 20:24:29	Multiview HEVC – experimental results	Marek Domanski, Tomasz Grajek, Damian Karwowski,

						Krzysztof Klimaszewski, Jacek Konieczny, Maciej Kurz, Adam Luczak, Robert Ratajczak, Jakub Siast, Olgierd Stankiewicz, Jakub Stankowski, Krzysztof Wegner
JCTVC-G583	m22148	2011-11-08 16:38:11	2011-11-08 20:20:57	2011-11-25 21:27:44	Reducing output delay for bumping process	J. Samuelsson, R. Sjöberg (Ericsson)
JCTVC-G584	m22149	2011-11-08 16:38:50	2011-11-08 20:22:31	2011-11-25 21:38:15	Temporal layer access pictures and CRA	J. Samuelsson, R. Sjöberg (Ericsson)
JCTVC-G585	m22150	2011-11-08 16:40:50	2011-11-08 18:01:04	2011-11-14 13:29:46	CE12 Subtest 2: Cross-check results of the parallel deblocking tool 1 of Sony (JCTVC-G255)	M. Narroschke, S. Esenlik (Panasonic)
JCTVC-G586	m22151	2011-11-08 16:44:18	2011-11-08 17:17:50	2011-11-24 12:24:49	Parallelizable context for significance coding of large transform blocks	J. Kang, J. Lainema, A. Hallapuro, K. Ugur (Nokia)
JCTVC-G587	m22152	2011-11-08 16:48:33	2011-11-08 18:06:53	2011-11-14 17:35:47	CE12 Subtest 2: Cross-check results of the parallel deblocking tool 2 of Sony (JCTVC-G256)	M. Narroschke, S. Esenlik (Panasonic)
JCTVC-G588	m22153	2011-11-08 16:58:58	2011-11-08 18:12:51	2011-11-08 18:12:51	CE12 Subtest 2: Cross-check results of the deblocking proposal of Texas Instruments (JCTVC-G088)	M. Narroschke, S. Esenlik (Panasonic)
JCTVC-G589	m22154	2011-11-08 17:03:44	2011-11-08 17:10:59	2011-11-16 10:31:33	Encoder optimization: Reduced number of reference pictures for RA	P. Wennersten, R. Sjöberg, J. Samuelsson (Ericsson)
JCTVC-G590	m22155	2011-11-08 17:04:20	2011-11-08 18:17:02	2011-11-22 10:00:59	CE12 Subtest 1: Results for modified decisions for deblocking	M. Narroschke, S. Esenlik, T. Wedi (Panasonic)
JCTVC-G591	m22156	2011-11-08 17:09:24	2011-11-09 06:10:11	2011-11-25 09:28:41	Non-CE 7: Supplementary Results for the Rotational Transform	Zhan Ma, Felix Fernandes, Elena Alshina, Alexander Alshin
JCTVC-G592	m22157	2011-11-08 17:12:08	2011-11-08 19:41:10	2011-11-08 19:41:10	Non-CE9: Removal of reference index derivation for TMVP in merge mode	O. Bici, J. Lainema, K. Ugur (Nokia)
JCTVC-G593	m22158	2011-11-08 17:12:19	2011-11-08 20:35:47	2011-11-25 13:15:18	Non-CE13: Simplification of merge mode	O. Bici, J. Lainema, K. Ugur (Nokia)
JCTVC-G594	m22159	2011-11-08 17:36:12	2011-11-08 17:39:16	2011-11-22 12:38:15	Improved Extrapolation for Intra Prediction Coding	J. Kim, S. Bae, H. Sabirin, M. Kim, J. Kim, B. Jeon
JCTVC-G595	m22160	2011-11-08 17:44:15	2011-11-08 17:47:55	2011-11-22 12:44:15	Linear model based chroma intra prediction coding for no access to LCU boundary reference pixels	J. Kim, M. Kim, B. Kim, S. Hahm, K. Lee
JCTVC-G596	m22161	2011-11-08 17:54:38	2011-11-19 09:11:17	2011-11-22 12:48:48	Cross-check report of Harmonization of HE residual coding and NSQT by Qualcomm and LGE (JCTVC-G750)	J. Kim, M. Kim
JCTVC-G597	m22162	2011-11-08 18:04:20	2011-11-14 11:03:03	2011-11-14 11:03:03	AHG 18: Cross-check of Adaptive Resolution Coding (ARC) (JCTVC-G264)	Glenn Van Wallendael, Jan De Cock, Rik Van de Walle (Ghent Univ.), David Flynn (BBC)

JCTVC-G598	m22163	2011-11-08 18:20:19	2011-11-09 00:25:30	2011-11-23 17:44:24	Non-CE6: Intra prediction based on weighted template matching predictors (WTM)	T Guionnet, L Guillo
JCTVC-G599	m22164	2011-11-08 18:29:22	2011-11-11 17:03:19	2011-11-15 20:06:51	Non-CE2: Cross-Check of non-square Hadamard transform for motion estimation and merge estimation	S. Oudin, B. Bross (Fraunhofer HHI)
JCTVC-G600	m22165	2011-11-08 18:30:18	2011-11-08 18:47:10	2011-11-24 19:52:12	Non-CE3: Adaptive Motion Vector Resolution based on the PU Size	J. Jung, J. Heo, S. Yea (LG)
JCTVC-G601	m22166	2011-11-08 18:39:48	2011-11-24 10:40:36	2011-11-24 10:40:36	Cross verification of SIMD-optimized partial butterfly HM transforms	D. Flynn (BBC)
JCTVC-G602	m22167	2011-11-08 18:43:17	2011-11-08 18:47:20	2011-11-08 18:47:20	Withdrawn	
JCTVC-G603	m22168	2011-11-08 19:19:04	2011-11-22 19:15:20	2011-11-22 20:09:57	Non-CE9: Cross-check of Bi-prediction for low delay coding (JCTVC-G305)	P. Helle, B. Bross (Fraunhofer HHI)
JCTVC-G604	m22169	2011-11-08 19:22:29	2011-11-17 19:29:01	2011-11-17 19:29:01	Non-CE6: Cross-checking of JCTVC-G598: Intra prediction based on weighted template matching predictors (WTM)	P Bordes, P Salmon (Technicolor)
JCTVC-G605	m22170	2011-11-08 19:22:43	2011-11-23 16:49:20	2011-11-23 16:49:20	Cross-check of Improvement to chroma TU specification (JCTVC-G442)	P. Helle, B. Bross (Fraunhofer HHI)
JCTVC-G606	m22171	2011-11-08 19:27:02	2011-11-15 15:44:54	2011-11-15 15:44:54	Crosscheck - VLC for high level syntax (ALF and SAO parameters) (JCTVC-G122)	T. Nguyen (Fraunhofer HHI)
JCTVC-G607	m22172	2011-11-08 19:33:17	2011-11-08 20:18:40	2011-11-26 19:53:40	High-Level Syntax for Bitstream Extraction	R. Sjöberg, T. Rusert (Ericsson)
JCTVC-G608	m22174	2011-11-08 19:34:33	2011-11-09 08:57:07	2011-11-24 09:28:41	Unifed Deblocking and SAO	A. Segall, J. Zhao (Sharp)
JCTVC-G609	m22175	2011-11-08 19:38:51	2011-11-09 01:07:39	2011-11-09 01:08:08	CE8.a.2: Directional feature calculation on subset of pixels	T. Yamakage, T. Watanabe, T. Chujoh (Toshiba), C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), M. Karczewicz, I. S. Chong (Qualcomm), T. Ikai, A. Segall, T. Yamamoto (Sharp)
JCTVC-G610	m22176	2011-11-08 19:43:36	2011-11-09 09:29:12	2011-11-19 02:26:15	Improvements to ALF	J. Zhao, A. Segall (Sharp)
JCTVC-G611	m22177	2011-11-08 19:43:39	2011-11-09 01:14:10	2011-11-09 01:14:10	CE8.a.3: Cross check of Samsung's directional feature calculation on subset of pixels	I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-G612	m22178	2011-11-08 19:46:00	2011-11-09 13:10:53	2011-11-09 13:10:53	CE1: Cross-check of test 9: Mitsubishi's study on PIPE/V2F with LowDelay buffer control	M. Siekmann (Fraunhofer HHI)
JCTVC-G613	m22179	2011-11-08 19:46:55	2011-11-09 01:12:30	2011-11-09 01:12:30	CE8 Subset d.2: Cross-Verification of Samsung's Filter Shapes and Coefficients constraints	I. S. Chong, M. Karczewicz (Qualcomm)

JCTVC-G614	m22180	2011-11-08 19:48:08	2011-11-09 01:10:32	2011-11-09 01:10:32	CE8 Subset c.2: Cross-Verification of MediaTek's Line memory reduction in ALF and SAO	I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-G615	m22181	2011-11-08 19:52:40	2011-11-09 03:18:54	2011-11-09 03:18:54	Non-CE8: Cross check of Mitsubishi's removing DC component of ALF filter coefficients	I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-G616	m22182	2011-11-08 19:55:28	2011-11-09 18:47:29	2011-11-22 13:27:54	On parallel deblocking	Andrey Norkin
JCTVC-G617	m22183	2011-11-08 19:56:32	2011-11-09 03:19:33	2011-11-09 03:19:33	Non-CE8: Cross check of MediaTek's pure VLC for SAO and ALF	I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-G618	m22184	2011-11-08 19:56:41	2011-11-09 18:48:10	2011-11-26 19:08:11	Level restrictions on tiles for line buffer reduction	Andrey Norkin, Rickard Sjöberg
JCTVC-G619	m22185	2011-11-08 19:59:14	2011-11-09 18:48:58	2011-11-25 09:28:39	Non-CE12: deblocking parameters signalling in slice header	A. Norkin, R. Sjöberg, K. Andersson, J. Enhorn,
JCTVC-G620	m22186	2011-11-08 20:00:40	2011-11-16 22:36:50	2011-11-16 22:36:50	Clean-up of deblocking filter description	Andrey Norkin
JCTVC-G621	m22187	2011-11-08 20:05:00	2011-11-21 10:19:48	2011-11-21 10:19:48	CE12: Cross-verification of deblocking filtering decisions from Panasonic (JCTVC-G590) by Ericsson	Andrey Norkin
JCTVC-G622	m22188	2011-11-08 20:06:12	2011-11-21 10:21:30	2011-11-21 10:21:30	CE12: Cross-verification of parallel deblocking from Sony (JCTVC-G256) by Ericsson	Andrey Norkin
JCTVC-G623	m22189	2011-11-08 20:07:10	2011-11-21 10:25:16	2011-11-21 10:25:16	CE12: Cross-verification of deblocking simplification JCTVC-G086 from TI by Ericsson	Andrey Norkin
JCTVC-G624	m22190	2011-11-08 20:09:04	2011-11-21 22:09:02	2011-11-21 22:09:02	Non-CE12: Cross-verification of parallel deblocking proposal JCTVC-G089 from TI	Andrey Norkin
JCTVC-G625	m22191	2011-11-08 20:20:47	2011-11-08 21:19:45	2011-11-15 14:54:23	Cross-check of JCTVC-G333, "Accuracy improvement of HM's transform bases"	A. Fuldseth (Cisco)
JCTVC-G626	m22192	2011-11-08 20:21:51	2011-11-08 21:20:15	2011-11-16 11:17:21	Cross-check of JCTVC-G365, "Nonzero coefficient coding in CAVLC"	A. Fuldseth (Cisco)
JCTVC-G627	m22194	2011-11-08 20:22:26	2011-11-08 21:21:07	2011-11-21 13:00:06	Cross-chekk of JCTVC-G199, "AHG4: Wavefront tile parallel processing"	A. Fuldseth (Cisco)
JCTVC-G628	m22195	2011-11-08 20:28:23	2011-11-08 23:28:33	2011-11-22 10:18:44	Comparison of core transform proposals	A. Fuldseth, G. Bjøntegaard (Cisco), M. Budagavi (TI),
JCTVC-G629	m22196	2011-11-08 20:42:41	2011-11-09 10:14:03	2011-11-20 12:00:31	Non CE 7: Harmonization of SDIP and Mode-Dependent Secondary Transforms	A. Saxena (Samsung), Y. Shibahara (Panasonic), F. Fernandes (Samsung), T Nishi (Panasonic)
JCTVC-G630	m22197	2011-11-08 20:44:51	2011-11-14 06:20:16	2011-11-20 11:58:48	Cross Check of JCTVC-G345: Restricted Mode-Dependent 8x8 DST for Intra prediction	A. Saxena, F. Fernandes (Samsung)
JCTVC-G631	m22198	2011-11-08	2011-11-14	2011-11-14	Cross-Check of JCTVC-G281 : Boundary Dependent Transform	A. Saxena, F. Fernandes

		20:45:59	06:34:04	22:48:48	for Inter Predicted Residue	(Samsung)
JCTVC-G632	m22199	2011-11-08 20:46:41	2011-11-09 11:17:50	2011-11-25 17:06:22	Non CE 7: On secondary transforms for inter prediction residual	Ankur Saxena, F. Fernandes (Samsung)
JCTVC-G633	m22200	2011-11-08 21:02:02	2011-11-08 23:58:48	2011-12-02 11:53:45	CE1: Report of test results related to PIPE-based Unified Entropy Coding	H. Kirchhoffer, B. Bross, A. Henkel, D. Marpe, T. Nguyen, M. Preiß, M. Siekmann, J. Stegemann, T. Wiegand (Fraunhofer HHI)
JCTVC-G634	m22201	2011-11-08 21:03:13	2011-11-14 06:29:14	2011-11-14 06:29:14	Cross check of MediaTek JCTVC-G136: Suggestion on picture quality hierarchy for Low Delay configurations	E. S. Ryu, Y. Ye (InterDigital)
JCTVC-G635	m22202	2011-11-08 21:09:27	2011-11-09 14:10:59	2011-11-22 17:11:38	Coding with a unified reference picture list	M. Naccari (BBC), G. Van Wallendael (Ghent University), M. Mrak (BBC), D. Flynn (BBC)
JCTVC-G636	m22203	2011-11-08 21:20:29	2011-11-20 19:25:56	2011-11-20 19:25:56	CE3: Cross-Verification of Samsung/Motorola's interpolation filter variant A	K. Ugur, O. Bici (Nokia)
JCTVC-G637	m22204	2011-11-08 21:26:57	2011-11-09 10:22:19	2011-11-22 20:00:48	AHG21: Long-term pictures and pruning of reference picture sets	R. Sjöberg, J. Samuelsson (Ericsson)
JCTVC-G638	m22205	2011-11-08 21:37:25	2011-11-08 21:42:32	2011-11-23 17:06:58	Deblocking boundary strength and filtering process simplifications	A. Kotra, M. Narroschke, T. Wedi (Panasonic)
JCTVC-G639	m22206	2011-11-08 21:45:10	2011-11-08 21:48:02	2011-11-23 17:16:16	Deblocking simplification and rounding optimization	A. Kotra, M. Narroschke, T. Wedi (Panasonic)
JCTVC-G640	m22207	2011-11-08 21:50:23	2011-11-08 21:57:00	2011-11-24 11:04:04	Deblocking bug fix for CU-Varying QP's and IPCM blocks	A. Kotra, M. Narroschke, T. Wedi (Panasonic)
JCTVC-G641	m22208	2011-11-08 22:04:08	2011-11-24 17:37:46	2011-11-24 17:37:46	CE1: Cross-check of Subtest C (test 1 and test 11) and Subtest B - multi-parameter probability update for CABAC (test 11)	Jinwen Zan,
JCTVC-G642	m22209	2011-11-08 22:05:20	2011-11-21 23:25:50	2011-11-21 23:25:50	Cross-check of Samsung context reduction in significance map coding	Jinwen Zan, Dake He
JCTVC-G643	m22210	2011-11-08 22:08:37	2011-11-08 23:57:59	2011-11-24 15:39:47	AHG21: On reference picture list construction and reference picture marking	M. M. Hannuksela, S. M. Gopalakrishna (Nokia)
JCTVC-G644	m22211	2011-11-08 22:15:56	2011-11-09 00:05:40	2011-11-26 08:34:33	Multi-level Significant Maps for Large Transform Units	N. Nguyen, T. Ji, D. He, G. Martin-Cocher, L. Song (RIM)
JCTVC-G645	m22212	2011-11-08 23:01:54	2011-11-18 03:36:26	2011-11-18 03:36:26	Crosscheck of JCTVC-G112 - Changing Luma/Chroma Coefficient Interleaving from CU to TU level	M. Budagavi (TI)
JCTVC-G646	m22213	2011-11-08 23:03:25	2011-11-13 22:53:52	2011-11-13 22:53:52	Non-CE6.a: Crosscheck of JCTVC-G244 - Luma-based chroma prediction - Model correction	M. Budagavi (TI)
JCTVC-G647	m22214	2011-11-08	2011-11-08	2011-11-16	CE8 Subtest a, Tool 3: Block-based filter adaptation with 8 initial	P. Lai, F. C. A. Fernandes, I.-K.

		23:04:12	23:50:28	23:44:15	filter classes (HV8)	Kim (Samsung)
JCTVC-G648	m22215	2011-11-08 23:04:48	2011-11-09 01:22:33	2011-11-09 20:01:07	CE8 Subtest d, Tool 2: ALF filters with 9 coefficients and up to vertical-size 7	P. Lai, F. C. A. Fernandes (Samsung), H. Guermazi, F. Kossentini, M. Horowitz (eBrisk),
JCTVC-G649	m22216	2011-11-08 23:05:18	2011-11-09 00:39:51	2011-11-09 20:10:10	CE8 Subtest a: Cross-check of Tool 1 (JCTVC-G316) 2-D mergeable syntax	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-G650	m22217	2011-11-08 23:05:35	2011-11-09 00:32:07	2011-11-09 20:15:21	CE8 Subtest a: Cross-check of Tool 2 (JCTVC-G609) Directional feature calculation on subset of pixels	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-G651	m22218	2011-11-08 23:05:59	2011-11-24 09:28:39	2011-11-24 09:28:39	Crosscheck of JCTVC-G499 - Improved ALF with low latency and reduced complexity	M. Budagavi (TI)
JCTVC-G652	m22219	2011-11-08 23:06:03	2011-11-09 01:31:48	2011-11-09 20:19:35	CE8 Subtest d: Cross-check of Tool 3 (JCTVC-G130): Chroma ALF with reduced vertical filter size, proposed by TI	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-G653	m22220	2011-11-08 23:06:42	2011-11-09 02:05:19	2011-11-09 20:10:49	Non-CE8: Cross-check of JCTVC-G691 Combination of CE8.a Tool 1 and Tool 2	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-G654	m22221	2011-11-08 23:07:12	2011-11-09 01:43:27	2011-11-20 12:59:48	Non-CE8: Cross-check of CE8.c Tool 7-1 (JCTVC-G212) on single-source SAO and ALF virtual boundary processing with cross9x9	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-G655	m22222	2011-11-08 23:07:55	2011-11-09 06:09:37	2011-11-23 10:37:35	Cross-check of JCTVC-G151 on prediction and partition mode binarization for Low Delay P	Y. Piao, P. Lai (Samsung)
JCTVC-G656	m22223	2011-11-08 23:10:23	2011-11-09 00:18:38	2011-11-17 01:07:28	Non-CE8 Subtest a: Harmonization of CE8a Tool 2 Shape-dependent BA (SDBA) and Tool 3 Block-based filter adaptation with 8 initial filter classes (HV8)	P. Lai, F. C. A. Fernandes, I.-K. Kim (Samsung)
JCTVC-G657	m22224	2011-11-08 23:26:33	2011-11-08 23:55:14	2011-11-26 15:45:28	Encoding and decoding significant coefficient flags for small Transform Units using partition sets	Gergely Korodi, Jinwen Zan, Dake He
JCTVC-G658	m22225	2011-11-08 23:29:59	2011-11-09 07:20:15	2011-11-23 10:38:48	Quantization matrices in fragmented APS	Y. Chen, Y.-K. Wang, R. Joshi, M. Karczewicz (Qualcomm)
JCTVC-G659	m22226	2011-11-08 23:30:21	2011-11-09 08:37:45	2011-11-09 08:37:45	Non-CE1: Study of Entropy Coding Methods Complexity	M. Karczewicz, I. S. Chong, X. Wang, R. Joshi (Qualcomm)
JCTVC-G660	m22227	2011-11-08 23:30:43	2011-11-09 01:41:32	2011-11-09 01:41:32	Cross-check of MediaTek's CE4 Subtest2.1 Adaptive Quantization Offset	X. Yu, D. He (RIM)
JCTVC-G661	m22228	2011-11-08 23:32:14	2011-11-09 06:56:52	2011-11-09 06:56:52	Parallel partition Profile & Level limits	Chad Fogg, Aaron Wells
JCTVC-G662	m22229	2011-11-08 23:38:56	2011-11-09 02:11:50	2011-11-09 16:31:44	Cross-check of QualCom's CE4 Subtest2.3 Fine QP	X. Yu, J. Wang, D. He (RIM)
JCTVC-G663	m22230	2011-11-08 23:41:11	2011-11-09 07:27:32	2011-11-25 20:09:37	AHG19: Modification to HE transform coefficient coding for transform skip mode	R. Joshi, J. Sole, X. Wang, M. Karczewicz (Qualcomm)

JCTVC-G664	m22231	2011-11-08 23:45:34	2011-11-09 01:33:16	2011-11-25 21:45:19	AHG22: A lossless coding solution for HEVC	W. Gao, M. Jiang, Y. He, J. Song, H. Yu (Huawei Technologies),
JCTVC-G665	m22232	2011-11-08 23:46:02	2011-11-08 23:50:56	2011-11-21 20:04:45	CE8.e.3: ALF coefficient prediction	K. Andersson (Ericsson)
JCTVC-G666	m22234	2011-11-08 23:47:37	2011-11-09 00:19:50	2011-11-25 16:48:09	1D-DCT based frequency domain adaptive loop filter (FD-ALF)	J. Lim (SK telecom), J. O. Lee (Sejong Univ.), H.-K. Kim (Sejong Univ.), J.-H. Moon (Sejong Univ.), S. Lim (Sejong Univ.)
JCTVC-G667	m22235	2011-11-08 23:47:42	2011-11-28 11:14:21	2011-11-28 11:14:21	HEVC field coded sequences vs. deinterlaced progressive coding	Chad Fogg
JCTVC-G668	m22236	2011-11-08 23:49:36	2011-11-08 23:57:03	2011-11-08 23:57:03	POC type 1	M. M. Hannuksela (Nokia)
JCTVC-G669	m22237	2011-11-08 23:50:20	2011-11-08 23:54:04	2011-11-20 18:14:41	Delayed Duplicate I-Frame for Video Conferencing	R. Srinivasan, C. Ghone, M. Mody, M. Zhou (TI)
JCTVC-G670	m22238	2011-11-09 00:01:49			Withdrawn	
JCTVC-G671	m22239	2011-11-09 00:05:22	2011-11-09 16:00:32	2011-11-09 16:00:32	CE3: Crosscheck for Qualcomm Adaptive MVD Resolution in JCTVC-G727	J. An, X. Guo (MediaTek)
JCTVC-G672	m22240	2011-11-09 00:06:13	2011-11-09 16:08:30	2011-11-09 16:08:30	CE3: Crosscheck for Panasonic Picture Adaptive 1/8 MC in JCTVC-G535	J. An, X. Guo (MediaTek)
JCTVC-G673	m22241	2011-11-09 00:07:33	2011-11-09 16:10:01	2011-11-09 16:10:01	CE12 Subtest 1: Crosscheck for Microsoft's Deblocking for Larger Blocks in JCTVC-G409	Q. Huang, X. Guo (MediaTek)
JCTVC-G674	m22242	2011-11-09 00:07:35	2011-11-09 08:30:07	2011-11-20 11:34:16	CE5: Sub-block coding of transform coefficients with CAVLC	M. Karczewicz, L. Guo, Y. Zheng, X. Wang (Qualcomm)
JCTVC-G675	m22243	2011-11-09 00:09:01	2011-11-09 16:11:33	2011-11-09 16:11:33	Non-CE12: Crosscheck for LGE's Simplified Bs Calculation in JCTVC-G176	J. An, X. Guo (MediaTek)
JCTVC-G676	m22244	2011-11-09 00:09:20	2011-11-19 21:38:56	2011-11-19 21:38:56	Non-CE6: Crosscheck for Intel's Intra Chroma Prediction in JCTVC-G173	M. Guo, X. Guo (MediaTek)
JCTVC-G677	m22245	2011-11-09 00:16:20	2011-11-09 08:44:16	2011-11-20 11:21:56	CE5: Limitation on VLC codeword length	M. Karczewicz, X. Wang, W. J. Chien, L. Guo (Qualcomm)
JCTVC-G678	m22246	2011-11-09 00:19:00	2011-11-10 00:54:16	2011-11-29 21:38:25	A tool for rate-constrained performance test	S. Campbell, J. Wang, X. Yu (RIM)
JCTVC-G679	m22247	2011-11-09 00:20:06	2011-11-09 08:18:10	2011-11-20 11:20:05	CE11: Extending horizontal and vertical scan to big block for CAVLC	M. Karczewicz, Y. Zheng, L. Guo, X. Wang (Qualcomm)
JCTVC-G680	m22248	2011-11-09	2011-11-09	2011-11-21	Non-CE8: Method of visual coding artifact removal for SAO	W.-S. Kim, D.-K. Kwon (TI)

		00:39:14	04:29:14	18:37:25		
JCTVC-G681	m22249	2011-11-09 00:39:59	2011-11-09 08:23:47	2011-11-21 00:06:38	Non-CE9: Simplified Merge candidate derivation	Y. Zheng, X. Wang, W.-J. Chien, M. Karczewicz (Qualcomm)
JCTVC-G682	m22250	2011-11-09 00:40:41	2011-11-09 04:30:11	2011-11-21 23:12:12	Non-CE8: Reduced number of band offsets in SAO	W.-S. Kim, D.-K. Kwon (TI)
JCTVC-G683	m22251	2011-11-09 00:41:28	2011-11-09 08:24:32	2011-11-22 02:02:36	Non-CE13: Simplification and improvement of additional merge candidate	Y. Zheng, X. Wang, W.-J. Chien, M. Karczewicz (Qualcomm)
JCTVC-G684	m22252	2011-11-09 00:41:58	2011-11-09 00:52:36	2011-11-09 00:52:36	Subjective Tests on ALF and SAO Using HM-4.0	W.-S. Kim, O. G. Sezer, M. Budagavi (TI)
JCTVC-G685	m22253	2011-11-09 00:42:20	2011-11-10 00:28:11	2011-11-21 18:35:00	Selective Run-Level Coding for CAVLC	S.-H. Kim, A. Segall (Sharp)
JCTVC-G686	m22254	2011-11-09 00:49:25	2011-11-09 06:33:42	2011-11-16 20:59:19	CE13: Crosscheck report of JCTVC-G231 Test 1	Y. Zheng, X. Wang (Qualcomm)
JCTVC-G687	m22255	2011-11-09 00:50:13	2011-11-09 00:53:37	2011-11-09 00:53:37	Fast fractional motion search with adaptive searching point reduction	Wan-Chi Siu (HKPU), Yan-Ho Kam (HKPU), Wai-Lam Hui (HKPU), Yui-Lam Chan (HKPU), Yu Liu (ASTRI), Jenny Yan Huo (ASTRI)
JCTVC-G688	m22256	2011-11-09 00:51:14	2011-11-09 06:34:27	2011-11-16 21:09:01	CE09: Crosscheck report of JCTVC-G052 test MRG_MVD03	Y. Zheng, X. Wang (Qualcomm)
JCTVC-G689	m22257	2011-11-09 00:53:18	2011-11-09 06:35:16	2011-11-16 21:13:17	CE09: Crosscheck report of JCTVC-G084 test SP04	Y. Zheng, X. Wang (Qualcomm)
JCTVC-G690	m22258	2011-11-09 00:56:41	2011-11-09 01:07:47	2011-11-23 08:02:37	Non-CE9: Some possible motion vector coding related simplifications	Y. H. Tan, C. Yeo, Z. Li (I2R)
JCTVC-G691	m22259	2011-11-09 01:03:03	2011-11-09 01:08:23	2011-11-09 01:08:23	Non-CE8: Combination of CE8.a.1 and CE8.a.2	T. Yamakage, T. Watanabe, T. Chujoh (Toshiba), C. Y. Chen, C. M. Fu, C. Y. Tsai, Y. W. Huang, S. Lei (MediaTek), M. Karczewicz, I. S. Chong (Qualcomm), T. Ikai, A. Segall, T. Yamamoto (Sharp),
JCTVC-G692	m22260	2011-11-09 01:08:53	2011-11-11 09:26:39	2011-11-21 18:36:06	Fixed Intra Mapping Mode for Run-Level Coding	S.-H. Kim, A. Segall (Sharp)
JCTVC-G693	m22261	2011-11-09 01:12:00	2011-11-21 03:42:39	2011-11-21 03:42:39	Cross-check of Qualcomm proposal on interpolation precision (JCTVC-G736)	Y. H. Tan, C. Yeo (I2R)
JCTVC-G694	m22262	2011-11-09	2011-11-09	2011-11-20	CE10: Cross-check report for FastVDO/Samsung's core Transform	J. Lou, L. Wang (Motorola

		01:13:01	05:27:59	07:13:30	by Motorola Mobility (JCTVC-G266)	Mobility)
JCTVC-G695	m22263	2011-11-09 01:13:40	2011-11-09 05:33:59	2011-11-09 22:15:33	CE3: Cross-check report for Samsung's interpolation filter 6H+7Q (JCTVC-G775)	J. Lou, K. Minoo, L. Wang (Motorola Mobility)
JCTVC-G696	m22264	2011-11-09 01:14:13	2011-11-09 05:40:57	2011-11-21 08:20:36	CE3: Fixed interpolation filter tests by Motorola Mobility	J. Lou, K. Minoo, D. Baylon, L. Wang, A. Luthra (Motorola Mobility)
JCTVC-G697	m22265	2011-11-09 01:14:34	2011-11-09 05:44:52	2011-11-21 23:08:12	CE3: Joint sub-pixel interpolation filter tests for bi-predicted motion compensation by Motorola Mobility	J. Lou, K. Minoo (Motorola Mobility)
JCTVC-G698	m22266	2011-11-09 01:15:02	2011-11-09 05:53:21	2011-11-09 23:54:23	On Chroma interpolation filter	J. Lou, K. Minoo, L. Wang, A. Luthra (Motorola Mobility)
JCTVC-G699	m22267	2011-11-09 01:15:22	2011-11-09 06:00:33	2011-11-15 06:37:35	Motion vector scaling for non-uniform interpolation offset	J. Lou, K. Minoo, L. Wang (Motorola Mobility)
JCTVC-G700	m22268	2011-11-09 01:15:44	2011-11-09 09:10:00	2011-11-30 02:00:45	On coeff_abs_level_minus3 coding	J. Lou, L. Wang, X. Fang (Motorola Mobility)
JCTVC-G701	m22269	2011-11-09 01:16:10			Withdrawn	,
JCTVC-G702	m22270	2011-11-09 01:19:27	2011-11-09 20:46:52	2011-11-09 20:46:52	CE9: Simplification of MVP Design for HEVC	Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)
JCTVC-G703	m22271	2011-11-09 01:21:28	2011-11-09 20:50:18	2011-11-09 20:50:18	CE11: Adaptive Scan for Large Blocks for HEVC	Y. Yu, K. Panusopone, J. Lou, L. Wang (Motorola Mobility)
JCTVC-G704	m22272	2011-11-09 01:21:35	2011-11-09 01:25:27	2011-11-21 19:43:27	Last position coding for CABAC	W. -J. Chien, J. Sole, M. Karczewicz
JCTVC-G705	m22273	2011-11-09 01:21:52	2011-11-10 00:00:50	2011-11-23 01:06:53	CABAC simplification for explicit signaling mode of AMVP	K. Misra, A. Segall (Sharp)
JCTVC-G706	m22274	2011-11-09 01:22:24	2011-11-09 20:01:38	2011-11-19 07:20:12	CE9: Cross-check report for TI's JCTVC-F083 by Motorola Mobility	Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)
JCTVC-G707	m22275	2011-11-09 01:23:08	2011-11-09 09:43:51	2011-11-22 00:04:35	Using CABAC bypass mode for coding intra prediction mode	K. Misra, A. Segall (Sharp)
JCTVC-G708	m22276	2011-11-09 01:23:25	2011-11-09 20:53:17	2011-11-19 07:23:40	CE11:Cross-check report for Huawei's JCTVC-F501 by Motorola Mobility	Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)
JCTVC-G709	m22277	2011-11-09 01:24:21	2011-11-09 09:53:34	2011-11-09 09:53:34	On partition size information coding using CABAC	T. Yamamoto, K. Misra, A. Segall (Sharp)
JCTVC-G710	m22278	2011-11-09 01:24:22	2011-11-10 01:38:59	2011-11-19 07:24:41	Non-CE9: The Parallel Friendly MVP Candidate Calculation for HEVC	Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)
JCTVC-G711	m22279	2011-11-09 01:24:37	2011-11-10 18:40:09	2011-11-10 18:40:09	Non-CE4: Cross-verification of MediaTek's proposal JCTVC-G152 on method and syntax for quantization matrices representation	M. Zhou (TI)

JCTVC-G712	m22280	2011-11-09 01:25:15	2011-11-10 01:40:27	2011-11-19 07:25:36	Non-CE9: The Simplification of MVP for HEVC	Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)
JCTVC-G713	m22281	2011-11-09 01:25:18	2011-11-09 09:56:59	2011-11-19 16:27:54	AHG21: Long term picture referencing using wrapped POC	K. Misra, S. Deshpande, A. Segall (Sharp)
JCTVC-G714	m22282	2011-11-09 01:26:03	2011-11-10 03:05:23	2011-11-19 16:28:36	AHG21: On picture referencing	K. Misra, S. Deshpande, A. Segall (Sharp)
JCTVC-G715	m22283	2011-11-09 01:26:46	2011-11-12 09:08:22	2011-11-19 16:29:37	AHG18/21: Absolute signaling for resolution switching	K. Misra, S. Deshpande, L. Kerofsky, A. Segall (Sharp)
JCTVC-G716	m22284	2011-11-09 01:27:18	2011-11-12 01:18:27	2011-11-24 13:10:13	On CABAC Init IDC	K. Misra, A. Segall (Sharp)
JCTVC-G717	m22285	2011-11-09 01:28:32	2011-11-10 01:42:04	2011-11-24 10:43:26	AHG21: The Improvements on Reference Picture Buffering and List Construction	Y. Yu, K. Panusopone, X. Fang, L. Wang (Motorola Mobility)
JCTVC-G718	m22286	2011-11-09 01:28:38	2011-11-09 01:32:43	2011-11-27 08:46:33	Context reduction for CABAC	W. -J. Chien, J. Sole, M. Karczewicz
JCTVC-G719	m22287	2011-11-09 01:29:00	2011-11-09 09:47:43	2011-11-19 03:26:18	Structured Level Limits	L. Kerofsky, A. Segall, K. Misra (Sharp), E. Alshina, A. Alshin (Samsung)
JCTVC-G720	m22288	2011-11-09 01:29:39	2011-11-09 23:57:46	2011-11-19 03:35:14	Dequantization with symmetric reconstruction points	L. Kerofsky, A. Segall, K. Misra (Sharp)
JCTVC-G721	m22289	2011-11-09 01:29:40	2011-11-09 06:46:23	2011-11-19 07:43:58	CE4 Subtest 1.1.a: QP adaptation at sub-CU level	X. Fang, J.-H. Kim, K. Panusopone, L. Wang, A. Luthra (Motorola Mobility)
JCTVC-G722	m22290	2011-11-09 01:30:18	2011-11-12 08:32:38	2011-11-24 10:51:59	Harmonization of entry points for tiles and wavefront processing	A. Segall, K. Misra (Sharp)
JCTVC-G723	m22291	2011-11-09 01:30:49	2011-11-09 06:31:11	2011-11-19 07:47:22	Support for finer QP granularity in HEVC	K. Panusopone, A. Luthra, X. Fang, J.-H. Kim, L. Wang (Motorola Mobility)
JCTVC-G724	m22292	2011-11-09 01:31:33	2011-11-09 06:12:31	2011-11-26 10:56:08	Non-CE11: Entropy coding for non-square TU blocks	W.-Y. Kung, K. Panusopone (Motorola Mobility)
JCTVC-G725	m22293	2011-11-09 01:32:03	2011-11-09 06:13:45	2011-11-26 10:56:38	Non-CE11: Simplification of significant coding for CABAC	W.-Y. Kung, K. Panusopone (Motorola Mobility)
JCTVC-G726	m22294	2011-11-09 01:32:31	2011-11-10 01:56:10	2011-11-20 14:08:08	CE4 Subtest 1.3.d: Cross-check report for Qualcomm's JCTVC-G728 by Motorola Mobility	K. Panusopone (Motorola Mobility)
JCTVC-G727	m22295	2011-11-09 01:35:19	2011-11-09 01:37:03	2011-11-09 01:37:03	CE3: Adaptive resolution on motion vector difference	W.-J. Chien, X. Wang, M. Karczewicz
JCTVC-G728	m22297	2011-11-09 01:56:13	2011-11-09 02:00:21	2011-11-15 18:56:14	CE4 Subtest 1: Spatial QP prediction (test 1.3.e): combination of test 1.3.b and test 1.3.d	M. Coban, M. Karczewicz (Qualcomm)

JCTVC-G729	m22298	2011-11-09 01:58:54	2011-11-09 06:26:00	2011-11-09 06:26:00	Proposal to start the discussion on HEVC profile/level	T. Suzuki (Sony)
JCTVC-G730	m22299	2011-11-09 02:00:53	2011-11-22 15:07:18	2011-11-22 15:07:18	Non-CE4: Cross check of layered quantization matrices compression in JCTVC-G530	T. Suzuki (Sony)
JCTVC-G731	m22300	2011-11-09 02:01:51	2011-11-18 18:52:39	2011-11-19 00:59:27	CE4 Subtest 1.3.c: cross-verification of JCTVC-G067	M. Coban (Qualcomm)
JCTVC-G732	m22301	2011-11-09 02:02:04	2011-11-18 02:26:42	2011-11-18 02:26:42	Study on test materials in common test condition	T. Suzuki (Sony)
JCTVC-G733	m22302	2011-11-09 02:04:29	2011-11-22 15:52:27	2011-11-22 15:52:27	Non-CE9: Cross-check report for I2R's JCTVC-G690 by Motorola Mobility	Y. Yu, K. Panusopone, L. Wang
JCTVC-G734	m22303	2011-11-09 02:07:54	2011-11-10 05:00:36	2011-11-22 17:47:32	CE 7: Crosscheck of JCTVC-G304 ROT Transform	P. Topiwala (FastVDO)
JCTVC-G735	m22304	2011-11-09 02:09:48	2011-11-22 16:03:07	2011-11-22 16:07:02	Non-CE 7: Crosscheck of JCTVC-G591 Supplemental ROT Results	M. Krishnan, P. Topiwala (FastVDO)
JCTVC-G736	m22305	2011-11-09 02:16:41	2011-11-09 02:18:23	2011-11-25 10:35:47	On luma/chroma interpolation precision	M. Coban, M. Karczewicz (Qualcomm)
JCTVC-G737	m22306	2011-11-09 02:18:50	2011-11-09 02:51:26	2011-11-22 17:56:43	CE10: Full Factorization Core Transforms for HEVC	E. Alshina, A. Alshin, W. Lee, J. Park, K. Pachauri (Samsung), P. Topiwala (FastVDO)
JCTVC-G738	m22307	2011-11-09 02:19:45	2011-11-09 02:21:15	2011-11-25 10:36:35	On angular intra prediction main array extension	M. Coban (Qualcomm)
JCTVC-G739	m22308	2011-11-09 02:22:10	2011-11-10 12:41:21	2011-11-10 12:41:21	Non-CE4: Cross-verification report for improvement of intra prediction based QP prediction (JCTVC-G357)	H. Aoki, K. Chono (NEC)
JCTVC-G740	m22310	2011-11-09 02:27:09	2011-11-21 03:45:09	2011-11-21 03:45:09	Non-CE9: Cross-check of Motorola proposals on motion vector prediction candidate derivation for rectangular PUs (JCTVC-G710, JCTVC-G712)	Y. H. Tan, C. Yeo (I2R)
JCTVC-G741	m22311	2011-11-09 02:29:04	2011-11-17 06:09:48	2011-11-17 06:09:48	Cross-check report on joint coding of splitting flag and inter modes (JCTVC-G355)	I.-K. Kim (Samsung)
JCTVC-G742	m22312	2011-11-09 02:29:48	2011-11-10 03:18:05	2011-11-10 03:18:05	Cross-check report on derivation process of reference indices for temporal merge candidates (JCTVC-G217)	I.-K. Kim (Samsung)
JCTVC-G743	m22313	2011-11-09 02:30:28	2011-11-10 07:10:44	2011-11-10 07:10:44	Cross-check report on Non-Square Partition Mode Grouping for CAVLC (JCTVC-G312)	I.-K. Kim (Samsung)
JCTVC-G744	m22314	2011-11-09 02:31:06	2011-11-10 02:50:41	2011-11-10 02:50:41	Cross-check report on Coding order of sign and level minus 3 with CABAC (JCTVC-G372)	I.-K. Kim (Samsung)
JCTVC-G745	m22315	2011-11-09 02:32:34	2011-11-10 03:39:47	2011-11-10 03:39:47	CE9: Cross-check report on MRG_ID02 A and B (JCTVC-G421)	I.-K. Kim (Samsung)
JCTVC-G746	m22316	2011-11-09	2011-11-10	2011-11-10	CE12 subset 5.6: Cross-check report on parallel deblocking	I.-K. Kim, J. Chen (Samsung)

		02:33:43	09:34:54	09:34:54	decision (JCTVC-G088)	
JCTVC-G747	m22317	2011-11-09 02:39:40	2011-11-19 04:41:42	2011-11-19 04:41:42	Non-CE2: Crosscheck of MediaTek's proposal on NSQT coefficient scan for CAVLC (JCTVC-G202)	X. Zheng (HiSilicon)
JCTVC-G748	m22318	2011-11-09 02:40:14	2011-11-11 03:45:39	2011-11-21 09:45:06	Non-CE8: Crosscheck of TI's Reduced number of band offsets in SAO (JCTVC-G682)	T. Ikai, Y. Yasugi (Sharp)
JCTVC-G749	m22319	2011-11-09 02:42:16	2011-11-09 09:51:15	2011-11-18 08:08:59	CE2: Overlapped Block Motion Compensation	L. Guo, W. Chien, I. S. Chong, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G750	m22320	2011-11-09 02:44:26	2011-11-09 09:05:33	2011-11-21 17:34:39	Non-CE2: Harmonization of HE residual coding and NSQT	J. Sole, X. Wang, M. Karczewicz (Qualcomm), J. Kim, B. Jeon (LGE)
JCTVC-G751	m22321	2011-11-09 02:44:57	2011-11-18 07:25:12	2011-11-18 07:25:12	Cross-check report for Sharp's proposal (JCTVC-G308) on Complexity reduction of significant map coding	H. Sasai, T. Nishi (Panasonic)
JCTVC-G752	m22322	2011-11-09 02:46:20	2011-11-19 04:46:21	2011-11-19 04:46:21	Non-CE9: Crosscheck of I2R's proposal on motion vector coding related simplifications (JCTVC-G690)	X. Zheng (HiSilicon)
JCTVC-G753	m22323	2011-11-09 02:46:42	2011-11-19 04:57:01	2011-11-19 04:57:01	CE1: Crosscheck of CE1 subtest C.6 (JCTVC-G633) proposed by HHI	X. Zheng (HiSilicon)
JCTVC-G754	m22324	2011-11-09 02:46:59	2011-11-09 02:52:05	2011-11-09 02:52:05	Non-CE6: Line buffer reduction for CABAC context of SDIP syntax	L. Guo, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G755	m22325	2011-11-09 02:47:05	2011-11-19 04:49:34	2011-11-19 04:49:34	CE4: Crosscheck of Sony's improvement of delta-QP coding	X. Zheng (HiSilicon)
JCTVC-G756	m22326	2011-11-09 02:47:28	2011-11-19 04:44:20	2011-11-19 04:44:20	Non-CE6: Crosscheck of Canon's improvement on LM mode (JCTVC-G245)	X. Zheng (HiSilicon)
JCTVC-G757	m22327	2011-11-09 02:47:28	2011-11-09 02:50:59	2011-11-21 18:54:28	On software complexity	F. Bossen (DOCOMO Innovations)
JCTVC-G758	m22328	2011-11-09 02:48:13	2011-11-21 10:53:59	2011-11-21 10:53:59	Non-CE11: Cross-check report for TI's proposal (JCTVC-G123) on Simplified Coefficient Scans for NSQT	H. Sasai, K. Terada, T. Nishi (Panasonic)
JCTVC-G759	m22329	2011-11-09 02:51:43	2011-11-18 07:55:26	2011-11-18 07:55:26	Cross-check report for Support of ChromaQPOffset in HEVC (JCTVC-G509)	T. Matsunobu, H. Sasai, T. Nishi (Panasonic)
JCTVC-G760	m22330	2011-11-09 02:54:55	2011-11-18 07:41:59	2011-11-18 07:41:59	Cross-check report for Mitsubishi's proposal (JCTVC-G444) on Proposed fix on cbf flag signaling	H. Sasai, T. Nishi (Panasonic)
JCTVC-G761	m22331	2011-11-09 02:57:57	2011-11-18 07:10:47	2011-11-18 07:10:47	Cross-check report for MediaTek's proposal (JCTVC-G201)	H. Sasai, T. Nishi (Panasonic)
JCTVC-G762	m22332	2011-11-09 03:01:18	2011-11-09 16:41:50	2011-11-09 16:41:50	Cross-check of JCTVC-G374 on improving Intra prediction	H. L. Tan, C. Yeo (I2R)
JCTVC-G763	m22333	2011-11-09 03:06:13	2011-11-09 03:08:05	2011-11-09 03:08:05	CE1: Table-based bit estimation for CABAC	F. Bossen (DOCOMO Innovations)

JCTVC-G764	m22334	2011-11-09 03:08:08	2011-11-09 06:46:25	2011-11-18 06:51:17	CE1 (subset B): Multi-parameter probability up-date for CABAC	A. Alshin, E. Alshina, J. H. Park (Samsung)
JCTVC-G765	m22335	2011-11-09 03:09:37	2011-11-09 20:31:02	2011-11-09 20:31:02	CE1: Crosscheck of Subtest C - Tests 12 and 13 (JCTVC-G210 and JCTVC-G233)	R. Joshi (Qualcomm)
JCTVC-G766	m22336	2011-11-09 03:10:54	2011-11-09 18:37:25	2011-11-09 18:37:25	CE1: Crosscheck of Subtest C - Test 5 (JCTVC-G633)	R. Joshi (Qualcomm)
JCTVC-G767	m22337	2011-11-09 03:12:27	2011-11-09 06:03:32	2011-11-21 11:10:36	Non-CE1: Bypass coding of Intra prediction modes in CABAC	T. Lee, J. Chen, J. H. Park (Samsung)
JCTVC-G768	m22338	2011-11-09 03:16:25	2011-11-09 05:22:47	2011-11-28 09:46:52	Reduced contexts for significance map coding of large transform in CABAC	Y. Piao, J. Min, J. H. Park (Samsung)
JCTVC-G769	m22339	2011-11-09 03:16:46	2011-11-09 06:04:18	2011-11-21 11:12:54	CE1 subtest A: Line buffer removal for CU split flag context model	T. Lee, J. Chen, J. H. Park (Samsung)
JCTVC-G770	m22340	2011-11-09 03:18:09	2011-11-09 10:45:57	2011-11-19 11:57:54	Non-CE3: A restriction of motion vector for small block size	T. Chujoh, T. Yamakage (Toshiba)
JCTVC-G771	m22341	2011-11-09 03:18:20	2011-11-09 06:39:14	2011-11-18 06:52:45	CE1 (subset C, test 11): Multi-parameter probability up-date for PIPE	A. Alshin, E. Alshina, J. H. Park (Samsung), H. Kirchhoffer (HHI)
JCTVC-G772	m22342	2011-11-09 03:18:51	2011-11-18 10:24:49	2011-11-18 10:24:49	Cross-check result of JCTVC-G353: Non-CE4: QP prediction using spatial QP	K Sato (Sony)
JCTVC-G773	m22343	2011-11-09 03:19:41	2011-11-09 06:05:31	2011-11-25 21:57:35	CE4 Subtest 1.2.c: Higher granularity of quantization parameter scaling	T. Lee, J. Chen, J. H. Park (Samsung), K. Chono (NEC)
JCTVC-G774	m22344	2011-11-09 03:20:39	2011-11-09 03:59:27	2011-11-10 00:09:52	Non-CE8: Modified ALF DC coefficients	T. Yamakage, T. Watanabe, T. Chujoh (Toshiba), C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), M. Karczewicz, I. S. Chong (Qualcomm),
JCTVC-G775	m22346	2011-11-09 03:21:33	2011-11-09 06:49:18	2011-11-09 06:49:18	CE3: 7Q6H taps interpolation filters test by Samsung	E. Alshina, A. Alshin, J. H. Park (Samsumg)
JCTVC-G776	m22347	2011-11-09 03:23:59	2011-11-09 06:06:29	2011-11-21 11:16:21	CE13: Merge candidates list construction	T. Lee, J. Chen, J. H. Park (Samsung)
JCTVC-G777	m22348	2011-11-09 03:24:23	2011-11-09 05:01:00	2011-11-09 05:03:18	The Art of Writing Standards: Some Shalls and Shoulds for Better Quality Interop Specs	G. J. Sullivan (Microsoft)
JCTVC-G778	m22349	2011-11-09 03:25:23	2011-11-09 06:57:03	2011-11-09 06:57:03	CE3: 7 taps interpolation filters for quarter pel position MC from Samsung and Motorola Mobility	E. Alshina, A. Alshin, J.-H. Park (Samsung), J. Lou, K. Minoo (Motorola Mobility)
JCTVC-G779	m22350	2011-11-09 03:27:51	2011-11-09 05:08:51	2011-11-09 05:08:51	Proposed constraint on reordering latency (for further consideration of JCTVC-F541)	G. J. Sullivan (Microsoft)

JCTVC-G780	m22351	2011-11-09 03:28:02	2011-11-09 07:00:05	2011-11-09 07:00:05	CE3: The worst case memory band-width reduction by 2D->1D interpolation replacement (from Samsung).	E. Alshina, A. Alshin, J. Chen, J. H. Park (Samsung)
JCTVC-G781	m22352	2011-11-09 03:28:16	2011-11-09 05:23:32	2011-11-09 05:23:32	Reduced chroma contexts for significance map coding in CABAC	Y. Piao, J. Min, E. Alshina, J. H. Park (Samsung)
JCTVC-G782	m22353	2011-11-09 03:31:21	2011-11-09 07:05:26	2011-11-24 10:26:20	AhG7: Overflow Prevention in HEVC inverse transform	E. Alshina, A. Alshin, J. H. Park (Samsung)
JCTVC-G783	m22354	2011-11-09 03:32:48	2011-11-09 05:24:19	2011-11-29 17:01:54	Context number reduction for level coding in CABAC	Y. Piao, J. Min, J. H. Park (Samsung)
JCTVC-G784	m22355	2011-11-09 03:35:11	2011-11-09 07:12:57	2011-11-15 19:35:54	Crosscheck on JCTVC-G185 Non-CE6: On intra chroma mode coding	W.-J. Chien
JCTVC-G785	m22356	2011-11-09 03:35:26	2011-11-09 05:25:06	2011-11-24 12:51:41	Unified Pred_type coding in CABAC	Y. Piao, J. Min, J. H. Park (Samsung)
JCTVC-G786	m22358	2011-11-09 03:44:05	2011-11-15 03:41:14	2011-11-15 03:41:14	CE5 : Cross-verification of Sony redundancy removal for Run-mode in CAVLC (JCTVC-G360)	C. Kim (Samsung)
JCTVC-G787	m22359	2011-11-09 03:45:39	2011-11-09 04:31:22	2011-11-22 09:48:43	Non-CE13: Additional merge candidates with MV dependent offsets	T. Lee, J. Chen, J. H. Park (Samsung), G. Laroche, P. Onno (Canon), J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-G788	m22360	2011-11-09 03:45:54	2011-11-09 05:13:25	2011-11-20 23:01:40	AHG21: Proposal on Decoded Picture Buffer Description Syntax Relating to JCTVC-F493	G. J. Sullivan, Y. Wu, J. Xu (Microsoft), B. Li (USTC)
JCTVC-G789	m22361	2011-11-09 03:46:13	2011-11-15 15:19:48	2011-11-15 15:19:48	CE6.b: Cross-check report for DCIM (JCTVC-G868)	C. Lai, L. Liu, J. Zheng (HiSilicon)
JCTVC-G790	m22362	2011-11-09 03:47:47	2011-11-14 16:16:58	2011-11-14 16:16:58	CE6.d: Cross-check report for JCTVC-G280 and JCTVC-G565 for Intra Prediction with Secondary Boundary	C. Lai, L. Liu, J. Zheng (HiSilicon)
JCTVC-G791	m22363	2011-11-09 03:49:41	2011-11-09 06:21:00	2011-11-27 15:22:23	Non-CE6: Simplified reference samples padding for intra prediction	T. Lee, J. Chen, J. H. Park (Samsung)
JCTVC-G792	m22364	2011-11-09 03:50:13	2011-11-09 05:30:20	2011-11-15 02:14:37	Cross-check for Huawei's proposal on PU dependent coefficient scan for inter block (JCTVC-G269)	Y. Piao, J. Chen, J. Min, J. H. Park (Samsung)
JCTVC-G793	m22365	2011-11-09 03:50:18	2011-11-15 05:16:57	2011-11-15 05:16:57	Non-CE12: Cross-check of Qualcomm's deblocking of IPCM blocks containing reconstructed samples (JCTVC-G138) by Panasonic	S. M. T. Naing, V. Wahadaniah, C. S. Lim (Panasonic)
JCTVC-G794	m22366	2011-11-09 03:50:22	2011-11-18 05:01:18	2011-11-18 05:01:18	Cross-check of Early skip detection for HEVC (JCTVC-G543)	Kiho Choi, Gyeong-gi Noh, Sang-hyo Park, Euee S. Jang
JCTVC-G795	m22367	2011-11-09 03:52:43	2011-11-09 05:30:56	2011-11-21 02:22:29	Crosscheck of TI's JCTVC-G669 on delay dependent intra frame for video conferencing	J. Min, K. P. Choi, Y. Park, Y. Piao, J. H. Park (Samsung)
JCTVC-G796	m22368	2011-11-09	2011-11-09	2011-11-09	Cross-check for RIM's proposal on small TU significance map	Y. Piao, E. Alshina, J. Min, J. H.

		03:57:21	05:31:49	08:51:36	coding (JCTVC-G657)	Park (Samsung)
JCTVC-G797	m22369	2011-11-09 03:58:05	2011-11-14 16:19:37	2011-11-14 16:19:37	CE6.c: Cross-check report for JCTVC-G322 on Harmonization of HE residual coding with non-square block transforms	C. Lai, L. Liu, J. Zheng (HiSilicon)
JCTVC-G798	m22370	2011-11-09 04:01:48	2011-11-11 04:49:14	2011-11-17 10:51:24	Cross verification of MediaTek's proposed residue quad-tree depth for intra chroma coding (JCTVC-G283)	Y. Chiu, L. Xu (Intel)
JCTVC-G799	m22371	2011-11-09 04:05:56	2011-11-22 04:37:10	2011-11-22 04:37:10	Non-CE9: Crosscheck for Sony's proposals (JCTVC-G516) by JVC KENWOOD	H. Nakamura, H. Takehara (JVC Kenwood)
JCTVC-G800	m22372	2011-11-09 04:06:27	2011-11-14 16:34:22	2011-11-14 16:34:22	CE6.c: Cross-check report for LG JCTVC-G142 and JCTVC-G143	C. Lai, L. Liu, J. Zheng (HiSilicon)
JCTVC-G801	m22373	2011-11-09 04:08:45	2011-11-19 00:55:17	2011-11-19 00:55:17	Cross-check for Samsung's proposal (JCTVC-G545)	J. Xu (Sony)
JCTVC-G802	m22374	2011-11-09 04:12:37	2011-11-09 05:09:12	2011-11-16 01:39:15	Cross-check of "AHG4: Non-cross-tiles loop filtering for independent tiles" (JCT-VC-G194)	M. Horowitz, S. Xu (eBrisk)
JCTVC-G803	m22375	2011-11-09 04:13:18	2011-11-17 09:21:12	2011-11-25 19:16:46	Non-CE8: Cross-check for Simplification of ALF Clasification (JCTVC-G351)	T. Yamamoto, T. Ikai (Sharp)
JCTVC-G804	m22376	2011-11-09 04:30:47	2011-11-14 16:39:05	2011-11-14 16:39:05	Non-CE6.c: Cross-check report for JCTVC-G354 on Improvements for SDIP	C. Lai, L. Liu, J. Zheng (HiSilicon)
JCTVC-G805	m22377	2011-11-09 05:07:31	2011-11-19 02:07:52	2011-11-19 02:07:52	Cross-check of Canon's modified probability update and table removal for multi-parameter CABAC update (JCTVC-G413)	J. Sole (Qualcomm)
JCTVC-G806	m22378	2011-11-09 05:12:09	2011-11-09 09:16:09	2011-11-25 09:02:30	Non CE3: On the phase offset selection for motion compensation interpolation filters	Koohyar Minoo, David Baylon, Jian Lou
JCTVC-G807	m22379	2011-11-09 05:14:16	2011-11-11 22:32:15	2011-11-25 08:52:27	Non CE3: On design of interpolation filters for Uni and Bi Predictive Motion Compensation	Koohyar Minoo, David Baylon, Jian Lou
JCTVC-G808	m22380	2011-11-09 05:14:26	2011-11-18 07:52:44	2011-11-18 07:52:44	Non-CE8: Cross-check report for TI's method of visual coding artifact removal for SAO (JCTVC-G680)	T. Matsunobu, T. Sugio, T. Nishi (Panasonic)
JCTVC-G809	m22381	2011-11-09 05:25:45	2011-11-19 00:56:41	2011-11-19 00:56:41	Crosscheck of JCTVC-G135 on rectangular (2NxN and Nx2N) intra prediction from MediaTek	J. Xu, C. Auyeung (Sony)
JCTVC-G810	m22382	2011-11-09 05:27:06	2011-11-21 04:15:40	2011-11-21 06:20:20	Crosscheck of JCTVC-G323 on sub-block scan for residual coding from Qualcomm	C. Auyeung (Sony)
JCTVC-G811	m22383	2011-11-09 05:29:47	2011-11-21 00:40:55	2011-11-21 00:41:36	Crosscheck of JCTVC-G497 on SIMD optimization of core transforms	C. Auyeung (Sony)
JCTVC-G812	m22384	2011-11-09 05:41:27	2011-11-09 08:47:49	2011-11-24 09:43:49	AHG16: Padding process simplification	X. Wang, W. J. Chien, M. Karczewicz (Qualcomm)
JCTVC-G813	m22385	2011-11-09 05:41:31	2011-11-09 06:36:29	2011-11-10 01:13:47	ALF with single filter type	M. Budagavi (TI)
JCTVC-G814	m22386	2011-11-09	2011-11-09	2011-11-09	CE7: Cross verification of JCTVC-G108, On secondary	R. Cohen (MERL)

		05:59:26	07:20:49	07:47:58	transforms for intra prediction residual	
JCTVC-G815	m22387	2011-11-09 06:00:19	2011-11-09 06:03:00	2011-11-09 06:03:00	Category-prefixed data batching for HEVC wavefront and PIPE/V2V/V2F coding	G. J. Sullivan (Microsoft)
JCTVC-G816	m22388	2011-11-09 06:02:04	2011-11-09 09:42:22	2011-11-09 09:42:22	Cross verification of JCTVC-G154, De-quantization without Rounding Offset	R. Cohen (MERL)
JCTVC-G817	m22389	2011-11-09 06:04:02	2011-11-09 08:48:00	2011-11-09 09:46:27	Non-CE7: Cross verification of JCTVC-G345, Restricted mode-dependent 8x8 DST for Intra prediction	R. Cohen (MERL)
JCTVC-G818	m22390	2011-11-09 06:12:48	2011-11-12 08:19:15	2011-11-12 09:12:05	Cross-check for Offset coding in SAO from MediaTek and Qualcomm (JCTVC-G609) by Samsung	E. Alshina, J. H. Park (Samsung)
JCTVC-G819	m22391	2011-11-09 06:13:43	2011-11-18 08:43:03	2011-11-18 08:43:03	CE10: Cross check for core transform proposed from Qualcomm (JCTVC-G579) by Samsung	E. Alshina, J. H. Park (Samsung)
JCTVC-G820	m22392	2011-11-09 06:14:38	2011-11-18 03:57:01	2011-11-22 07:18:16	CE3: Cross-check for Motorola Mobility proposals on interpolation MC (JCTVC-G696, JCTVC-G697) by Samsung	E. Alshina, A. Alshin, K. Jaemoon (Samsung), J. H. Park (Samsung)
JCTVC-G821	m22393	2011-11-09 06:15:35	2011-11-13 11:55:58	2011-11-13 11:55:58	CE3: Cross-check for eBrisk proposals on fixed (JCTVC-G058) and adaptive (JCTVC-G063) interpolation filter by Samsung	E. Alshina, J. H. Park (Samsung)
JCTVC-G822	m22394	2011-11-09 06:16:23	2011-11-12 05:22:49	2011-11-12 09:19:44	CE1: Cross-check for delayed probability up-date from Qualcomm (JCTVC-G576) by Samsung	E. Alshina, J. H. Park (Samsung)
JCTVC-G823	m22395	2011-11-09 06:17:11	2011-11-15 09:44:07	2011-11-15 09:44:07	CE4-subtest2.2: Cross-verification of RIM's Quantization with Reconstruction Levels (JCTVC-G382) by Samsung	E. Alshina, C. Kim, J. H. Park (Samsung)
JCTVC-G824	m22396	2011-11-09 06:18:04	2011-11-18 03:25:27	2011-11-18 03:25:27	Non CE3: Cross-check for Motorola Mobility proposals on Chroma interpolation filter (JCTVC-698) by Samsung	E. Alshina, J. H. Park (Samsung)
JCTVC-G825	m22397	2011-11-09 06:18:58	2011-11-18 03:28:37	2011-11-18 03:28:37	Cross-check for Motorola Mobility proposals on MV scaling (JCTVC-G699) by Samsung	E. Alshina, J. H. Park (Samsung)
JCTVC-G826	m22398	2011-11-09 06:28:09	2011-11-22 15:27:39	2011-11-22 15:27:39	Non-CE4: Cross check of quantization matrix coding in JCTVC-G578	T. Suzuki (Sony)
JCTVC-G827	m22399	2011-11-09 06:42:09	2011-11-16 14:56:28	2011-11-16 14:56:28	Non-CE8: Crosscheck for Ericsson's modified SAO edge offsets in JCTVC-G490	C.-M. Fu, Y.-W. Huang (MediaTek)
JCTVC-G828	m22400	2011-11-09 06:46:52	2011-11-21 02:35:22	2011-11-21 02:35:22	Non-CE8: Crosscheck for Canon's additional SAO band offset classifications in JCTVC-G246	C.-M. Fu, Y.-W. Huang (MediaTek)
JCTVC-G829	m22401	2011-11-09 06:54:31	2011-11-09 06:56:39	2011-11-21 19:44:14	Context modeling of split flag for CABAC	W. -J. Chien, M. Karczewicz (Qualcomm)
JCTVC-G830	m22402	2011-11-09 07:02:50	2011-11-21 02:36:56	2011-11-21 02:36:56	Non-CE9: Crosscheck for Qualcomm's simplified merge candidate derivation in JCTVC-G681	J.-L. Lin, Y.-W. Huang (MediaTek)
JCTVC-G831	m22403	2011-11-09 07:03:11	2011-11-09 07:07:20	2011-11-10 01:09:07	Non-CE8: Sample Adaptive Offset with LCU-based Syntax	C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), M. Karczewicz, I.

						S. Chong (Qualcomm)
JCTVC-G832	m22404	2011-11-09 07:09:13	2011-11-17 02:05:46	2011-11-17 02:05:46	Cross-check of LGE "AHG21: Explicit Reference Pictures Signaling with Output Latency Count Scheme"(JCTVC-G166)	H. Yang, Y. Park (Samsung)
JCTVC-G833	m22405	2011-11-09 07:11:30	2011-11-09 07:34:24	2011-11-24 12:24:18	Non-CE1: Adaptive initialization for CABAC with fixed probability contexts	L. Guo, J. Sole, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G834	m22406	2011-11-09 07:15:05	2011-11-18 07:59:11	2011-11-18 07:59:11	Cross-check result of Samsung's proposal JCTVC-G533 by LG Electronics	Hendry, S. Park, B. Jeon (LG)
JCTVC-G835	m22407	2011-11-09 07:15:53	2011-11-15 05:38:22	2011-11-18 01:53:41	Cross verification of LG's Block-based filter adaptation with intra prediction mode and CU depth information (JCTVC-G463)	Y. Chiu, L. Xu (Intel)
JCTVC-G836	m22408	2011-11-09 07:22:30	2011-11-09 07:25:37	2011-11-09 07:25:37	CE6.c: Cross-verification of Huawei's SDIP chroma extension scheme (JCTVC-G267)	T. Lee, J. Chen, J. H. Park (Samsung)
JCTVC-G837	m22409	2011-11-09 07:55:17	2011-11-09 09:19:22	2011-11-28 08:54:12	Non-CE1: 8-bit Initialization for CABAC	L. Guo, R. Joshi, J. Sole, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G838	m22410	2011-11-09 07:59:01	2011-11-17 08:59:20	2011-11-17 08:59:20	Cross-check of CAVLC last position coding (JCTVC-G537)	T. Yamamoto (Sharp)
JCTVC-G839	m22411	2011-11-09 08:08:01	2011-11-15 07:12:00	2011-11-15 07:12:00	Non-CE13: cross-verification of Samsung, Canon, MediaTek proposal JCTVC-G787 on additional merge candidates with MV dependent offsets	Y. Jeon, B. Jeon (LG)
JCTVC-G840	m22412	2011-11-09 08:31:41	2011-11-09 08:34:11	2011-11-09 08:34:11	Cross-verification of Mitsubishi's reduced number of intra chroma prediction mode (JCTVC-G449)	T. Lee, J. Chen, J. H. Park (Samsung)
JCTVC-G841	m22413	2011-11-09 08:33:05	2011-11-16 14:58:09	2011-11-16 14:58:09	CE5.2.2: Crosscheck for Samsung and Qualcomm's handling for exception cases longer than 32bit code-word in CAVLC in JCTVC-G563	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-G842	m22415	2011-11-09 08:47:15	2011-11-09 08:49:52	2011-11-11 08:00:36	CE13 Section 3.5: Cross-verification of Canon's test 3 (JCTVC-G240)	T. Lee, J. Chen, J. H. Park (Samsung)
JCTVC-G843	m22416	2011-11-09 08:54:02	2011-11-09 10:09:25	2011-11-09 10:09:25	CE4: Fine granularity QP offset	X. Wang, R. Joshi, G. Auwera, M. Karczewicz (Qualcomm)
JCTVC-G844	m22417	2011-11-09 09:12:20	2011-11-10 05:28:53	2011-11-10 05:28:53	Cross-verification of MediaTek and Sony's reducing pixel line buffers by modifying DF to R3W2 for horizontal LCU edges (JCTVC-G230)	T. Lee, J. Chen, J. H. Park (Samsung)
JCTVC-G845	m22418	2011-11-09 09:14:29	2011-11-09 09:52:03	2011-11-22 07:12:39	CE13 Section 3.1: Cross-verification of MediaTek's test 2d and 3d (JCTVC-232 and JCTVC-G231)	T. Lee, J. Chen, J. H. Park (Samsung)
JCTVC-G846	m22419	2011-11-09 09:17:40	2011-11-15 13:24:42	2011-11-15 13:24:42	Cross-verification of One-stage non-deblocking loop filter (JCTVC-G218)	C. Kim, Y. Park (Samsung)
JCTVC-G847	m22420	2011-11-09 09:25:33	2011-11-18 05:38:18	2011-11-18 05:38:18	CE6: Cross-check results for combination of subtest 4.1.2.1 & 4.1.2.2 (JCTVC-G512)	S. Cho, S. Lee, N. Eum (ETRI)

JCTVC-G848	m22421	2011-11-09 09:39:51	2011-11-16 15:01:39	2011-11-16 15:01:39	Non-CE1: Crosscheck for Qualcomm's context reduction for CABAC in JCTVC-G718	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-G849	m22422	2011-11-09 09:44:06	2011-11-16 15:00:35	2011-11-16 15:00:35	Non-CE1: Crosscheck for Qualcomm's context modeling of split flag for CABAC in JCTVC-G829	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-G850	m22423	2011-11-09 10:55:29	2011-11-09 11:01:11	2011-11-28 19:56:08	Non CE4: Fine granularity QP offset	X. Li, X. Guo, S. Lei (MediaTek), X. Wang, R. Joshi, G. Auwera, M. Karczewicz (Qualcomm)
JCTVC-G851	m22424	2011-11-09 11:19:47	2011-11-17 00:51:38	2011-11-17 00:51:38	CE5: Crosscheck of Yonsei and Samsung's contribution (JCTVC-G389) on CAVLC coding table modification	X. Wang (Qualcomm)
JCTVC-G852	m22425	2011-11-09 11:37:30	2011-11-17 06:36:21	2011-11-17 06:36:21	Cross-check report on Harmonization of implicit TU, AMP and NSQT (JCTVC-G519)	I.-K. Kim (Samsung)
JCTVC-G853	m22426	2011-11-09 12:15:35	2011-11-16 01:36:24	2011-11-16 01:36:24	Crosscheck report of constrained ALF coefficients (JCTVC-G214)	S. Park, B. Jeon (LG)
JCTVC-G854	m22427	2011-11-09 12:33:38	2011-11-15 15:45:21	2011-11-15 15:45:21	Crosscheck - On coeff_abs_level_minus3 coding (JCTVC-G700)	T. Nguyen (Fraunhofer HHI)
JCTVC-G855	m22428	2011-11-09 13:04:56	2011-11-13 15:48:25	2011-11-13 15:48:25	Performance evaluation of full search mode decision for Intra of HM4.0	C. Lai, Y. Lin, L. Liu, J. Zheng (HiSilicon)
JCTVC-G856	m22429	2011-11-09 13:55:39	2011-11-09 13:57:49	2011-11-09 22:26:25	AHG7: IDCT output range after T+Q+IQ+IT with valid residual inputs	M. Zhou (TI)
JCTVC-G857	m22430	2011-11-09 15:36:42	2011-11-24 15:41:16	2011-11-24 15:41:16	SIMD Analysis of Some Core Spatial Transforms	S. Riabtsev (CSR)
JCTVC-G858	m22433	2011-11-09 16:38:16	2011-11-19 04:51:45	2011-11-19 04:51:45	Crosscheck of JCTVC-G549 proposed by Samsung	X. Zheng (HiSilicon)
JCTVC-G859	m22434	2011-11-09 16:38:35	2011-11-19 04:54:39	2011-11-19 04:54:39	Crosscheck of JCTVC-G551 proposed by Samsung	X. Zheng (HiSilicon)
JCTVC-G860	m22435	2011-11-09 17:07:29	2011-11-18 06:15:59	2011-11-18 06:15:59	Non-CE9/Non-CE13: Cross-check of JCTVC-G165 on new MVP positions for merge/skip modes	V. Seregin (Qualcomm)
JCTVC-G861	m22438	2011-11-09 18:24:40	2011-11-14 19:18:53	2011-11-14 19:18:53	Cross-check of JCTVC-G373--Performance of secondary boundary DC intra prediction	X. Zhang, S. Liu (MediaTek)
JCTVC-G862	m22439	2011-11-09 19:33:39	2011-11-09 20:04:19	2011-11-09 20:04:19	Advanced Resampling Filters For HEVC Applications	W. Dai, M. Krishnan, P. Topiwala (FastVDO)
JCTVC-G863	m22440	2011-11-09 19:40:08	2011-11-19 03:15:00	2011-11-19 03:15:00	CE10: Crosscheck of FastVDO/Samsung proposal on core transforms (JCTVC-G266) for high and low QPs	R. Joshi (Qualcomm)
JCTVC-G864	m22441	2011-11-09 19:55:36	2011-11-10 00:14:04	2011-11-10 00:14:04	CE8 Subset b.1: Cross check of Cisco's ALF with low latency and reduced complexity	I. S. Chong, M. Karczewicz
JCTVC-G865	m22442	2011-11-09	2011-11-12	2011-11-12	AHG7: New Results for Guaranteeing 16-bit Transform Dynamic	Kiran Misra, Louie Kerofsky,

		23:33:29	01:39:29	01:39:29	Range	Andrew Segall (Sharp)
JCTVC-G866	m22443	2011-11-09 23:35:12			Withdrawn	
JCTVC-G867	m22444	2011-11-10 01:43:48	2011-11-15 06:16:05	2011-11-15 06:16:05	Non-CE1: Crosscheck of I2R's CABAC Context Initialization (JCTVC-G155) by Qualcomm	L. Guo (Qualcomm)
JCTVC-G868	m22445	2011-11-10 04:06:44	2011-11-11 04:22:37	2011-11-11 04:22:37	CE6: Test results of DCIM	E. Maani, A. Tabatabai, T. Yamamoto (Sharp)
JCTVC-G869	m22446	2011-11-10 04:08:31	2011-11-11 04:23:09	2011-11-22 23:30:44	CE6: Combinations of MPM derivation and remaining mode coding	E. Maani, A. Tabatabai (Sony)
JCTVC-G870	m22447	2011-11-10 05:27:32	2011-11-11 05:45:39	2011-11-11 05:45:39	Cross-check report of JCTVC-G418	K Sato (Sony)
JCTVC-G871	m22448	2011-11-10 09:25:54	2011-11-17 09:12:57	2011-11-17 09:12:57	Non-CE6: Crosscheck of Qualcomm buffer reduction for CABAC context of SDIP syntax (JCTVC-G754) by HKUST	X. Wen, O. AU, X. Zhang, K. Tang, C. Pang, F. Zou, J. Dai (HKUST)
JCTVC-G872	m22449	2011-11-10 09:46:03	2011-11-15 07:12:48	2011-11-15 07:12:48	Non-CE13: crosscheck of Qualcomm proposal JCTVC-G683 on simplification and improvement of additional merge candidate	Y. Jeon, B. Jeon (LG)
JCTVC-G873	m22450	2011-11-10 12:16:16	2011-11-16 10:48:04	2011-11-16 10:48:04	Cross-check of JCTVC-G704 on last position coding for CABAC from Qualcomm	E. François (Canon)
JCTVC-G874	m22451	2011-11-10 13:51:42	2011-11-17 16:01:34	2011-11-17 16:01:34	Cross-check of MC Complexity Reduction for Bi-prediction (JCTVC-G415) from ETRI	Patrice Onno (Canon)
JCTVC-G875	m22452	2011-11-10 13:53:37	2011-11-20 16:37:19	2011-11-26 10:50:22	Cross-check of Motorola's proposal (JCTVC-G724) - entropy coding for non-square blocks	H. Yang, H. Yu (Huawei)
JCTVC-G876	m22453	2011-11-10 13:55:22	2011-11-20 16:37:43	2011-11-20 16:37:43	Cross-check of Motorola's proposal (JCTVC-G725) - Simplification of significant map coding for CABAC	H. Yang, H. Yu (Huawei)
JCTVC-G877	m22454	2011-11-10 16:46:22	2011-11-10 16:49:34	2011-11-14 10:58:18	Interlaced and 4:2:2 color format support in HEVC standard	J. Vieron (Ateme)
JCTVC-G878	m22455	2011-11-10 17:04:46	2011-11-16 07:32:00	2011-11-16 07:32:00	Non-CE9: Crosscheck for Panasonic's proposals (JCTVC-G542) by JVCKENWOOD	H. Nakamura, S. Fukushima (JVC Kenwood)
JCTVC-G879	m22456	2011-11-10 17:05:50	2011-11-14 06:55:24	2011-11-14 22:45:21	Non-CE 7: Cross Check Report for proposal on mode dependent DCT/DST for Chroma (JCTVC-G282)	A. Saxena, F. Fernandes
JCTVC-G880	m22458	2011-11-11 00:04:53	2011-11-11 00:11:01	2011-11-18 19:30:36	HVS Model based Default Quantization Matrices	Munsi Haque, Ali Tabatabai, Yoshitaka Morigami
JCTVC-G881	m22459	2011-11-11 02:45:52	2011-11-17 09:40:14	2011-11-17 09:40:14	Cross-check for Improved coding of CU-level information in CAVLC (JCTVC-G417)	T. Yamamoto (Sharp)
JCTVC-G882	m22460	2011-11-11 03:17:38	2011-11-15 05:14:07	2011-11-16 04:52:51	Cross-verification report for 8-bit precision slope computation on angular prediction array extension (JCTVC-G738)	H. Aoki, K. Chono (NEC)

JCTVC-G883	m22461	2011-11-11 03:26:41	2011-11-14 05:33:30	2011-11-14 05:33:30	Non-CE12: Cross-verification of Qualcomm's Deblocking of IPCM Blocks Containing Reconstructed Samples (JCTVC-G138)	K. Chono, H. Aoki (NEC)
JCTVC-G884	m22462	2011-11-11 04:24:10	2011-11-15 00:35:30	2011-11-15 00:35:30	Verification of JCTVC-G131 on interpolation filter order	F. Bossen (Docomo Innovations)
JCTVC-G885	m22463	2011-11-11 04:48:25	2011-11-25 07:05:37	2011-11-25 07:05:37	AHG22: Crosscheck of a lossless coding solution for HEVC (JCTVC-G664)	B. Li (USTC), J. Xu (Microsoft)
JCTVC-G886	m22464	2011-11-11 07:15:13	2011-11-11 07:36:29	2011-11-11 07:36:29	Cross-verification of ETRI's Inconsistency of intra LM mode between HM and WD (JCTVC-G419)	T. Lee, J. Chen, J. H. Park
JCTVC-G887	m22465	2011-11-11 12:29:14	2011-11-11 12:47:20	2011-11-11 12:47:20	CE 10: hardware test of inverse transform proposals	S. Johar, D. Alfonso (STM),
JCTVC-G888	m22466	2011-11-11 15:58:03	2011-11-15 19:10:27	2011-11-15 19:10:27	CE7: Crosscheck of JCTVC-G108 on secondary transforms	Marta Mrak, Andrea Gabriellini (BBC)
JCTVC-G889	m22467	2011-11-11 16:01:02	2011-11-15 13:45:36	2011-11-15 13:45:36	Crosscheck of JCTVC-G271 on Sign Data Hiding	A. Gabriellini, M. Mrak (BBC)
JCTVC-G890	m22468	2011-11-11 16:19:23	2011-11-18 19:07:52	2011-11-18 19:07:52	CE6: Cross-check of JCTVC-G322 on harmonization of non-square residual coding	M. Mrak, A. Gabriellini (BBC)
JCTVC-G891	m22469	2011-11-11 16:37:23	2011-11-13 01:06:48	2011-11-13 01:06:48	Non-CE9: cross-verification of Panasonic's simplification on AMVP/Merge (JCTVC-G542)	M. Zhou (TI)
JCTVC-G892	m22472	2011-11-11 20:58:16	2011-11-11 23:47:24	2011-11-11 23:47:24	Non-CE8: Cross-check of JCTVC-G774 on modified ALF DC coefficients	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-G893	m22474	2011-11-12 17:37:16	2011-11-19 07:38:44	2011-11-19 07:38:44	A Unified LCU, sub-LCU and sub-CU (TU) Delta QP Signaling	X. Fang, A. Luthra, K. Panusopone, J.-H. Kim, L. Wang (Motorola Mobility)
JCTVC-G894	m22475	2011-11-12 17:45:30	2011-11-23 00:31:19	2011-11-23 00:31:19	Cross-check report for BBC's JCTVC-G575 by Motorola Mobility	K. Panusopone (Motorola Mobility)
JCTVC-G895	m22479	2011-11-14 05:26:55	2011-11-14 06:42:20	2011-11-15 07:28:17	CE6: Cross-verification of Combination of SDIP and Its Improvements (JCTVC-G558)	K. Chono, H. Aoki (NEC)
JCTVC-G896	m22481	2011-11-14 10:08:25	2011-11-18 12:39:11	2011-11-18 12:39:11	Cross verification of improved directional intra prediction smoothing (JCTVC-G443)	J. Lainema, K. Ugur (Nokia)
JCTVC-G897	m22482	2011-11-14 11:31:38	2011-11-18 11:36:41	2011-11-24 09:35:09	AHG16: Cross-verification and additional results of reference sample padding harmonization for intra DC mode (JCTVC-G572)	K. Chono, H. Aoki (NEC)
JCTVC-G898	m22483	2011-11-14 11:51:28	2011-11-14 12:06:00	2011-11-19 13:22:18	Non-CE3: Cross check for Toshiba's proposal (JCTVC-G770)	K. Kondo, T. Suzuki (Sony)
JCTVC-G899	m22484	2011-11-14 12:19:30	2011-11-15 20:07:32	2011-11-15 20:07:32	Cross-check of CU-based Merge Candidate List Construction	S. Oudin, B. Bross (Fraunhofer HHI)
JCTVC-G900	m22485	2011-11-14 12:45:42	2011-11-22 10:24:44	2011-11-22 10:24:44	Cross-check of binarisation of last position for higher throughput (JCTVC-G370)	V. Drugeon, M. Narroschke (Panasonic)

JCTVC-G901	m22486	2011-11-14 12:49:51	2011-11-17 12:29:33	2011-11-17 12:29:33	CE4 Subtest 2.1.b: Cross-verification of JCTVC-G278	M. Yang (Huawei)
JCTVC-G902	m22487	2011-11-14 12:52:11	2011-11-17 12:32:19	2011-11-17 12:32:19	CE4 Subtest 2.1.b: Cross-verification of JCTVC-G382	M. Yang (Huawei)
JCTVC-G903	m22488	2011-11-14 18:14:09			Withdrawn	
JCTVC-G904	m22489	2011-11-14 18:27:18	2011-11-20 11:56:49	2011-11-20 11:56:49	Cross-Check Report for JCTVC-G381 proposal on nearest placement of Y/Cb/Cr transform coefficients locating at same spatial position	Ankur Saxena, Felix Fernandes
JCTVC-G905	m22490	2011-11-14 21:55:13	2011-11-16 22:53:27	2011-11-16 22:53:27	Crosscheck report of ZTE's joint coding of splitting flag and inter modes (JCTVC-G355)	X. Wang (Qualcomm)
JCTVC-G906	m22491	2011-11-15 00:35:35	2011-11-17 09:22:31	2011-11-17 09:22:31	cross check report of Samsung's Unified Pred_type coding in CABAC (JCTVC-G785)	W. Zhang
JCTVC-G907	m22493	2011-11-15 01:02:00	2011-11-19 01:47:29	2011-11-19 01:47:29	Crosscheck of JCTVC-G509 - Support of ChromaQPOffset in HEVC	E. S. Ryu (InterDigital)
JCTVC-G908	m22494	2011-11-15 01:07:16	2011-11-22 19:29:31	2011-11-22 19:29:31	Cross-check of BBC's transform skip mode (JCTVC-G575)	J. Sole
JCTVC-G909	m22495	2011-11-15 01:47:16	2011-11-17 01:29:09	2011-11-17 01:29:09	Non-CE1: Cross-check of JCTVC-G833 on adaptive initialization for CABAC	C. Yeo (I2R)
JCTVC-G910	m22496	2011-11-15 05:26:06	2011-11-15 09:39:58	2011-11-15 09:39:58	Non-CE6: Cross-check of HiSilicon's performance evaluation of full search mode decision for intra of HM4.0 (JCTVC-G855) by Panasonic	S. M. T. Naing, V. Wahadaniah, C. S. Lim (Panasonic)
JCTVC-G911	m22497	2011-11-15 05:29:37	2011-11-17 10:52:18	2011-11-17 10:52:18	Cross verification of KDDI's Chroma intra prediction based on residual luma samples (JCTVC-G346)	Y. Chiu, W. Zhang, L. Xu, Y. Han (Intel)
JCTVC-G912	m22498	2011-11-15 06:52:14	2011-11-18 11:43:40	2011-11-27 20:33:11	Request to establish AHG on interlaced format support in HEVC standard	K. Chono, H. Aoki (NEC), J. Koyama, A. Yamori, K. Kazui, S. Shimada, A. Nakagawa (Fujitsu), K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi), D. Flynn (BBC), J. Vieron (ATEME), T. Yamakage (Toshiba), A. Luthra (Motorola Mobility), S. Sakaida, A. Ichigaya (NHK), T. Yamamoto (Sharp), O. Bar-Nir (Harmonic), T. Suzuki (Sony)
JCTVC-G913	m22499	2011-11-15 07:39:01	2011-11-15 07:42:30	2011-11-18 07:08:56	Cross-check for Qualcomm's proposal on 8-bit initialization for CABAC (JCTVC-G837)	Y. Piao, J. Min, J. H. Park (Samsung)

JCTVC-G914	m22470	2011-11-11 16:51:41	2011-11-11 17:11:40	2011-11-11 17:11:40	UKNB Comment on HEVC Extensions	UKNB
JCTVC-G915	m22501	2011-11-15 09:44:25	2011-11-15 09:48:59	2011-11-27 04:55:34	Coding and selection of SAO parameters	D. Baylon, K. Minoo (Motorola Mobility)
JCTVC-G916	m22504	2011-11-15 14:00:08	2011-11-20 21:03:56	2011-11-20 21:03:56	AHG16: Crosscheck of JCTVC-G812 on Padding process simplification	X. Li, X. Guo (MediaTek)
JCTVC-G917	m22507	2011-11-15 23:14:30	2011-11-18 18:00:29	2011-11-27 00:27:05	On significance map coding for CABAC	V. Sze (TI)
JCTVC-G918	m22508	2011-11-15 23:30:34	2011-11-15 23:43:42	2011-11-15 23:43:42	Non-CE8: Cross-check of JCTVC-G445 on removing DC component of ALF filter coefficients	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-G919	m22509	2011-11-15 23:32:23	2011-11-17 20:39:48	2011-11-17 20:39:48	Non-CE8: Cross-check of JCTVC-G146 on CU-based ALF control re-design process	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-G920	m22511	2011-11-16 01:40:08	2011-11-16 01:42:50	2011-11-16 01:42:50	Cross-check of Mitsubishi's reduction of the number of pixels used in Adaptive Loop Filter JCTVC-G446	T. Yamakage, T. Itoh (Toshiba)
JCTVC-G921	m22512	2011-11-16 02:43:03			Withdrawn (duplicate registration)	
JCTVC-G922	m22513	2011-11-16 02:44:36	2011-11-18 11:46:59	2011-11-18 11:46:59	Non-CE9: cross-check of LGE's proposal JCTVC-G164 on improvement on parallel merge/skip mode	H. Yang, Y. Park (Samsung)
JCTVC-G923	m22514	2011-11-16 03:00:41	2011-11-19 06:51:48	2011-11-19 06:51:48	ALF decoding time reduction by adopting a simple SIMD code (Informative)	T. Yamakage, T. Itoh (Toshiba)
JCTVC-G924	m22515	2011-11-16 03:16:50	2011-11-16 03:36:29	2011-11-16 03:36:29	CE5 : Cross-verification of Qualcomm proposal (JCTVC-G677)	C. Kim (Samsung)
JCTVC-G925	m22518	2011-11-16 07:38:56	2011-11-20 11:39:41	2011-11-20 11:39:41	Cross-check of JCTVC-G550 on TU_size based dQP	V. Seregin (Qualcomm)
JCTVC-G926	m22519	2011-11-16 07:43:43	2011-11-20 22:56:38	2011-11-20 22:56:38	Non-CE13: Cross-check of JCTVC-G787 on MV dependent offset	V. Seregin (Qualcomm)
JCTVC-G927	m22520	2011-11-16 07:46:29	2011-11-20 21:56:00	2011-11-20 21:56:00	Non-CE9: Cross-check of JCTVC-G396 on merge candidate for rectangular partitions	V. Seregin (Qualcomm)
JCTVC-G928	m22521	2011-11-16 09:30:15	2011-11-19 06:49:05	2011-11-19 06:49:05	CE8.e.3: Cross-check of Ericsson's ALF coefficient prediction JCTVC-G665	T. Yamakage, T. Watanabe (Toshiba)
JCTVC-G929	m22522	2011-11-16 11:18:35	2011-11-16 11:22:51	2011-11-16 11:22:51	Cross check of Qualcomms deblocking filter simplifications (JCTVC-G290)	A. Kotra, M. Narroschke, T. Wedi (Panasonic)
JCTVC-G930	m22523	2011-11-16 12:06:04	2011-11-18 06:48:31	2011-11-25 13:09:36	CE7: Cross check report on secondary transforms for intra prediction residual (JCTVC-G108)	A. Ichigaya (NHK)
JCTVC-G931	m22524	2011-11-16 12:30:25	2011-11-18 05:40:39	2011-11-18 05:40:39	Non CE3: Cross-check for memory band-width reduction proposal from Toshiba (JCTVC-G770) by Samsung	E. Alshina, J. H. Park (Samsung)

JCTVC-G932	m22525	2011-11-16 12:31:41	2011-11-18 09:28:21	2011-11-18 09:28:21	CE1: Cross-check for bug-fix version of test 12 in subset C from HHI (JCTVC-G633) by Samsung	E. Alshina, J. H. Park
JCTVC-G933	m22526	2011-11-16 12:33:23	2011-11-20 07:51:24	2011-11-20 07:51:24	Cross-check for skipped transform from BBC (JCTVC-G575) by Samsung	I.-K. Kim, E. Alshina, J. H. Park (Samsung)
JCTVC-G934	m22527	2011-11-16 12:35:04	2011-11-18 12:25:24	2011-11-18 12:25:24	Non CE1: cross-check for CABAC probability up-date modification from Sony (JCTVC-G501, JCTVC-G504) by Samsung	A. Alshin, E. Alshina, J. H. Park (Samsung)
JCTVC-G935	m22528	2011-11-16 12:36:14	2011-11-18 07:40:46	2011-11-18 07:40:46	Cross-check for LCU based SAO from MediaTek and Qualcomm (JCTVC-G831) by Samsung	E. Alshina, J. H. Park (Samsung)
JCTVC-G936	m22530	2011-11-16 14:03:49	2011-11-18 15:59:10	2011-11-18 15:59:10	Cross verification of NEC's proposal JCTVC-G213 on TMVP performance	Y. Lin, J. Zheng (HiSilicon)
JCTVC-G937	m22531	2011-11-16 14:27:31	2011-11-20 16:51:51	2011-11-20 16:51:51	Cross-check of JCTVC-G629 : Harmonization of SDIP and Mode-Dependent Secondary Transforms	H. Yang (Huawei), C. Lai (Hisilicon)
JCTVC-G938	m22532	2011-11-16 15:10:10	2011-11-21 12:48:02	2011-11-21 12:48:02	Cross-check of JCTVC-G380 non-CE8 coding tree level signaling of alf_cu_flag	A. Fuldseth (Cisco)
JCTVC-G939	m22533	2011-11-16 15:30:09	2011-11-24 19:52:06	2011-11-24 19:52:06	CE2: Crosscheck for Qualcomm overlapped block motion compensation in JCTVC-G749	C.-W. Hsu, Y.-W. Huang (MediaTek)
JCTVC-G940	m22534	2011-11-16 16:56:35	2011-11-21 17:45:03	2011-11-24 11:35:28	Cross-check for JCTVC-593: Non-CE13: Simplification of merge mode	S. Esenlik (Panasonic)
JCTVC-G941	m22535	2011-11-16 19:38:41	2011-11-16 19:46:43	2011-11-16 19:46:43	AHG19: Cross-check of JCTVC-G663, modifications to HE transform coefficient coding for transform skip mode	R. Cohen (MERL)
JCTVC-G942	m22536	2011-11-17 02:58:18	2011-11-18 05:53:27	2011-11-26 16:02:42	Non-CE11: Cross-check of Modified Context Derivation for last coefficient flag (JCTVC-G520)	T. Tsukuba, T. Ikai (Sharp)
JCTVC-G943	m22537	2011-11-17 05:47:56	2011-11-25 06:25:53	2011-11-25 06:25:53	Non-CE11: Crosscheck for Sony's MDCS in Proposal JCTVC-G491	X. Zhao, X. Guo (MediaTek)
JCTVC-G944	m22538	2011-11-17 06:40:13	2011-11-19 14:31:04	2011-11-19 14:31:04	Cross-check report on additional tests of reordering of merge candidate (JCTVC-G396)	I.-K. Kim (Samsung)
JCTVC-G945	m22541	2011-11-17 11:17:25	2011-11-19 22:37:25	2011-11-19 22:37:25	Cross-check of JCTVC-G663, modifications to HE transform coefficient coding for transform skip mode	A. Gabriellini, M. Mrak (BBC)
JCTVC-G946	m22542	2011-11-17 12:15:10	2011-11-21 12:27:25	2011-11-21 12:27:25	Non-CE13: Cross-check report of JCTVC-G787 (MvDepOffset+Fast)	S.-C. Lim, J. Lee, H. Y. Kim (ETRI), K. Y. Kim, S. M. Kim, G. H. Park (KHU)
JCTVC-G947	m22548	2011-11-17 15:53:48	2011-11-18 13:19:01	2011-11-24 20:24:44	Crosscheck for Modified method for coding the positions of last significant coefficients in the CABAC mode (JCTVC-G239)	G. Clare, F. Henry (Orange FT)
JCTVC-G948	m22556	2011-11-17 22:25:49	2011-11-21 20:04:25	2011-11-21 20:04:25	Draft requirements and discussion on the scalable enhancement of HEVC	A. Luthra (Motorola)
JCTVC-G949	m22557	2011-11-17	2011-11-21	2011-11-21	Draft requirements for the scalable enhancement of HEVC	A. Luthra (Motorola)

		22:30:10	20:35:28	20:35:28		
JCTVC-G950	m22558	2011-11-17 22:36:01	2011-11-21 20:38:07	2011-11-21 20:38:07	Draft use cases for the scalable enhancement of HEVC	A. Luthra (Motorola)
JCTVC-G951	m22559	2011-11-17 22:38:37	2011-11-21 20:52:41	2011-11-21 20:52:41	Draft Call for Proposals on the Scalable Video Coding Extensions of HEVC	A. Luthra (Motorola)
JCTVC-G952	m22561	2011-11-18 00:08:35	2011-11-19 05:51:25	2011-11-22 13:03:19	Non-CE8: Cross-check of JCTVC-G610 on improvements to ALF	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-G953	m22562	2011-11-18 02:30:08	2011-11-21 08:06:03	2011-11-21 08:06:03	CE10: Cross-check of JCTVC-G579 core transform - low and high QP range	M. Budagavi (TI)
JCTVC-G954	m22565	2011-11-18 03:15:00	2011-11-18 18:52:04	2011-11-18 18:52:04	Non-CE8: Cross check of ALF decoding time reduction by adopting a simple SIMD code (JCTVC-G923)	I. S. Chong, M. Karczewicz
JCTVC-G955	m22578	2011-11-18 15:32:42	2011-11-21 20:04:18	2011-11-26 16:09:52	Joint contribution on the integration of several chroma coding tools	Gisquet Christophe (Canon), Chiu Yi-Jen (Intel), Minezawa Akira (Mitsubishi), Ichigaya Atsuro (NHK)
JCTVC-G956	m22579	2011-11-18 15:40:57	2011-11-18 15:43:37	2011-11-18 15:43:37	Non-CE4: Cross-verification of Sony's proposal JCTVC-G362 by Nokia	J. Kang, A. Hallapuro, J. Lainema (Nokia)
JCTVC-G957	m22580	2011-11-18 16:02:26	2011-11-18 16:07:38	2011-11-20 10:35:08	Non-CE11: Cross-check result of diagonal sub-block scan for HE residual coding by Qualcomm (JCTVC-G323)	C. Rosewarne, M. Maeda (Canon)
JCTVC-G958	m22581	2011-11-18 16:33:19	2011-11-18 16:56:50	2011-11-26 12:15:03	Non-CE11: Modified context selection for significant coefficient flags with diagonal sub-block scan	C. Rosewarne, M. Maeda (Canon)
JCTVC-G959	m22584	2011-11-18 18:24:04	2011-11-18 18:28:22	2011-11-18 18:28:22	Cross check of Non-CE12: BS Decision Tree Simplification (JCTVC-G175)	A. Kotra, M. Narroschke, T. Wedi (Panasonic)
JCTVC-G960	m22585	2011-11-18 18:30:15	2011-11-18 19:59:21	2011-11-18 19:59:21	Cross-check for JCTVC-G139 (Non-CE6.d: Intra Prediction With Selective Secondary Boundary)	J. Zhao, A. Segall (Sharp)
JCTVC-G961	m22586	2011-11-18 18:32:39	2011-11-18 19:59:51	2011-11-18 19:59:51	Cross-check for JCTVC-G197 (AHG4: Low latency CABAC initialization for dependent tiles)	J. Zhao, A. Segall (Sharp)
JCTVC-G962	m22588	2011-11-18 20:18:04	2011-11-19 00:22:46	2011-11-19 00:22:46	Interlace profiling in HEVC	David Singer
JCTVC-G963	m22592	2011-11-18 23:24:18	2011-11-19 02:29:18	2011-11-19 02:29:18	Cross verification of CABAC packet based stream (JCTVC-G494)	M. Coban (Qualcomm)
JCTVC-G964	m22593	2011-11-19 00:54:42			Withdrawn	
JCTVC-G965	m22594	2011-11-19 02:05:24	2011-11-20 05:00:25	2011-11-24 20:11:56	Cross-check report for MediaTek's rectangular Intra prediction by Motorola Mobility	J. Lou, L. Wang (Motorola Mobility)
JCTVC-G966	m22595	2011-11-19 03:11:51	2011-11-21 05:13:13	2011-11-21 05:13:13	Non-CE6: Cross-verification of Nokia proposal on Simplified DC prediction (JCTVC-G567)	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)

JCTVC-G967	m22596	2011-11-19 03:13:52	2011-11-19 05:10:41	2011-11-19 05:10:41	4:2:2 support in HEVC	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-G968	m22598	2011-11-19 05:37:55	2011-11-25 09:43:11	2011-11-25 09:43:11	A Cross-check report for JCTVC-G183 on low delay tile	K. Misra, A. Segall (Sharp)
JCTVC-G969	m22599	2011-11-19 05:39:04			Withdrawn	
JCTVC-G970	m22600	2011-11-19 07:32:23	2011-11-22 12:29:41	2011-11-22 12:29:41	Cross verification of Some possible motion vector coding related simplifications (JCTVC-G690)	M. Coban (Qualcomm)
JCTVC-G971	m22601	2011-11-19 11:51:08	2011-11-23 10:23:07	2011-11-23 10:23:07	Crosscheck of BBC transform skipping proposal (JCTVC-G577)	H. Yang (Huawei), X. Zheng (HiSilicon), H. Yu (Huawei)
JCTVC-G972	m22602	2011-11-19 14:44:02	2011-11-19 19:03:01	2011-11-24 07:09:47	Cross-verification of Panasonic's proposal JCTVC-G570 on byte alignment overhead reduction	O. Bici, J. Lainema, K. Ugur (Nokia)
JCTVC-G973	m22608	2011-11-19 21:49:01	2011-11-25 08:12:57	2011-11-25 08:12:57	Non-CE12: Crosscheck for Ericsson's Parallel Deblocking in JCTVC-G616	J. An, X. Guo (MediaTek)
JCTVC-G974	m22610	2011-11-20 05:10:07	2011-11-20 05:16:50	2011-11-20 05:16:50	Cross-check for JCTVC-G326: On the exponential memory decay probability update	G. Korodi, J. Zan, D. He (RIM)
JCTVC-G975	m22621	2011-11-20 19:11:58	2011-11-20 23:14:06	2011-11-21 18:47:51	CE11: Crosscheck - Adaptive Scan for Large Blocks for HEVC (JCTVC-G703)	T. Nguyen (Fraunhofer HHI)
JCTVC-G976	m22622	2011-11-20 20:51:42	2011-11-22 15:29:38	2011-11-22 15:29:38	Cross-check of Canon's modified context selection for significant coefficient flags with diagonal sub-block scan (JCTVC-G958)	J. Sole
JCTVC-G977	m22623	2011-11-20 21:57:05	2011-11-21 07:15:32	2011-11-24 18:59:56	nonCE10: new 8-bits core spatial transform with fast algorithm	Hongbo Zhu
JCTVC-G978	m22627	2011-11-21 01:09:44	2011-11-21 03:10:20	2011-11-24 01:53:30	Cross check of syntax refinements for SAO and ALF in JCTVC-G566	J. Tanaka, T. Suzuki (Sony)
JCTVC-G979	m22727	2011-11-22 03:14:44	2011-11-22 03:18:29	2011-11-22 03:18:29	non-CE4: Crosscheck of Fine granularity QP offset (JCTVC-G850)	B. Li (USTC), J. Xu (Microsoft)
JCTVC-G980	m22636	2011-11-21 04:01:16	2011-11-21 04:02:21	2011-11-24 23:39:50	Evaluation of Limiting Chroma Transform Depth in RQT on HM4.0	L. Guo, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G981	m22637	2011-11-21 04:19:35	2011-11-21 06:17:30	2011-11-22 07:41:35	Crosscheck of JCTVC-G917 on significance map coding in CABAC from TI	C. Auyeung (Sony)
JCTVC-G982	m22639	2011-11-21 06:26:28	2011-11-21 06:29:53	2011-11-21 15:05:16	Non-CE12 Subtest 5: Cross-check of Qualcomm's transform dependent deblocking filter parameter adjustment in slice level JCTVC-G291	T. Yamakage, S. Asaka (Toshiba)
JCTVC-G983	m22640	2011-11-21 07:53:27	2011-11-23 00:12:30	2011-11-23 00:12:30	Cross-check of Sharp's contribution On CABAC Init IDC (JCTVC-G716) by Qualcomm	L. Guo (Qualcomm)
JCTVC-G984	m22645	2011-11-21 09:18:54	2011-11-22 15:05:30	2011-11-22 15:05:30	Cross check result of Modified LPS range and state transition tables for BAC by Qualcomm (JCTVC-G324)	C. Rosewarne, M. Maeda (Canon)

JCTVC-G985	m22664	2011-11-21 14:15:29	2011-11-21 14:19:32	2011-11-21 14:19:32	Crosscheck on JCTVC-G209 modified method for coding MVD in the CABAC mode	W.-J. Chien (Qualcomm)
JCTVC-G986	m22665	2011-11-21 14:20:59	2011-11-22 14:54:19	2011-11-22 14:54:19	Fast algorithm and some comments on the significance map coding	Hongbo Zhu
JCTVC-G987	m22673	2011-11-21 15:45:07	2011-11-25 05:08:23	2011-11-25 05:08:23	Cross-check of Varying QP Deblocking (JCTVC-G384)	K. Andersson (Ericsson)
JCTVC-G988	m22677	2011-11-21 16:44:31	2011-11-21 16:56:38	2011-11-21 16:56:38	HEVC software player demonstration on mobile devices	K. McCann, J. Choi, J. H. Park (Samsung)
JCTVC-G989	m22700	2011-11-21 19:00:50	2011-11-21 19:06:56	2011-11-21 19:06:56	Cross-check of JCTVC-G301 on the context simplification for coefficients coding by Huawei	H. Yang (Huawei)
JCTVC-G990	m22701	2011-11-21 19:15:05	2011-11-21 19:36:42	2011-11-21 19:36:42	Cross check of inverse transfom complexity reported in JCTVC-G757	A. Fuldseth (Cisco)
JCTVC-G991	m22702	2011-11-21 19:38:23	2011-11-22 17:19:47	2011-11-22 17:19:47	Cross-check of contribution JCTVC-G635: Coding with a unified reference picture list	J. Jung (Orange Labs)
JCTVC-G992	m22703	2011-11-21 20:11:47	2011-11-21 20:41:52	2011-11-23 07:11:23	Cross-check of JCTVC-G530-- Layered quantization matrices compression	X. Zhang, S. Liu (MediaTek)
JCTVC-G993	m22729	2011-11-22 06:41:43	2011-11-24 19:54:19	2011-11-24 19:54:19	Non-CE3: Cross-check of Motorola Mobility's motion compensation interpolation filter (JCTVC-G806) by Qualcomm	L. Guo (Qualcomm)
JCTVC-G994	m22730	2011-11-22 06:44:15	2011-11-25 07:56:43	2011-11-25 07:56:43	Non-CE3: Cross-check of Motorola Mobility's Interpolation Filter for Uni and Bi Predictive Motion Compensation (JCTVC-G807) by Qualcomm	L. Guo (Qualcomm)
JCTVC-G995	m22732	2011-11-22 07:41:59	2011-11-22 07:48:19	2011-11-22 07:48:19	Cross-verification of joint contribution on the integration of several chroma coding tools (JCTVC-G955)	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-G996	m22740	2011-11-22 10:20:21	2011-11-22 14:51:56	2011-11-22 14:51:56	Cross check of Sharp JCTVC-G705	
JCTVC-G997	m22745	2011-11-22 17:15:55	2011-11-23 18:15:54	2011-11-24 15:51:52	Non-CE11: Cross-check of JCTVC-G448 on context reduction for coding transform coefficients	V. Seregin, J. Sole (Qualcomm)
JCTVC-G998	m22747	2011-11-22 19:50:17	2011-11-22 22:13:14	2011-11-23 09:37:56	Combined Result of JCTVC-G610 and JCTVC-G774	J. Zhao, A. Segall (Sharp), M. Karczewicz, I. S. Chong (Qualcomm)
JCTVC-G999	m22748	2011-11-22 20:51:52	2011-11-24 15:39:42	2011-11-24 15:39:42	Verification of JCTVC-G324 on CABAC state machine	F. Bossen (Docomo Innovations)
JCTVC-G1000	m22749	2011-11-22 20:52:18	2011-11-30 08:13:34	2011-11-30 08:13:34	Suggested revised common test conditions	F. Bossen (Docomo Innovations)
JCTVC-G1001	m22750	2011-11-22 21:06:06	2011-11-24 11:37:45	2011-11-24 11:37:45	Cross-check of RIM multi-level significant maps for large transform units (JCTVC-G644)	J. Sole (Qualcomm)
JCTVC-G1002	m22756	2011-11-23	2011-11-23	2011-11-29	BoG report: Reference picture buffering and list construction	J. Boyce, R. Sjoberg, Y.-K.

		07:14:10	07:19:20	11:27:02		Wang (BoG coordinators)
JCTVC-G1003	m22758	2011-11-23 09:45:15	2011-11-23 09:49:52	2011-11-23 09:49:52	Integration of proposals on transform skipping	M. Mrak, A. Gabriellini, D. Flynn (BBC), G. Van Wallendael (Ghent University), R. Joshi, J. Sole, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-G1004	m22760	2011-11-23 15:42:09	2011-11-23 15:50:11	2011-11-24 16:59:08	Proposed text for some features not yet integrated into JCTVC-F803	M Horowitz (eBrisk)
JCTVC-G1005	m22779	2011-11-25 10:08:36	2011-11-25 14:34:07	2011-11-25 15:51:58	BoG report on review of non-CE deblocking filter proposals	A. Norkin
JCTVC-G1006	m22762	2011-11-23 16:45:32	2011-11-23 19:30:10	2011-11-28 10:00:55	BoG Report on Non-CE MV Coding Proposals	B. Bross, J. Jung, S. Oudin, M. Zhou
JCTVC-G1007	m22763	2011-11-23 17:28:19	2011-11-23 18:04:09	2011-11-23 18:04:09	Crosscheck of JCTVC-G1003	T. Davies (Cisco)
JCTVC-G1008	m22764	2011-11-23 18:06:59	2011-11-24 10:35:10	2011-11-24 10:35:10	Cross-check of JCTVC-G569	T. Davies (Cisco)
JCTVC-G1009	m22765	2011-11-24 02:14:30	2011-11-24 02:20:52	2011-11-24 02:20:52	A joint contribution on the coding tools of residual prediction for intra chroma prediction	Y. Chiu, Y. Han, L. Xu, W. Zhang, H. Jiang (Intel), K. Kawamura, T. Yoshino, H. Kato, S. Naito (KDDI)
JCTVC-G1010	m22766	2011-11-24 08:40:46	2011-11-24 08:57:08	2011-11-24 08:57:08	Cross Check of Ericsson's Proposal JCTVC-G619	G. Van der Auwera (Qualcomm),
JCTVC-G1011	m22769	2011-11-24 15:39:31	2011-11-24 15:57:22	2011-11-24 15:57:22	Cross-check results of the Unified Deblocking and SAO of Sharp (JCTVC-G608)	M. Narroschke, S. Esenlik (Panasonic)
JCTVC-G1012	m22770	2011-11-24 16:53:56	2011-11-25 10:17:07	2011-11-25 10:17:07	Non-CE8: Supplementary results to JCTVC-G813 regarding ALF using one filter type (Luma only)	P. Lai (Samsung), H. Guermazi (eBrisk Video)
JCTVC-G1013	m22772	2011-11-24 18:12:39	2011-11-24 19:08:01	2011-11-24 19:08:01	Cross Check of Panasonic's Proposal JCTVC-G640 On Varying QP Deblocking	G. Van der Auwera (Qualcomm)
JCTVC-G1014	m22773	2011-11-24 18:12:59	2011-11-26 05:48:43	2011-11-26 05:48:43	Non-CE8: Crosscheck for Motorola's coding and selection of SAO parameters in JCTVC-G915	C.-M. Fu, Y.-W. Huang (MediaTek)
JCTVC-G1015	m22778	2011-11-25 06:23:35	2011-11-25 09:01:47	2011-11-28 17:46:23	A combined proposal from JCTVC-G366, JCTVC-G657, and JCTVC-G768 on context reduction of significance map coding with CABAC	C. Auyeung, J. Xu (Sony), G. Korodi, J. Zan, D. He (RIM), Y. Piao, E. Alshina, J. Min, J. Park (Samsung)
JCTVC-G1016	m22780	2011-11-25 10:16:38	2011-11-26 11:46:21	2011-11-30 09:05:01	BoG Report on APS matters	S. Wenger (BoG coordinator)
JCTVC-G1017	m22781	2011-11-25 10:32:49	2011-11-26 10:05:21	2011-11-26 17:41:15	BoG Report on Intra Mode Coding	V. Sze, R. Allen (BoG coordinators)

JCTVC-G1018	m22782	2011-11-25 14:21:54	2011-11-25 22:05:07	2011-11-25 22:05:07	Cross-check of modified JCTVC-G108 on secondary transforms for intra prediction residual	V. Seregin, R. Joshi (Qualcomm)
JCTVC-G1019	m22768	2011-11-24 14:46:18	2011-11-24 14:51:45	2011-11-24 14:51:45	Samsung comments on HEVC Extension	K. McCann, C. Kim, B. Choi, J. H. Park (Samsung)
JCTVC-G1020	m22785	2011-11-25 16:44:02	2011-11-25 16:46:38	2011-11-25 16:46:38	BoG report: Loop filtering (AHG6)	T. Yamakage (BoG coordinator)
JCTVC-G1021	m22787	2011-11-25 19:21:35	2011-11-25 19:22:47	2011-11-25 19:26:05	Non-CE11: Cross check result of JCVC-G323 proposed by Qualcomm	J. Kim
JCTVC-G1022	m22795	2011-11-26 08:03:18	2011-11-26 08:09:01	2011-11-30 09:34:05	On line buffer removal for CU split flag and skip flag context model	T. Lee, J. Chen, J. Park (Samsung), T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek), W.-J. Chien, M. Karczewicz (Qualcomm)
JCTVC-G1023	m22797	2011-11-26 10:57:57	2011-11-26 11:06:55	2011-11-26 11:06:55	CE8 subset 0: Improved ALF N pass encoding	I. S. Chong, M. Karczewicz, T. Yamakage, T. Watanabe, T. Chujoh, C.-Y. Chen, C.-M. Fu, C.-Y. Tsai, Y.-W. Huang, S. Lei,
JCTVC-G1024	m22799	2011-11-26 15:00:47	2011-11-26 15:02:34	2011-11-27 09:22:32	Report of combining two coding tools for Chroma intra prediction (JCTVC-G173 and JCTVC-G358)	X. Zhang, O. Au, X. Wen (HKUST), Y.-J. Chiu, Y. Han, L. Xu, W. Zhang (Intel)
JCTVC-G1025	m22801	2011-11-26 15:15:30	2011-11-26 17:02:05	2011-11-26 17:02:05	BoG report: Tiles and wavefront parallel processing	M. Horowitz (BoG coordinator)
JCTVC-G1026	m22807	2011-11-26 17:37:05	2011-11-27 09:57:59	2011-11-27 09:57:59	Using Multiple APSs for Quantization Matrix Parameters Signaling	M. Li, P. Wu (ZTE), J. Tanaka, Y. Morigami, T. Suzuki, K. Sato (Sony)
JCTVC-G1027	m22808	2011-11-26 19:06:39	2011-11-26 19:18:02	2011-11-26 19:18:02	Non-CE9: Additional test result on LG's simplification of merge/skip TMVP refidx derivation (JCTVC-G163)	T. Sugio (Panasonic), S. Fukushima (JVC KENWOOD)
JCTVC-G1028	m22809	2011-11-26 22:29:22	2011-11-26 22:45:35	2011-11-27 23:06:08	Non-CE4: Rate control friendly spatial QP prediction	H. Aoki, K. Chono (NEC), M. Kobayashi, M. Shima (Canon), M. Coban, M. Karczewicz (Qualcomm), K. Sato (Sony)
JCTVC-G1029	m22811	2011-11-27 08:15:20	2011-11-27 09:59:37	2011-11-27 09:59:37	Non-CE4: Crosscheck for JCTVC-G1028 by JVC Kenwood	H. Nakamura, S. Fukushima, H. Takehara, M. Ueda (JVC Kenwood)
JCTVC-G1030	m22813	2011-11-27 09:58:52	2011-11-27 10:31:13	2011-11-27 10:31:13	Crosscheck for Canon, Intel, Mitsubishi, NHK integration of several chroma coding tools in JCTVC-G955	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-G1031	m22815	2011-11-27 10:27:50	2011-11-27 10:33:24	2011-11-27 10:33:24	Support of varying QP in deblocking	G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm), M.

						Narroschke, A. Kotra, T. Wedi (Panasonic)
JCTVC-G1032	m22816	2011-11-27 14:44:08	2011-11-28 15:37:29	2011-11-28 15:37:29	BoG report on intra prediction complexity reduction and filtering	R. Joshi (BoG coordinator)
JCTVC-G1033	m22820	2011-11-27 18:39:37	2011-11-27 19:15:40	2011-11-27 19:15:40	Crosscheck Report for JCTVC-G1031 by Qualcomm and Panasonic	S. Park, B. Jeon (LG)
JCTVC-G1034	m22823	2011-11-28 08:34:57	2011-11-28 08:37:38	2011-11-28 12:18:40	BoG report on chroma intra prediction	A. Tabatabai
JCTVC-G1035	m22824	2011-11-28 08:58:58	2011-11-28 18:04:06	2011-11-30 13:37:49	BoG report on resolving deblocking filter description issues	A. Norkin (BoG coordinators)
JCTVC-G1036	m22828	2011-11-28 10:21:48	2011-11-29 10:39:04	2012-01-04 19:51:32	BoG report: Common conditions for reference picture marking and list construction proposals	Y.-K. Wang, M. M. Hannuksela, T. K. Tan, R. Sjöberg (BoG coordinators)
JCTVC-G1037	m22833	2011-11-28 12:43:55	2011-11-28 15:00:20	2011-11-28 15:00:20	Non-CE6: Crosscheck of JCTVC-G419 with alpha7bit bugfix	K Sato (Sony)
JCTVC-G1038	m22834	2011-11-28 14:46:19	2011-11-28 14:58:55	2011-11-29 14:46:00	BoG report: Harmonization of NSQT with residual coding	J. Sole (BoG coordinator)
JCTVC-G1039	m22835	2011-11-28 15:36:49	2011-11-28 15:59:29	2011-11-28 15:59:29	BoG report on chroma formats	D. Flynn (BoG coordinator)
JCTVC-G1040	m22836	2011-11-28 16:07:00	2011-11-29 14:22:16	2011-11-29 14:22:16	Non-CE4: Crosscheck of updated fine granularity QP offset (JCTVC-G850) by Intel	Y. Chiu, W. Zhang (Intel)
JCTVC-G1041	m22837	2011-11-28 16:36:31	2011-11-28 18:02:46	2011-11-28 18:36:34	BoG report on subjective viewing test for deblocking filter proposals	A. Norkin, M. Narroschke, K. Andersson, D. Flynn, X. Guo, G. v. d. Auwera
JCTVC-G1042	m22838	2011-11-28 18:00:36	2011-11-28 18:05:36	2011-11-29 18:51:58	Harmonization of the prediction and partitioning mode binarization of P and B slices	S. Oudin, B Bross, Y. Piao, J. Min, J. Park, X. Zhang, S. Liu, S. Lei, W.-J. Chien, J. Sole, M. Karczewicz
JCTVC-G1043	m22829	2011-11-28 10:35:00	2011-11-30 08:43:43	2011-11-30 08:43:43	20 years after MPEG-2	J. Song (Samsung)
JCTVC-G1044	m22839	2011-11-29 11:48:02	2011-11-29 13:58:24	2011-11-29 13:58:24	BoG report on Quantization	M. Budagavi, L. Kerofsky
JCTVC-G1045	m22841	2011-11-29 14:48:16	2011-11-29 14:58:58	2011-11-29 14:58:58	Cross-check of JCTVC-G382 (Quantization with Adaptive Reconstruction Levels) set-2 modifications	D. Flynn (BBC)
JCTVC-G1100	m22866	2011-12-04 22:31:21			Meeting report of the seventh meeting of the Joint Collaborative Team on Video Coding (JCT-VC), Geneva, CH, 21-30 Nov. 2011	G. J. Sullivan, J.-R. Ohm (JCT-VC chairs)
JCTVC-G1102	m22867	2011-12-04	2012-01-30	2012-01-30	High Efficiency Video Coding (HEVC) Test Model 5 (HM 5)	K. McCann, B. Bross, W.-J.

		22:34:48	10:57:21	11:34:52	Encoder Description	Han, S. Sekiguchi, G. J. Sullivan (Editors)
JCTVC-G1103	m22868	2011-12-04 22:36:27	2011-12-19 19:45:50	2012-01-27 09:59:09	High Efficiency Video Coding (HEVC) text specification Working Draft 5	B. Bross, W.-J. Han, G. J. Sullivan, J.-R. Ohm, T. Wiegand (Editors)
JCTVC-G1200	m22869	2011-12-04 22:38:03	2012-01-10 00:36:52	2012-01-12 23:06:08	Common HM test conditions and software reference configurations	F. Bossen (software & test condition coordinator)
JCTVC-G1201	m22848	2011-11-30 00:08:48	2011-11-30 08:30:31	2011-12-21 20:12:38	Description of Core Experiment 1 (CE1): Entropy coding investigation	R. Joshi, E. Alshina, H. Sasai, H. Kirchhofer, J. Lainema (CE coordinators)
JCTVC-G1202	m22847	2011-11-29 23:43:57	2011-11-30 08:27:34	2011-12-22 02:31:13	Description of Core Experiment 2 (CE2): Chroma RQT depth	K. Sugimoto, X. Guo, X. Wang (CE Coordinators)
JCTVC-G1203	m22852	2011-11-30 07:57:14	2011-11-30 07:58:16	2011-12-21 09:38:24	Description of Core Experiment 3 (CE3): Chroma Interpolation Filter	T. Chujoh, E. Alshina (CE Coordinators)
JCTVC-G1204	m22856	2011-11-30 08:55:03	2011-11-30 09:33:08	2012-01-10 05:16:13	Description of Core Experiment 4 (CE4): Quantization	K. Sato, M. Budagavi, M. Coban, H. Aoki, X. Li (CE coordinators)
JCTVC-G1205	m22855	2011-11-30 08:40:23	2011-11-30 08:46:37	2011-12-20 17:20:37	Description of core experiment 5 (CE5): Transform Skipping	M. Mrak, J. Sole, J. Xu, A. Saxena (CE coordinators)
JCTVC-G1206	m22851	2011-11-30 07:19:00	2011-11-30 08:12:24	2011-12-16 23:11:13	Description of Core Experiment 6 (CE6): Intra Coding Improvements	A. Tabatabai, E. Francois, K. Chono (CE coordinators)
JCTVC-G1207	m22846	2011-11-29 19:54:54	2011-11-29 22:33:45	2011-12-28 16:12:15	Description of Core Experiment 7 (CE7): Additional Transforms	R. Cohen, C. Yeo, R. Joshi, F. Fernandes (CE Coordinators)
JCTVC-G1208	m22849	2011-11-30 01:13:11	2011-11-30 01:18:36	2011-12-22 04:09:56	Description of Core Experiment 8 (CE8): Non-deblocking loop filtering	T. Yamakage, I. S. Chong, M. Narroschke, Y.-W. Huang (CE coordinators)
JCTVC-G1209	m22853	2011-11-30 08:02:30	2011-11-30 08:09:07	2012-01-09 07:44:34	Description of Core Experiment 9 (CE9): MV Coding and Skip/Merge Operations	I.-K. Kim, J. Jung, S. Oudin (CE coordinators)
JCTVC-G1210	m22850	2011-11-30 02:26:21	2011-11-30 12:53:07	2011-12-22 17:29:49	Description of Core Experiment 10 (CE10): Deblocking Filtering	A. Norkin, X. Guo, B. Jeon, M. Narroschke (CE coordinators)
JCTVC-G1211	m22854	2011-11-30 08:12:28	2011-11-30 10:39:31	2011-12-22 16:10:58	Description of Core Experiment 11 (CE11): Coefficient scanning and coding	V. Sze, T. Nguyen, K. Panusopone, Y. Piao, J. Sole (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 284 in total), were as follows:

1. Daniele Alfonso (STMicroelectronics)
2. Rik Allen (Altera Corporation)
3. Elena Alshina (Samsung Electronics)
4. Peter Amon (Siemens AG)
5. Kenneth Andersson (LM Ericsson)
6. Pierre Andrivon (Technicolor)
7. Hirofumi Aoki (NEC Corporation)
8. Oscar Au (Hong Kong University of Science and Technology)
9. Cheung Auyeung (Sony Corp.)
10. Oguz Bici (Nokia)
11. Lazar Bivolarsky (Skype)
12. Gisle Bjøntegaard (Cisco Systems Norway)
13. Philippe Bordes (Technicolor)
14. Frank Bossen (Docomo Innovations, Inc.)
15. Stephen Botzko (Polycom)
16. Jill Boyce (Vidyo, Inc.)
17. Benjamin Bross (Fraunhofer HHI)
18. Madhukar Budagavi (Texas Instruments Inc)
19. Junwon Byun (Yonsei University)
20. Peisong Chen (Broadcom Corporation)
21. Weizhong Chen (Huawei technologies Co., Ltd.)
22. Ying Chen (Qualcomm Inc.)
23. Wei-Jung Chien (Qualcomm)
24. Yi-Jen Chiu (Intel Corp.)
25. Seunghyun Cho (Electronics and Telecommunications Research Institute)
26. Dugyoung Choi (Chips&Media)
27. Hyomin Choi (Kwangwoon University (KWU))
28. Kiho Choi (Hanyang University)
29. In Suk Chong (Qualcomm)
30. Keiichi Chono (NEC)
31. Tzu-Der Chuang (MediaTek)
32. Takeshi Chujoh (Toshiba Corporation)
33. Muhammed Coban (Qualcomm Inc)
34. Robert Cohen (Mitsubishi Electric)
35. Thomas Davies (Cisco Norway (Tandberg))
36. Jan De Cock (Ghent University - IBBT)
37. Jie Dong (InterDigital Communications, LLC)
38. Alberto Duenas (Cavium, Inc.)
39. Alex Eleftheriadis (Vidyo, Inc.)
40. Semih Esenlik (Panasonic Corporation)
41. Pascal Eymery (Allegro DVT)
42. Xue Fang (Motorola Mobility)
43. Eyal Farkash (NDS)
44. Felix Fernandes (Samsung Telecommunications America)
45. David Flynn (BBC Research & Development)
46. Chad Fogg (Harmonic Inc.)
47. Rémy Foray (Allegro DVT)
48. Edouard Francois (Canon)
49. Akira Fujibayashi (NTT Docomo, Inc.)
50. Shigeru Fukushima (JVC Kenwood Corporation)
51. Arild Fuldseth (Ciso Systems Norway)
52. Wen Gao (Huawei Technologies (USA))
53. Patrick Gendron (Thomson Video Networks)
54. Christophe Gisquet (Canon Research Centre France S.A.S.)
55. Hsan Guermazi (eBrisk video Inc.)
56. Laurent Guillo (IRISA/CNRS)
57. Thomas Guionnet (IRISA / INRIA Rennes)
58. Xun Guo (MediaTek (Beijing) Inc.)
59. Antti Hallapuro (Nokia)
60. Woo-Jin Han (Kyungwon University)
61. Jong-Ki Han (Sejong University)
62. Miska Hannuksela (Nokia Corporation)
63. Munsi Haque (Sony Corporation)
64. Shinobu Hattori (Sony Corp.)
65. Yong He (InterDigital Communications Corp)
66. Dake He (Research In Motion)
67. Yun He (The MIIT of P.R.China)
68. Tim Hellman (Broadcom Corporation)
69. Hendry Hendry (LG Electronics)
70. Anastasia Henkel (Fraunhofer HHI)
71. Felix Henry (France Telecom R&D)
72. Yingjie Hong (ZTE)
73. Sung-Wook Hong (Sejong University)
74. Michael Horowitz (eBrisk Video, Inc.)
75. Shih-Ta Hsiang (MediaTek)
76. Chih-Wei Hsu (MediaTek Inc.)
77. Yu-Wen Huang (MediaTek)
78. Wai Lam Hui (The Hong Kong Polytechnic University)
79. Atsuro Ichigaya (NHK (Japan Broadcasting Corporation))
80. Kwon Jae Cheol (KT Corporation)
81. Wonkap Jang (Vidyo Inc.)
82. Byeong Moon Jeon (LG Electronics)
83. Byeungwoo Jeon (SKKU)

84. Yongjoon Jeon (LG Electronics)
85. Rajan Joshi (Qualcomm)
86. Joel Jung (Orange Labs)
87. Jiwook Jung (LG Electronics)
88. Sungwook Jung (Korean Standards Association)
89. Jewon Kang (Nokia)
90. Jung Won Kang (ETRI (Electronics and Telecommunications Research Institute))
91. Marta Karczewicz (Qualcomm)
92. Damian Karwowski (Poznan University of Technology)
93. Kei Kawamura (KDDI Corp.)
94. Kimihiko Kazui (FUJITSU LABORATORIES LTD.)
95. Louis Kerofsky (Sharp Electronics)
96. Abdellatif Khindouf (Allegro DVT)
97. Munchurl Kim (Korea Advanced Institute of Science and Technology)
98. Yonghoun Kim (Hanyang uiveristy)
99. Il-Koo Kim (Samsung Electronics Co., Ltd.)
100. Joohyeok Kim (Hanyang University)
101. Hui Yong Kim (ETRI)
102. Jongho Kim (Yonsei University)
103. Chanyul Kim (Samsung electronics. Ltd)
104. Hae Kwang Kim (Sejong University)
105. Jaeil Kim (Korea Advanced Institute of Science and Technology)
106. Kyung Yong Kim (Kyunghee University Media Lab.)
107. Jungsun Kim (LG electronics)
108. Heiner Kirchhoffer (Fraunhofer HHI)
109. Kenji Kondo (Sony Corporation)
110. Faouzi Kossentini (eBrisk Video Inc.)
111. Anand Kotra (Panasonic R&D Center Germany GmbH)
112. Jumpei Koyama (Fujitsu Labs, Ltd.)
113. Thomas Kunlin (STMicroelectronics)
114. Changcai Lai (Huawei)
115. Polin Lai (Samsung)
116. Jani Lainema (Nokia)
117. Guillaume Laroche (Canon Research Centre France S.A.S)
118. Fabrice Le Léannec (Canon Research Centre France S.A.S)
119. Ju Ock Lee (Sejong University)
120. Jae Yung Lee (Sejong University)
121. Snagyoun Lee (Yonsei University)
122. Wonjae Lee (Samsung electronics)
123. Jinho Lee (ETRI)
124. Bae-Keun Lee (KT)
125. Chulhee Lee (KCC/Yonsei)
126. Hoyoung Lee (Sungkyunkwan Univ.)
127. Sukho Lee (ETRI)
128. Jaeyong Lee (Kwangwoon University)
129. Tammy Lee (Samsung Electronics Corporation)
130. Sunyoung Lee (Pantech)
131. Shawmin Lei (MediaTek)
132. Xiang Li (MediaTek (Beijing) Inc.)
133. Guichun Li (Huawei Technologies Co. Ltd.)
134. Zhengguo Li (Institute for Infocomm Research)
135. Ming Li (ZTE Corporation)
136. Chongsoon Lim (Panasonic Corporation)
137. Jaehyun Lim (LG Electronics)
138. Sung-Chang Lim (ETRI)
139. Chun-Lung Lin (ITRI International)
140. Peter List (Deutsche Telekom)
141. Lingzhi Liu (Huawei Technologies USA)
142. Shan Liu (MediaTek)
143. Zhong Luo (Huawei Technologies)
144. Ajay Luthra (Motorola Mobility Inc.)
145. Siwei Ma (Pek)
146. Detlev Marpe (Fraunhofer HHI)
147. Gaelle Martin-Cocher (Research in Motion)
148. Ikeda Masaru (Sony Corporation)
149. Masaaki Matsumura (NTT Corporation)
150. Shohei Matsuo (NTT Corporation)
151. Ken McCann (ZetaCast/Samsung)
152. Holger Meuel (Leibniz University Hannover)
153. Akira Minezawa (Mitsubishi Electric Corporation)
154. Koohyar Minoo (Motorola Mobility Inc.)
155. Kiran Misra (Sharp Corporation)
156. Kazuyuki Miyazawa (Mitsubishi Electric Corporation)
157. Seiji Mochizuki (Renesas Electronics Corporation)
158. Dhawal Moghe (Cable Television Labs)
159. Fulvio Moschetti (European Patent Office)
160. Marta Mrak (BBC)
161. Tokumichi Murakami (Mitsubishi Electric Corporation)
162. Matteo Naccari (British Broadcasting Corporation - Research and Development)
163. Sue Mon Thet Naing (Panasonic Corporation)
164. Sei Naito (KDDI Corporation)
165. Takayuki Nakachi (NTT)
166. Hiroya Nakamura (JVC Kenwood Corporation)
167. Junghak Nam (Kwangwoon University (KWU))
168. Matthias Narroschke (Panasonic R&D Center Germany)
169. Tung Nguyen (Fraunhofer Gesellschaft)

170. Takahiro Nishi (Panasonic)
171. Andrey Norkin (Ericsson)
172. Jens-Rainer Ohm (RWTH Aachen University)
173. Patrice Onno (Canon Research Centre France S.A.S)
174. Simon Oudin (Fraunhofer HHI)
175. Krit Panusopone (Motorola Mobility)
176. Joonyoung Park (LG electronics)
177. Seungwook Park (LG Electronics)
178. Youngo Park (Samsung Electronics Co., Ltd.)
179. Dongjin Park (Chips&Media)
180. Sang-Hyo Park (Hanyang University)
181. Jiho Park (KETI)
182. Jeonghoon Park (Samsung Electronics Co., Ltd.)
183. Nicolas Pellerin (ST microelectronics)
184. Wen-Hsiao Peng (ITRI International/NCTU)
185. Isabelle Perroux (Allegro DVT)
186. Yinji Piao (Samsung Electronics)
187. Matthias Preiß (Fraunhofer Heinrich Hertz Institut (HHI))
188. Mohamad Raad (RaadTech Consulting)
189. Shevach Riabtsev (CSR)
190. Justin Ridge (Nokia Oyj)
191. Arturo Rodriguez (Cisco Systems)
192. Francisco Javier Roncero (Cavium, Inc.)
193. Christopher Rosewarne (CANON Inc)
194. Dmytro Rusanovskyy (Nokia)
195. Thomas Rusert (Ericsson AB)
196. James Russell (Altera Corporation)
197. Shinichi Sakaida (NHK)
198. Jesus Sampedro (Polycom)
199. Jonatan Samuelsson (Telefonaktiebolaget LM Ericsson)
200. Hisao Sasai (Panasonic)
201. Kazushi Sato (Sony Corp.)
202. Nicholas Saunders (Broadcast & Professional Research Labs, Sony Europe Ltd)
203. Ankur Saxena (Samsung Telecommunication America)
204. Thomas Schierl (Fraunhofer Heinrich Hertz Institute)
205. Heiko Schwarz (Fraunhofer Gesellschaft zur Förderung der angewandten Forschung (FGFF))
206. Andrew Segall (Sharp Corporation)
207. Shun-Ichi Sekiguchi (Mitsubishi Electric Corporation)
208. Stian Selnes (Cisco Systems)
209. Vadim Seregin (Qualcomm Incorporated)
210. Osman Gokhan Sezer (Texas Instruments Inc.)
211. Karl Sharman (Broadcast & Professional Research Labs, Sony Europe Ltd.)
212. Bz (bazhong) Shen (Broadcom)
213. Masato Shima (Canon Inc.)
214. Satoshi Shimada (Fujitsu Labs, Ltd.)
215. Donggyu Sim (Kwangwoon University)
216. Didier Siron (STMicroelectronics)
217. Rickard Sjöberg (Telefonaktiebolaget LM Ericsson)
218. Joel Sole (Qualcomm)
219. Eunyong Son (LG Electronics)
220. Jakub Stankowski (Poznan University of Technology)
221. Karsten Suehring (Fraunhofer HHI)
222. Kazuo Sugimoto (Mitsubishi Electric Corporation)
223. Toshiyasu Sugio (Panasonic Corporation)
224. Gary Sullivan (Microsoft Corporation)
225. Huifang Sun (Mitsubishi Electric Research Labs)
226. Jaewon Sung (LG Electronics)
227. Yoshinori Suzuki (NTT Docomo, Inc.)
228. Teruhiko Suzuki (Sony Corp.)
229. Vivienne Sze (Texas Instruments)
230. Ali Tabatabai (Sony Electronics)
231. Yoshitomo Takahashi (Sony Corporation, Sony City Osaki)
232. Seishi Takamura (NTT Cyber Space Laboratories, NTT Corporation)
233. Thiow Keng Tan (NTT Docomo, Inc)
234. Akiyuki Tanizawa (TOSHIBA Corporation)
235. Herbert Thoma (Fraunhofer IIS)
236. Ikai Tomohiro (Sharp Corporation)
237. Pankaj Topiwala (FastVDO LLC)
238. Matsunobu Toru (Panasonic)
239. Cong-Thang Truong (University of Aizu)
240. Yi-Shin Tung (MStar Semiconductor, Inc. / ITRI International Inc.)
241. Kemal Ugur (Nokia)
242. Geert Van Der Auwera (Qualcomm Inc.)
243. Glenn Van Wallendael (Ghent University - IBBT - Multimedia Lab)
244. Jérôme Vieron (ATEME)
245. Viktor Wahadaniah (Panasonic Corporation)
246. Wade Wan (Broadcom Corporation)
247. Xianglin Wang (Qualcomm Inc.)
248. Yunfei Wang (Tsinghua University)
249. Jing Wang (Research In Motion Limited)
250. Dong Wang (ZTE Corporation)
251. Ye-Kui Wang (Qualcomm Incorporated)
252. Thomas Wedi (Panasonic)
253. Xing Wen (Hong Kong Univeristy of Science and Technology)
254. Stephan Wenger (Vidyo)
255. Thomas Wiegand (FGFF)

256. Mathias Wien (RWTH Aachen University)
257. Kwanghyun Won (Sungkyunkwan University (SKKU))
258. Stewart Worrall (Aspex Semiconductor)
259. Ping Wu (ZTE (UK) Ltd)
260. Jizheng Xu (Microsoft Corp.)
261. Tomoo Yamakage (Toshiba Corporation)
262. Tomoyuki Yamamoto (Sharp Corporation)
263. Sevlgi Yang (Yonsei University)
264. Haitao Yang (Huawei Technologies Co., Ltd.)
265. Yan Ye (InterDigital Communications)
266. Sehoon Yea (LG Electronics)
267. Chuohao Yeo (Institute for Infocomm Research)
268. Sang Yong Yi (Korea Aerospace University)
269. Tan Yih Han (Institute for Infocomm Research)
270. Peng Yin (Dolby Laboratories, Inc.)
271. Shibahara Youji (Panasonic Corporation)
272. Yue Yu (Motorola Mobility)
273. Yong Yu (Broadcom Corp)
274. Haoping Yu (Huawei Technologies (USA))
275. Lu Yu (Zhejiang University)
276. Yichen Zhang (Zhejiang University)
277. Wenhao Zhang (Intel Corporation)
278. Xingyu Zhang (Hong Kong Univeristy of Science and Technology)
279. Wen Zhang (ZTE)
280. Louis (Lei) Zhang (AMD)
281. Xiaozhen Zheng (Huawei Technologies)
282. Minhua Zhou (Texas Instruments Inc)
283. Xiaosong Zhou (Apple Inc.)
284. Hongbo Zhu (None)